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The 2011 International Joint Conference on Neural Networks

Final Program

July 31 – August 5, 2011
Doubletree Hotel
San Jose, California, USA

Sponsored by:

International Neural Network Society

IEEE Computational Intelligence Society

The 2011 International Joint Conference on Neural Networks

IJCNN 2011 Conference Proceedings

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Print Edition:
IEEE Catalog Number: CFP11IJS-PRT
ISBN: 978-1-4577-1086-5
ISSN: 2161-4393

CD Edition:
IEEE Catalog Number: CFP11IJS-CDR
ISBN: 978-1-4244-9636-5

Welcome from the General Chair

On behalf of the Organizing Committee, I welcome you to the 2011 International Joint Conference on Neural Networks (IJCNN 2011) in San Jose, California. This conference continues the tradition of joint sponsorship of IJCNN by the International Neural Network Society (INNS) and the IEEE Computational Intelligence Society (IEEE-CIS). This collaboration has produced many successful meetings in past years, and this year's meeting is no exception. I would like to thank the leadership of both organizations, and particularly the Presidents, Ron Sun and Gary Yen, for making this possible.

It is fitting that IJCNN is being held in the heart of Silicon Valley just as new technologies are creating a truly fruitful integration of neural information processing and neuromorphic hardware along many dimensions ranging from brain-scale computational systems and memristor technology to neural implants and brain-machine interfaces. This fusion of biology and engineering is the key theme of IJCNN 2011, and is prominent in many aspects of the conference. The most notable of these is a special day-long symposium called "From Brains to Machines," organized with the generous sponsorship of the National Science Foundation (NSF). This symposium brings together some of the leading researchers working to understand the brain and produce brain-like intelligence in machines. In addition to this keynote symposium, the conference theme is also reinforced by extended tracks of invited and contributed talks and panels on neuromorphic systems – especially memristor technology – and autonomous intelligent systems. The plenary talks by Stefan Schaal, Juergen Schmidhuber, Michael Arbib, Dharmendra Modha, Leon Glass, and Andrew Ng also reflect the broad themes of cognition and intelligence, and go beyond traditional neural networks into areas like embodied robotics, data mining, nanotechnology, cognition and creativity, culminating in a featured plenary session entitled "The Emergence of Mind" with talks by Walter Freeman, Stephen Grossberg, and Bernard Baars. The tutorials and workshops also cover a broad range of themes and topics. All in all, this is probably one of the most interdisciplinary IJCNNs in recent years.

A special – if somber – event at IJCNN 2011 is a special plenary session convened to remember one of the pioneers in the field of neural networks, David Rumelhart, who passed away in March 2011. The session, will include remembrances by colleagues, friends and family, and a technical talk by Michael Jordan who worked with David Rumelhart in the 1990s.

This year's IJCNN is also trying out a new experiment, allowing authors in the areas of neuroscience and neurocognition (broadly interpreted) to submit abstracts rather than full papers. The goal was to elicit submissions from research communities where writing full-length papers for a conference is not standard practice. The experiment has been successful in that 85 abstracts were submitted to the conference, of which 53 (64%) are included in the final program. In addition to these, we also received 620 full paper submissions, of which 468 (75%) are in the program. The final program has 521 oral and poster presentations plus 21 invited or plenary presentations, 20 tutorial sessions, and 10 post-conference workshop sessions.

Putting together a meeting of the scope and size of IJCNN is a monumental task – and one to which all members of the Organizing Committee have contributed both effort and judgment. Above all, I would like to thank my colleagues on the conference Executive Committee – Hava Siegelmann, the Program Chair, and the two Technical Co-Chairs, Michael Georgiopoulos and Cesare Alippi – whose willing dedication made the organization of the conference a pleasure rather than a duty. A most special thanks is due to Steve Bressler (Special Sessions Chair) for his heroic work in helping obtain NSF funding and putting together the "From Brains to Machines" symposium in addition to fulfilling his duties as the Special Sessions Chair. I also thank all other members of the Organizing Committee for their great help – in particular Marios Polycarpou (Publications Chair), Georgios Anagnostopoulos (Registration Chair), Robert Kozma (Tutorials Chair), Robi Polikar (Workshops Chair), Simona Doboli (Panels Chair), Risto Miikkulainen (Plenary Chair), Tom Cholewo (Web Reviews Chair), and Kun Tu (Webmaster), all of whom put in a special effort towards the meeting's success. Thanks are also due to Sven Crone and Isabelle Guyon for organizing a wonderful set of competitions whose results we look forward to seeing at the conference. Several members of the Organizing Committee – notably Irwin King, Yoonsuck Choe, Haibo He, and Manuel Roveri – worked very actively to publicize the conference in various forums, for which I am grateful. All members of the Program Committee and all reviewers also deserve great appreciation for providing discerning and timely reviews of over 700 submissions. I am also very grateful for the support I have received from many members of the INNS Board of Governors, and especially for sage advice from the Vice-President for Conferences, Danil Prokhorov. Finally, I would like to thank the organizational team at The Rees Group led by Jane Shepard, without whose work the meeting would have been infinitely harder to organize.

As in past years, INNS and IEEE-CIS have provided support for many students to attend the conference. This year, the support has been supplemented by a grant from NSF to encourage more students – especially women, under-represented minorities, and students from undergraduate institutions. We hope that IJCNN will continue to serve as a place where young researchers can find both knowledge and inspiration.

Three decades ago, the computer revolution took root and flourished in the fertile soil of what came to be known as Silicon Valley. It is appropriate that today, those who are igniting another technological revolution to create truly life-like intelligence have assembled in the heart of Silicon Valley once again to exchange ideas and celebrate the future.

I wish you a wonderful, productive, and pleasant IJCNN 2011.

Ali A. Minai, General Chair – IJCNN 2011
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- Minho Lee
- Vincent Lemaire
- Alessio Leoncini
- Davide Leoncini
- Philippe Leray
- Stefan Lessmann
- Dan Levine
- Pierre Levy
- Baichuan Li
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- Heejin Lim Lim
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- Daw-Tung Lin
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- Tran Hoai Linh
- Paulo Lisboa
- Huaping Liu
- Jindong Liu
- Jing Liu
- Qingfang Liu
- RuoQian Liu
- Tianming Liu
- Yu Liu
- James T. Lo
- Giosue' Lo Bosco
- Victor Lobo
- Chu Kiong Loo
- Andras Lorincz
- Andre Lourenco
- Carlos Lourenco
- Christopher Lowrie
- Diego G. Loyola
- Teresa Bernarda Ludermir
- Xiao Luo
- Elbert Macau
- Danilo Maccio'
- Chris Macnab
- Yutaka Maeda
- Marco Maggini
- Babak Mahmoudi
- Valeri Makarov
- Mary Malliaris
- Jordan Malof
- James Malone
- Jacek Mandziuk
- Olivier F.L. Manette
- Timothy Mann
- Daniel Manrique
- Francesco Marcelloni
- Luca Marchese
- Lukashevich Marina
- Tomasz Markiewicz
- Ken Marko
- Davide Marocco
- Salvatore Marra
- Eugenio Martinelli
- Jose D. Martin-Guerrero
- Antonio Marullo
- Satoshi Matsuda
- Masakazu Matsugu
- Nobuyuki Matsui
- Tetsuo Matsui
- Matteo Matteucci
- John Matthias
- Jay McClelland
- Liam McDaid
- Yan Meng
- Anke Meyer-Baese
- Jun Miao
- Alessio Micheli
- Gaolin Milledge
- Selim Mimaroglu
- Ali Minai
- Marco Mirolli
- Pinaki Mitra
- Mingzhen Mo
- Rafael Molina
- Gabriele Monfardini
- Oscar Montiel
- Alfonso Montuori
- Sangwoo Moon
- Saber Moradi
- Behzad Moshiri
- Douglas Mota
- Henning Mueller
- Daniel Nehme Muller
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- John Murray
- Lebbah Mustapha

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- Shingo Nakamura
- Ryohei Nakano
- Boo Hee Nam
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- Arun Narayanan
- Andrew Neel
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- Michael Oakes
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- Erkki Oja
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- Luiz Oliveira
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- Takashi Onoda
- Jeff Orchard
- Christos Orovas
- James O'Shea
- Stanislaw Osowski
- Mohamed Oubbati
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- Seichi Ozawa
- Umut Ozertem
- Ari Paasio
- Theodore Pachidis
- Antonio Paiva
- Dmitriy Paliy
- Yaozhang Pan
- Dimokritos Panagiotopoulos
- Stelios Papadakis
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- Francesco Pappalardo
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- Kamban Parasuraman
- Jungme Park
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- Krzysztof Patan
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- Edward Sazonov
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- Germano Crispim Vasconcelos
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- David Verstraeten
- Stephen Verzi
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- Thierry Vieville
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- Alessandro Villa
- Jose Antonio Villacorta
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- Craig Vineyard
- Julien Vitay
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- Bogdan Vrusias
- Hiroaki Wagatsuma
- Julie Wall
- Wan Ahmad Tajuddin Wan Abdullah
- Ding Wang
- Jeen-Shing Wang
- Lipo Wang
- Shaojun Wang
- Xiao-Feng Wang
- Ying Wang
- Yuxuan Wang
- Zhanshan Wang
- Zhenhai Wang
- Qinglai Wei
- John Weng
- Paul Werbos
- Joerg D. Wichard
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- Rodolfo Zunino
- Xingquan Zuo

This list only includes reviewers who submitted at least one completed review, regardless of whether the reviewed paper was accepted, rejected, or withdrawn for the final proceedings.

Conference Topics

1 NEURAL NETWORK MODELS
- 1a Feedforward neural networks
- 1b Recurrent neural networks
- 1c Self-organizing maps
- 1d Radial basis function networks
- 1e Attractor neural networks and associative memory
- 1f Modular networks
- 1g Fuzzy neural networks
- 1h Spiking neural networks
- 1i Reservoir networks (echo-state networks, liquid-state machines, etc.)
- 1j Large-scale neural networks
- 1k Other topics in artificial neural networks

2 MACHINE LEARNING
- 2a Supervised learning
- 2b Unsupervised learning and clustering, (including PCA, and ICA)
- 2c Reinforcement learning
- 2d Probabilistic and information-theoretic methods
- 2e Support vector machines and kernel methods
- 2f EM algorithms
- 2g Mixture models, ensemble learning, and other meta-learning or committee algorithms
- 2h Bayesian, belief, causal, and semantic networks
- 2i Statistical and pattern recognition algorithms
- 2j Visualization of data
- 2k Feature selection, extraction, and aggregation
- 2l Evolutionary learning
- 2m Hybrid learning methods
- 2n Computational power of neural networks
- 2o Other topics in machine learning

3 NEURODYNAMICS
- 3a Dynamical models of spiking neurons
- 3b Synchronization and temporal correlation in neural networks
- 3c Dynamics of neural computation
- 3d Chaotic neural networks
- 3e Itinerant dynamics in neural systems
- 3f Neural oscillators and oscillator networks
- 3g Dynamics of attractor networks
- 3h Dynamics of analog networks
- 3i Other topics in neurodynamics

4 COMPUTATIONAL NEUROSCIENCE
- 4a Models of large-scale networks in the nervous system
- 4b Models of neurons and local circuits
- 4c Models of synaptic learning and synaptic dynamics
- 4d Models of neuromodulation
- 4e Brain imaging
- 4f Analysis of neurophysiological and neuroanatomical data
- 4g Cognitive neuroscience
- 4h Models of neural development
- 4i Models of neurochemical processes
- 4j Neuroinformatics
- 4k Other topics in computational neuroscience

5 NEURAL MODELS OF PERCEPTION, COGNITION, AND ACTION
- 5a Neurocognitive networks
- 5b Cognitive architectures
- 5c Models of conditioning, reward and behavior
- 5d Cognitive models of decision-making
- 5e Embodied cognition
- 5f Cognitive agents
- 5g Multi-agent models of group cognition
- 5h Developmental and evolutionary models of cognition
- 5i Visual system
- 5j Auditory system
- 5k Olfactory system
- 5l Other sensory systems
- 5m Attention
- 5n Learning and memory
- 5o Spatial cognition, representation and navigation
- 5p Semantic cognition and language
- 5q Neural models of symbolic processing
- 5r Reasoning and problem-solving
- 5s Working memory and cognitive control
- 5t Emotion and motivation
- 5u Motor control and action
- 5v Dynamical models of coordination and behavior
- 5w Consciousness and awareness
- 5x Models of sleep and diurnal rhythms
- 5y Mental disorders
- 5z Other topics in neural models of perception, cognition and action

6 NEUROENGINEERING
- 6a Brain-machine interfaces
- 6b Neural prostheses
- 6c Neuromorphic hardware
- 6d Embedded neural systems
- 6e Other topics in neuroengineering

7 BIO-INSPIRED AND BIOMORPHIC SYSTEMS
- 7a Brain-inspired cognitive architectures
- 7b Embodied robotics
- 7c Evolutionary robotics
- 7d Developmental robotics
- 7e Computational models of development
- 7f Collective intelligence
- 7g Swarms
- 7h Autonomous complex systems
- 7i Self-configuring systems
- 7j Self-healing systems
- 7k Self-aware systems

Conference Topics - *continued*

7l Emotional computation
7m Artificial life
7n Other topics in bio-inspired and biomorphic systems

8 APPLICATIONS
8a Bioinformatics
8b Biomedical engineering
8c Data analysis and pattern recognition
8d Speech recognition and speech production
8e Robotics
8f Neurocontrol
8g Approximate dynamic programming, adaptive critics, and Markov decision processes
8h Neural network approaches to optimization
8i Signal processing, image processing, and multi-media
8j Temporal data analysis, prediction, and forecasting; time series analysis
8k Communications and computer networks
8l Data mining and knowledge discovery
8m Power system applications
8n Financial engineering applications
8o Military and security applications
8p Applications in multi-agent systems and social computing
8q Manufacturing and industrial applications
8r Expert systems
8s Clinical applications
8t Other applications

9 CROSS-DISCIPLINARY TOPICS
9a Hybrid intelligent systems
9b Swarm intelligence
9c Sensor networks
9d Quantum computation
9e Computational biology
9f Molecular and DNA computation
9g Computation in tissues and cells
9h Artificial immune systems
9i Computational intelligence in Earth and environmental sciences
9j Other cross-disciplinary topics

C COMPETITIONS
Ca Detecting driver drowsiness (Ford challenge 2)
Cb Predicting connections in a social network (Kaggle Social Network Competition)
Cc Recognizing German traffic signs (Uni Bochum Traffic Sign Benchmark)
Cd Forecasting transportation data (NNGC, Neural Net Grand Challenge in Forecasting)
Ce Benchmark for unsupervised learning and transfer learning algorithms (Clopinet UTL Challenge)

S SPECIAL SESSIONS
S02 Biologically Inspired Computational Vision
S03 Consciousness-Driven Vision: Toward a Breakthrough in Bio-Inspired Computer Vision
S04 Memristor Minds: Current and Future Applications of Memristor in Artificial Intelligence
S05 Modeling of Socio-Cultural and Linguistic Phenomena
S06 Neural Network Models and Human Nature
S07 Complex-Valued Neural Networks
S08 Emerging Neuromorphic Hardware Architectures and Applications
S09 Embodied and Developmental Robotics
S10 Hybrid Neural Intelligent Systems
S11 Intelligent Sensor Networks
S12 Intelligent Embedded Systems
S13 Computational Intelligence for Smart Grid and Energy Applications
S17 Cognitive and Computational Intelligence Research in Driver Fatigue and Distraction
S19 Computational Intelligence in Direct Support of Patient Care
S20 Automated Supervised and Unsupervised Learning
S21 Autonomous Learning of Object Representation and Control
S22 Autonomous Social Learning and Knowledge Representation
S23 Brain-Mind Architectures and Learning Mechanisms
S25 Autonomous and Incremental Learning (AIL)
S26 Neuro-Cognitive Modelling of Auditory Perception, Learning, and Speech Understanding
S27 Concept Drift and Learning Dynamic Environments
S28 Computational Social Neuroscience

Abstracts

Neural dynamics
Sensory systems
Motor systems
Cognition
Models of learning and memory
Molecular and cellular processes
Neuromodulation
Neuroinformatics
Neurocognitive networks
Neuroevolution and development
Brain-machine interfaces
Neural prostheses
Models of neurological diseases and treatments
Systems and computational biology
Neuromorphic hardware and memristors

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Welcome Message from the President of INNS

It is my distinct pleasure and honor to welcome all contributors, presenters, exhibitors, and attendees to IJCNN 2011, in San Jose, California.

The IJCNN 2011 conference reflects the INNS mission as a truly international, interdisciplinary, and inclusive scientific and professional society. The exciting IJCNN 2011 technical program covers fields as diverse as neuroscience, cognitive science, neuroinformatics, bioinformatics, artificial neural network models and systems, brain-like computing, machine learning, pattern recognition, image processing, vision, control, brain-computer interface, applications of neural networks in science, engineering, business, and many other areas. New, emerging research topics will certainly be covered.

Continuing the long-standing cooperation between the International Neural Network Society and the IEEE Computational Intelligence Society, this conference is jointly sponsored by both. Together, and with the cooperation of other international societies, we have ensured that IJCNN would remain the premier conference in the broad field of neural networks.

The Society is always looking for opportunities to help and support our communities. Recently, two new regional chapters have been added or significantly expanded. New measures have been approved by the Board to strengthen the activities of regional chapters and special interest groups. A new membership survey is in the working. A new magazine is also being planned.

To ensure that IJCNN remains a top-notch venue for the dissemination of new results in neural network research, we also continue to look for new ways of improving its organization. For the sake of better serving our communities, some of these new ways adopted by this year's conference organizers include: a new, abstract-only submission category; a special day-long symposium "From Brains to Machines", featuring invited talks and panel discussions in neuroscience, cognitive science, cognitive computing and embodied systems, sponsored by the National Science Foundation.

At this conference, I am also proud to present the prestigious INNS awards for 2011 as follows:

- Hebb Award: Paul Werbos
- Helmholtz Award: Jack Cowan
- Gabor Award: Robert Kozma
- INNS Young Investigator Award: Damien Coyle and Weifeng Liu

Our goals to understand information processing in the brain and to create powerful brain-like machines for solving complex problems of the 21st century are challenging and rewarding, With our collective efforts, significant progress will be made in the future as in the past.

Finally, I wish to thank the organizing team led by Ali Minai and Hava Sieglemann for their diligence and hard work, our sponsors for their financial and other contributions, and all attendees for their participation.

Ron Sun, President of INNS
Cognitive Science Department
Rensselaer Polytechnic Institute

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- Enrique H. Ruspini
- Lipo Wang
- Jacek M. Zurada

Welcome Message from the President of the IEEE Computational Intelligence Society

On behalf of IEEE Computational Intelligence Society (IEEE CIS), I would like to send my highest regard to the organizing committee of the *2011 International Joint Conference on Neural Network* (IJCNN). Many of its leading figures represent the best minds we treasure in this community. In particular, I want to pay my tribute to the General Chair, Ali Minai, for another very successful IJCNN in its 20+ years of history. Congratulations!

In looking back, the IJCNN has sustained over a long period of time, providing a forum for researchers from around the world to share common interest and to rekindle lifetime friendships. Active participation from the members of IEEE CIS and International Neural Network Society (INNS) plays a key role to sustain the continuing growth of this technical event for many years from the past and to come.

IEEE CIS's current activities are well represented by its publications and conferences. *IEEE Transactions on Neural Networks and Learning Systems* (name changed beginning 2012), *IEEE Transactions on Fuzzy Systems*, and *IEEE Transactions on Evolutionary Computation* routinely rate high in their respective categories at ISI (Institute for Scientific Information). *IEEE Computational Intelligence Magazine*, *IEEE Transactions on Computational Intelligence and AI in Games*, and *IEEE Transactions on Autonomous Mental Development,* as newer additions, have paved paths to a greater success in years to come. Our main conferences in addition to IJCNNs, the *IEEE International Conference on Fuzzy Systems* (FUZZ-IEEE), and the *IEEE Congress on Evolutionary Computation* (IEEE CEC) each continue to showcase well-regarded peer-reviewed technical contributions and attract growing participation from around the world. These three meetings join force even-years in the *IEEE World Congress on Computational Intelligence* (IEEE WCCI). Additionally, the bi-annual *IEEE Symposium Series on Computational Intelligence* (IEEE SSCI) held in every odd-year has witnessed overwhelming success, featuring a large number of concurrent symposia in specialized topics.

Our technical activities are catered by eleven technical committees and many task forces that comprise of over 1,000 active volunteers. Leading researchers are encouraged to participate in these working groups to help shape the strategic and tactical advances that are required for our society to flourish. It is through the concerted efforts of motivated individuals and these grassroot organizations that novel ideas are born, new symposia are initiated, and special issues of our transactions are proposed.

In conclusion, I personally send my best wishes to every attendee. It is YOU and your peers who collectively define the quality of this technical event as an author, a reviewer, a presenter, and an attendee. I am looking forward to meeting many of you in San Jose, California, for 2011 IJCNN.

Gary G. Yen, President
IEEE Computational Intelligence Society (2010-2011)

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Conference Information

Registration
Registration for the conference will be open at the following times in the Gateway Foyer on the 2nd floor of the San Jose DoubleTree Hotel:

Sunday, July 31 .....7:00 a.m.-5:00 p.m.
Monday, August 1.....7:30 a.m.-5:00 p.m.
Tuesday, August 2.....7:30 a.m.-5:00 p.m.
Wednesday, August 3 .....8:00 a.m.-5:00 p.m.
Thursday, August 4.....8:00 a.m.-2:00 p.m.

Internet Access
Free Wi-Fi Internet access is available in most parts of the hotel lobby.

Speaker Ready Room
The Speaker Ready Room is located in the San Simeon Room on the lobby level of the hotel. Please stop by prior to your presentation to preview your slides and review your presentation. The Speaker Ready Room will be open at the following times:

Monday, August 1.....7:00 a.m.-5:00 p.m.
Tuesday, August 2.....7:00 a.m.-5:00 p.m.
Wednesday, August 3 .....7:00 a.m.-5:00 p.m.
Thursday, August 4.....7:00 a.m.-12:00 noon

Conference Badges
Please wear your badge to all IJCNN 2011 functions. It will admit you to the sessions and the exhibit area.

Poster Sessions
If you are presenting a poster at the IJCNN meeting, please review the schedule carefully and be sure to assemble and tear down your poster when indicated:

General Poster Session A

Monday, August 1 – Bayshore Ballroom
Setup Posters: 1:00 p.m.-3:10 p.m.
Match the poster number from the program book to the number in the upper corner of the poster board.

Poster Viewing: 3:10 p.m.-7:30 p.m.
Posters available for attendees to visit.

Poster Authors Present: 7:30 p.m.-9:00 p.m.
Presenters available at their poster for presentation and discussion with attendees.

Tuesday, August 2 – Bayshore Ballroom
Poster Viewing: 8:00 a.m.-10:00 a.m.
Remove Posters: 10:00 a.m.-11:00 a.m

General Poster Session B &
Competition Poster Session C

Tuesday, August 2 – Bayshore Ballroom
Setup Posters: 1:00 p.m.-3:10 p.m.
Match the poster number from the program book to the number in the upper corner of the poster board.

Poster Viewing: 3:10 p.m.-6:20 p.m.
Posters presentations available for attendees to visit.

Poster Authors Present: 7:30 p.m.-9:00 p.m.
Presenters available at their poster for presentation and discussion with attendees.

Wednesday, August 3 – Bayshore Ballroom
Poster Viewing: 8:00 a.m.-10:00 a.m.
Remove Posters: 10:00 a.m.-11:00 a.m

Exhibits
Plan to spend time in the Bayshore Ballroom, visiting with exhibitors at IJCNN 2011. Refreshment breaks and poster sessions will be located adjacent to the exhibit area. The exposition will be open at the following times:

Monday, August 1..... 3:00 p.m.-9:00 p.m.
Tuesday, August 2.....9:00 a.m.-9:00 p.m.
Wednesday, August 3 .....9:00 a.m.-1:00 p.m.

Conference Exhibitors

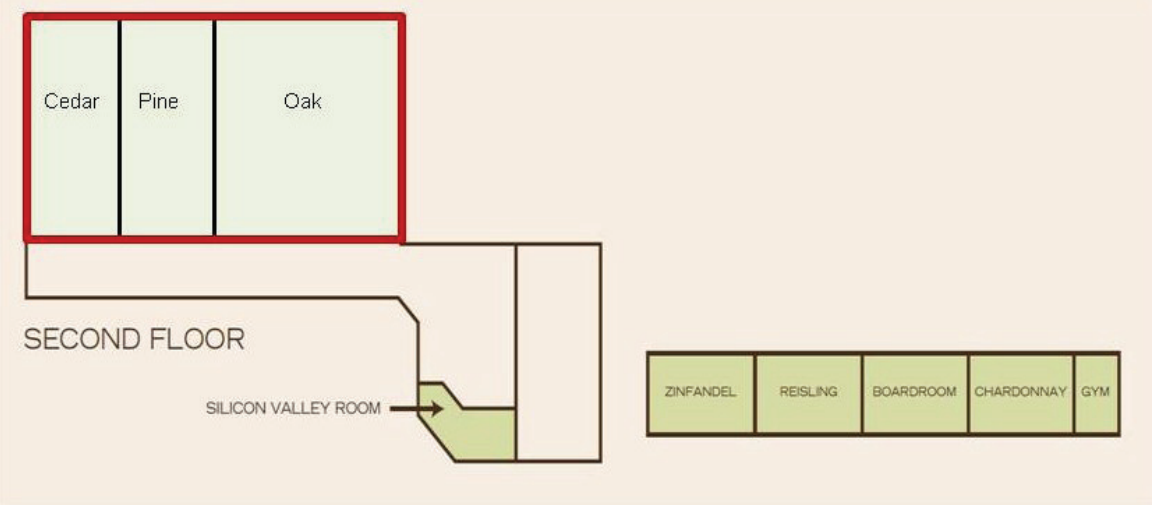
- International Neural Network Society
- IEEE Computational Intelligence Society
- Cognimem Technologies, Inc.
- School of Electronic & Computing Systems, CEAS, University of Cincinnati
- Elsevier
- Springer
- 3Scan (3D Brain Imaging, Reconstruction, and Connectivity)
- Brain Networks Laboratory, Texas A&M University
- Real-Time Power and Intelligent Systems Laboratory, Missouri University of Science & Technology
- Okinawa Institute of Science and Technology

Hotel Maps

All IJCNN activities will take place at the Lobby Level and the Second Floor of the San Jose Doubletree Hotel. The rooms used for these activities are bordered in red in the maps below.

Lobby Level:

Second Floor:



The Banquet will be held in the Gateway Ballroom, which is the combination of the Cedar, Pine, and Oak Rooms.

IJCNN 2011 Schedule-at-a-Glance

Sunday, July 31, 2011

7:00 a.m.-5:00 p.m.	Registration	Gateway Ballroom Foyer
8:00 a.m.-10:00 a.m.	Tutorial T1: Signal Processing & Machine Learning Approaches in Brain-Machine Interfaces	Cedar
8:00 a.m.-10:00 a.m.	Tutorial T2: Adaptive Critic Designs	Monterey
8:00 a.m.-10:00 a.m.	Tutorial T3: Introduction to the Evaluation of Neural Networks and Other Decision Functions	Carmel
8:00 a.m.-10:00 a.m.	Tutorial T4: Dynamic Logic	San Martin
8:00 a.m.-10:00 a.m.	Tutorial T5: Complex-Valued Neural Networks: New Trends & Applications	San Simeon
10:30 a.m.-12:30 p.m.	Tutorial T6: Neuropercolation & Neurodynamics	Cedar
10:30 a.m.-12:30 p.m.	Tutorial T7: Advanced Computational and Learning Methods for Smart Grid	Monterey
10:30 a.m.-12:30 p.m.	Tutorial T8: Evolving Neural Networks	Carmel
10:30 a.m.-12:30 p.m.	Tutorial T9: Computational Social Science I: Sociodynamics	San Martin
10:30 a.m.-12:30 p.m.	Tutorial T10: Learning Deep Architectures and Applications	San Simeon
12:30 p.m.-1:30 p.m.	Lunch Break (on your own)	
1:30 p.m.-3:30 p.m.	Tutorial T11: Cognitive Memory	Cedar
1:30 p.m.-3:30 p.m.	Tutorial T12: Brain-Like Prediction, Decision, and Control	Monterey
1:30 p.m.-3:30 p.m.	Tutorial T13: Advanced Methodologies for Learning Sparse Data	Carmel
1:30 p.m.-3:30 p.m.	Tutorial T14: Computational Social Science II: Social Systems	San Martin
1:30 p.m.-3:30 p.m.	Tutorial T15: Conformal Predictions for Reliable Machine Learning	San Simeon
4:00 p.m.-6:00 p.m.	Tutorial T16: Autonomous Machine Learning	Cedar
4:00 p.m.-6:00 p.m.	Tutorial T18: Ensemble Learning Through Diversity Management	Carmel
4:00 p.m.-6:00 p.m.	Tutorial T19: Effective Modeling of the Time Domain in Neural Networks	San Martin
4:00 p.m.-6:00 p.m.	Tutorial T20: Stochastic Artificial Neurons and Neural Networks	San Simeon
6:30 p.m.-8:00 p.m.	Opening Reception	Pine

Monday, August 1, 2011

7:00 a.m.-5:00 p.m.	Speaker Ready Room	San Simeon
7:30 p.m.-5:00 p.m.	Registration	Gateway Ballroom Foyer
8:00 a.m.-9:00 a.m.	Plenary Talk Mo-Plen1: Learning Motor Skills in Humans and Humanoids, *Stefan Schaal*	Oak
9:00 a.m.-9:30 a.m.	Refreshment Break/Visit the Exhibits	Bayshore Ballroom
9:30 a.m.-11:30 a.m.	Special Session Mo1-1: Embodied and Developmental Robotics	Cedar
9:30 a.m.-11:30 a.m.	Session Mo1-2: Recurrent Networks	Pine
9:30 a.m.-11:30 a.m.	Special Session Mo1-3: Autonomous and Incremental Learning (AIL)	Oak
9:30 a.m.-11:30 a.m.	Session Mo1-4: Neurocontrol I: Methods	Monterey
9:30 a.m.-11:30 a.m.	Session Mo1-5: Supervised, Unsupervised, and Ensemble Learning	Carmel
9:30 a.m.-11:30 a.m.	Session Mo1-6: Feature Extraction	Santa Clara
11:40 a.m.-12:40 p.m.	Special Session Mo2-1: Hybrid Intelligent Systems	Cedar
11:40 a.m.-12:40 p.m.	Session Mo2-2: Models of Neurobiological Disorders	Pine
11:40 a.m.-12:40 p.m.	Special Session Mo2-3: Neuro-Cognitive Modelling of Auditory Perception, Learning, and Speech Understanding	Oak
11:40 a.m.-12:40 p.m.	Session Mo2-4: Neurocontrol II: Applications	Monterey
11:40 a.m.-12:40 p.m.	Session Mo2-5: Clustering	Carmel
11:40 a.m.-12:40 p.m.	Session Mo2-6: Music Recognition & Generation	Santa Clara
12:40 p.m.-1:50 p.m.	Lunch Break (on your own)	
1:50 p.m.-2:50 p.m.	Plenary Talk Mo-Plen2: Neural Network ReNNaissance, *Juergen Schmidhuber*	Oak
2:50 p.m.-9:00 p.m.	Exhibits Open	Bayshore Ballroom
2:50 p.m.-3:20 p.m.	Refreshment Break/Visit the Exhibits	Bayshore Ballroom
3:20 p.m.-5:20 p.m.	Special Session Mo3-1: Emerging Neuromorphic Hardware: Architectures and Applications	Cedar
3:20 p.m.-5:20 p.m.	Session Mo3-2: Reinforcement Learning I	Pine
3:20 p.m.-5:20 p.m.	Special Session Mo3-3: Brain-Mind Architectures and Learning Mechanisms	Oak
3:20 p.m.-5:20 p.m.	Session Mo3-4: Bayesian Systems	Monterey
3:20 p.m.-5:20 p.m.	Session Mo3-5: Visualization	Carmel
3:20 p.m.-5:20 p.m.	Session Mo3-6: Signal Processing in Biology and Engineering	Santa Clara
5:30 p.m.-6:30 p.m.	Special Session Mo4-1: Intelligent Embedded Systems	Cedar
5:30 p.m.-6:30 p.m.	Session Mo4-2: Reinforcement Learning II	Pine
5:30 p.m.-6:30 p.m.	Special Session Mo4-3: Autonomous Learning of Object Representation and Control	Oak
5:30 p.m.-6:30 p.m.	Session Mo4-4: Cognitive Systems	Monterey
5:30 p.m.-6:30 p.m.	Panel Session Mo4-5: Undergraduate Education in Cognitive Science and NN	Carmel
5:30 p.m.-6:30 p.m.	Session Mo4-6: Neuromorphic Engineering	Santa Clara
7:30 p.m.-9:00 p.m.	Poster Session A	Bayshore Ballroom

Tuesday, August 2, 2011

7:00 a.m.-5:00 p.m.	Speaker Ready Room	San Simeon
7:30 a.m.-5:00 p.m.	Registration	Gateway Ballroom Foyer
8:00 a.m.-9:00 a.m.	Plenary Talk Tu-Plen1: Brains, Machines, and Buildings, *Michael Arbib*	Oak
9:00 a.m.-9:00 p.m.	Exhibits Open	Bayshore Ballroom
9:00 a.m.-9:30 a.m.	Refreshment Break/Visit the Exhibits	Bayshore Ballroom
9:30 a.m.-11:30 a.m.	Special Session Tu1-1: Computational Intelligence in Patient Care	Cedar
9:30 a.m.-11:30 a.m.	Session Tu1-2: Self Organization	Pine
9:30 a.m.-11:30 a.m.	Special Track Tu1-3: From Brains to Machines I	Oak
9:30 a.m.-11:30 a.m.	Session Tu1-4: Kernel Methods and SVM I	Monterey
9:30 a.m.-11:30 a.m.	Special Session Tu1-5: Consciousness-Driven Vision: Toward a Breakthrough in Bio-Inspired Computer Vision	Carmel
9:30 a.m.-11:30 a.m.	Session Tu1-6: Feed-Forward Networks	Santa Clara
11:40 a.m.-12:40 p.m.	Special Session Tu2-1: Automated Supervised and Unsupervised Learning	Cedar
11:40 a.m.-12:40 p.m.	Session Tu2-2: Deep Learning	Pine
11:40 a.m.-12:40 p.m.	Special Track Tu2-3: From Brains to Machines I (cont.)	Oak
11:40 a.m.-12:40 p.m.	Session Tu2-4: Information Retrieval	Monterey
11:40 a.m.-12:40 p.m.	Special Session Tu2-5: Biologically Inspired Computational Vision	Carmel
11:40 a.m.-12:40 p.m.	Session Tu2-6: Evolutionary Learning	Santa Clara
12:40 p.m.-1:50 p.m.	Lunch Break (on your own)	
1:50 p.m.-2:50 p.m.	Plenary Talk Tu-Plen2: Cognitive Computing: Neuroscience, Super-Computing, Nanotechnology, *Dharmendra Modha*	Oak
2:50 p.m.-3:20 p.m.	Refreshment Break/Visit the Exhibits	Bayshore Ballroom
3:20 p.m.-5:20 p.m.	Special Session Tu3-1: Smart Grid and Energy Applications I	Cedar
3:20 p.m.-5:20 p.m.	Session Tu3-2: Fuzzy Methods	Pine
3:20 p.m.-5:20 p.m.	Special Track Tu3-3: From Brains to Machines II	Oak
3:20 p.m.-5:20 p.m.	Session Tu3-4: Kernel Methods and SVM II	Monterey
3:20 p.m.-5:20 p.m.	Special Session Tu3-5: Competition: Machine Learning for Traffic Sign Recognition	Carmel
3:20 p.m.-5:20 p.m.	Session Tu3-6: Applications I	Santa Clara
5:30 p.m.-6:30 p.m.	Special Session Tu4-1: Smart Grid and Energy Applications II	Cedar
5:30 p.m.-6:30 p.m.	Session Tu4-2: Radial Basis Functions	Pine
5:30 p.m.-6:30 p.m.	Special Track Tu4-3: From Brains to Machines II (cont.)	Oak
5:30 p.m.-6:30 p.m.	Session Tu4-4: Information Theoretic Methods	Monterey
5:30 p.m.-6:30 p.m.	Special Session Tu4-5: Computational Intelligence Research in Driver Fatigue and Distraction	Carmel
5:30 p.m.-6:30 p.m.	Session Tu4-6: Classification	Santa Clara
7:30 p.m.-9:00 p.m.	Poster Session B and C	Bayshore Ballroom

Wednesday, August 3, 2011

7:00 a.m.-5:00 p.m.	Speaker Ready Room	San Simeon
8:00 a.m.-5:00 p.m.	Registration	Gateway Ballroom Foyer
8:00 a.m.-9:00 a.m.	Plenary Talk We-Plen1: Challenges for Computational Vision: From Random Dots to the Wagon Wheel Illusion, *Leon Glass*	Oak
9:00 a.m.-1:00 p.m.	Exhibits Open	Bayshore Ballroom
9:00 a.m.-9:30 a.m.	Refreshment Break/Visit the Exhibits	Bayshore Ballroom
9:30 a.m.-11:30 a.m.	Special Session We1-1: Memristor Minds I	Cedar
9:30 a.m.-11:30 a.m.	Special Session We1-2: From Neuroscience to Robotics and Human-Computer Interfaces	Pine
9:30 a.m.-11:30 a.m.	Special Session We1-3: Neural Modeling of Socio-Cultural and Linguistic Phenomena: Neural Network and Neural Modeling Fields Approaches	Oak
9:30 a.m.-11:30 a.m.	Session We1-4: Unsupervised Learning I	Monterey
9:30 a.m.-11:30 a.m.	Session We1-5: Applications II	Carmel
9:30 a.m.-11:30 a.m.	Session We1-6: Time Series Modeling and Prediction	Santa Clara
11:40 a.m.-12:40 p.m.	Special Session We2-1: Memristor Minds II	Cedar
11:40 a.m.-12:40 p.m.	Special Session We2-2: Mining the Brain: Better Neural Networks Inspired by Neurobiology	Pine
11:40 a.m.-12:40 p.m.	Special Session We2-3: Autonomous Social Learning and Knowledge Representation	Oak
11:40 a.m.-12:40 p.m.	Session We2-4: Unsupervised Learning	Monterey
11:40 a.m.-12:40 p.m.	Special Session We2-5: Concept Drift and Learning in Dynamic Environments	Carmel
11:40 a.m.-12:40 p.m.	Session We2-6: Financial Applications	Santa Clara
12:40 a.m.-1:50 p.m.	Lunch Break (on your own)	
1:50 p.m.-2:50 p.m.	Plenary Talk We-Plen2: Deep Learning and Unsupervised Feature Learning, *Andrew Ng*	Oak
2:50 p.m.-3:20 p.m.	Refreshment Break/Visit the Exhibits	Bayshore Ballroom
3:20 p.m.-4:20 p.m.	Special Session We3-1.1: Memristor Minds III	Cedar
4:20 p.m.-6:00 p.m.	Panel Session We3-1.2: Is the Memristor the Future of AI?	Cedar
3:20 p.m.-6:00 p.m.	Special Session We3-2: Advances Towards Natural Human-Computer Interfaces	Pine
3:20 p.m.-6:00 p.m.	Special Session We3-3: Neural Network Models and Human Nature	Oak
3:20 p.m.-6:00 p.m.	Session We3-4: Optimization	Monterey
3:20 p.m.-6:00 p.m.	Special Session We3-5: Complex-Valued Neural Networks	Carmel
3:20 p.m.-6:00 p.m.	Session We3-6: Learning and Neural Dynamics	Santa Clara
6:15 p.m.-7:30 p.m.	David Rumelhart Memorial Plenary Talk We-DR: Learning Natural Language Semantics, *Michael I. Jordan*	Bayshore Ballroom
8:00 p.m.-10:00 p.m.	Banquet	Gateway Ballroom

Thursday, August 4, 2011

7:00 a.m.-12:00 p.m.	Speaker Ready Room	San Simeon
8:00 a.m.-2:00 p.m.	Registration	Gateway Ballroom Foyer
8:00 a.m.-9:30 a.m.	Featured Plenary Session Th-Plen1: The Emergence of Mind, *Walter J. Freeman*	Oak
9:30 a.m.-10:00 a.m.	Refreshment Break	Gateway Ballroom Foyer
10:00 a.m.-12:20 p.m.	Session Th1-1: Bioinformatics and Biomedical Applications	Cedar
10:00 a.m.-12:20 p.m.	Session Th1-2: Spiking Neural Networks	Pine
10:00 a.m.-11:20 a.m.	Panel Session Th1-3.1: Autonomous Machine Learning Panel I - Architectural Issues for Autonomous Learning Systems	Oak
11:20 a.m.-12:20 p.m.	Panel Session Th1-3.2: Autonomous Machine Learning Panel II - Brain-Mind Architectures: Module-Free, General Purpose, and Immediate Learning?	Oak
10:00 a.m.-12:20 p.m.	Session Th1-4: Brain-Computer Interface & EEG	Monterey
10:00 a.m.-12:20 p.m.	Session Th1-5: Pattern Analysis: Biology and Engineering	Carmel
10:00 a.m.-12:20 p.m.	Session Th1-6: Robotics and Control	Santa Clara
	Workshops	
2:00 p.m.-5:00 p.m.	W-1: Autonomous Machine Learning	Monterey
2:00 p.m.-5:00 p.m.	W-2: Concept Drift & Learning in Non-Stationary Environments	Carmel
2:00 p.m.-5:00 p.m.	W-3: Cognition and the Fringe: Intuition, Feelings of Knowing, and Coherence	San Carlos
2:00 p.m.-5:00 p.m.	W-4: Integral Biomathics	San Juan
2:00 p.m.-5:00 p.m.	W-7: Results and Methods for the Neural Network Grand Forecasting Challenge on Time-Series Prediction	San Simeon
2:00 p.m.-5:00 p.m.	W-8: Future Perspectives of Neuromorphic Memristor Science and Technology	San Martin

Friday, August 5, 2011

9:00 a.m.-12:00 noon and 1:30 p.m.-4:30 p.m.	W-5: Neuromorphic Hardware: VLSI Spiking Neural Networks (SNN) and Bio-Sensors	Monterey
9:00 a.m.-12:00 noon and 1:30 p.m.-4:30 p.m.	W-6: IJCNN Competitions	Carmel

IJCNN 2011: SCHEDULE GRIDS
Sunday, July 31, 2011: Tutorials

	Cedar	Monterey	Carmel	San Martin	San Simeon
8:00 am - 10:00 am	**T1:** Signal Processing & Machine Learning Approaches in Brain-Machine Interfaces *G. Garcia-Molina*	**T2:** Adaptive Critic Designs *G.K. Venayagamoorthy*	**T3:** Introduction to the Evaluation of Neural Networks and Other Decision Functions *D. Brown*	**T4:** Dynamic Logic *L. Perlovsky*	**T5:** Complex-Valued Neural Networks: New Trends & Applications *I. Aizenberg, D. Mandic & A. Hirose*
10:00 am - 10:30 am	**Break**				
10:30 am - 12:30 pm	**T6:** Neuropercolation & Neurodynamics *W.J. Freeman & R. Kozma*	**T7:** Advanced Computational & Learning Methods for Smart Grid *G.K. Venayagamoorthy*	**T8:** Evolving Neural Networks *R. Miikkulainen*	**T9:** Computational Social Science I: Sociodynamics *P. Erdi*	**T10:** Learning Deep Architectures and Applications *K. Chen*
12:30 pm – 1:30 pm	**Lunch Break**				
1:30 pm - 3:30 pm	**T11:** Cognitive Memory *B. Widrow*	**T12:** Brain-Like Prediction, Decision and Control *P. Werbos*	**T13:** Advanced Methodologies for Learning Sparse Data *V. Cherkassky*	**T14:** Computational Social Science II: Social Systems *P. Erdi*	**T15:** Conformal Predictions for Reliable Machine Learning. *V. Balasubraminian, S. Ho, S. Panchanathan, & V. Vovk*
3:30 am - 4:00 am	**Break**				
4:00 pm - 6:00 pm	**T16:** Autonomous Machine Learning *A. Roy*		**T18:** Ensemble Learning through Diversity Management *H. Chen & X. Yao*	**T19:** Effective Modeling of the Time Domain in Neural Networks *A.R. Rao & G.A. Cecchi*	**T20:** Stochastic Artificial Neurons and Neural Networks *R. Windecker*
6:00 pm 6:30 pm	**Break**				
6:30 pm - 8:00 pm	**Opening Reception**				

Monday, August 1, 2011

	Cedar	Pine	Oak	Monterey	Carmel	Santa Clara
8:00 am - 9:00 am	**Plenary Talk: Learning Motor Skills in Humans and Humanoids** **Stefan Schaal** (University of Southern California)					
9:00 am - 9:30 am	**Coffee Break**					
9:30 am - 11:30 am	Session Mo1-1 Embodied & Developmental Robotics	Session Mo1-2 Recurrent Networks	Session Mo1-3 Autonomous and Incremental Learning (AIL)	Session Mo1-4 Neurocontrol I: Methods	Session Mo1-5 Supervised, Unsupervised & Ensemble Learning	Session Mo1-6 Feature Extraction
11:30 am - 11:40 am	**Break**					
11:40 am - 12:40 pm	Session Mo2-1 Hybrid Intelligent Systems	Session Mo2-2 Models of Neurobiological Disorders	Session Mo2-3 Auditory Perception & Learning	Session Mo2-4 Neurocontrol II: Applications	Session Mo2-5 Clustering	Session Mo2-6 Music Recognition & Generation
12:40 pm – 1:50 pm	**Lunch Break**					
1:50 pm - 2:50 pm	**Plenary Talk: Neural Network ReNNaissance** **Juergen Schmidhuber** (IDSIA, Switzerland)					
2:50 pm - 3:20 pm	**Coffee Break**					
3:20 pm - 5:20 pm	Session Mo3-1 Emerging Neuromorphic Hardware	Session Mo3-2 Reinforcement Learning I	Session Mo3-3 Brain-Mind Architectures	Session Mo3-4 Bayesian Systems	Session Mo3-5 Visualization	Session Mo3-6 Signal Processing in Biology & Engineering
5:20 pm - 5:30 pm	**Break**					
5:30 pm - 6:30 pm	Session Mo4-1 Intelligent Embedded Systems	Session Mo4-2 Reinforcement Learning II	Session Mo4-3 Autonomous Learning	Session Mo4-4 Cognitive Systems	Session Mo4-5 Panel: Undergrad Education in Cognitive Sci & NN	Session Mo4-6 Neuromorphic Engineering
6:30 pm - 7:30 pm	**Break**					
7:30 pm - 9:00 pm	**Poster Session A**					

Tuesday, August 2, 2011

	Cedar	Pine	Oak	Monterey	Carmel	Santa Clara
8:00 am - 9:00 am	**Plenary Talk: Brains, Machines and Buildings** **Michael Arbib** (University of Southern California)					
9:00 am - 9:30 am	**Coffee Break**					
9:30 am - 11:30 am	Session Tu1-1 Computational Intelligence in Patient Care	Session Tu1-2 Self-Organization	Session Tu1-3 From Brains to Machines I	Session Tu1-4 Kernel Methods & SVM I	Session Tu1-5 Consciousness-Driven Vision	Session Tu1-6 Feed-Forward Networks
11:30 am - 11:40 am	**Break**					
11:40 am - 12:40 pm	Session Tu2-1 Automated Supervised & Unsupervised Learning	Session Tu2-2 Deep Learning	Session Tu2-3 From Brains to Machines I (cont.)	Session Tu2-4 Information Retrieval	Session Tu2-5 Bio-Inspired Computational Vision	Session Tu2-6 Evolutionary Learning
12:40 pm – 1:50 pm	**Lunch Break**					
1:50 pm - 2:50 pm	**Plenary Talk: Cognitive Computing: Neuroscience, Supercomputing and Nanotechnology** **Dharmendra Modha** (IBM Almaden Research Center)					
2:50 pm - 3:20 pm	**Coffee Break**					
3:20 pm - 5:20 pm	Session Tu3-1 Smart Grid and Energy Applications I	Session Tu3-2 Fuzzy Methods	Session Tu3-3 From Brains to Machines II	Session Tu3-4 Kernel Methods & SVM II	Session Tu3-5 Competition: Traffic Sign Recognition	Session Tu3-6 Applications I
5:20 pm - 5:30 pm	**Break**					
5:30 pm - 6:30 pm	Session Tu4-1 Smart Grid and Energy Applications II	Session Tu4-2 Radial Basis Function Networks	Session Tu4-3 From Brains to Machines II (cont.)	Session Tu4-4 Information Theoretic Methods	Session Tu4-5 Driver Fatigue & Distraction	Session Tu4-6 Classification
6:30 pm - 7:30 pm	**Break**					
7:30 pm - 9:00 pm	**Poster Sessions B & C**					

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Wednesday, August 3, 2011

	Cedar	Pine	Oak	Monterey	Carmel	Santa Clara
8:00 am - 9:00 am	**Plenary Talk : Challenges for Computational Vision: From Random Dots to the Wagon Wheel Illusion** **Leon Glass** (McGill University)					
9:00 am - 9:30 am	**Coffee Break**					
9:30 am - 11:30 am	Session We1-1 Memristor Minds I	Session We1-2 From Neuroscience to Robotics & HCI	Session We1-3 Socio-Cultural & Linguistic Phenomena	Session We1-4 Unsupervised Learning I	Session We1-5 Applications II	Session We1-6 Time Series Modeling & Prediction
11:30 am - 11:40 am	**Break**					
11:40 am - 12:40 pm	Session We2-1 Memristor Minds II	Session We2-2 Mining the Brain	Session We2-3 Autonomous Social Learning	Session We2-4 Unsupervised Learning II	Session We2-5 Concept Drift & Dynamic Environments	Session We2-6 Financial Applications
12:40 pm – 1:50 pm	**Lunch Break**					
1:50 pm - 2:50 pm	**Plenary Talk: Deep Learning and Unsupervised Feature Learning** **Andrew Ng** (Stanford University)					
2:50 pm - 3:20 pm	**Coffee Break**					
3:20 pm - 6:00 pm	Session We3-1 Talks & Panel: Is the Memristor the Future of AI?	Session We3-2 Natural Human-Computer Interfaces	Session We3-3 Neural Network Models and Human Nature	Session We3-4 Optimization	Session We3-5 Complex-Valued Neural Networks	Session We3-6 Learning & Neural Dynamics
6:00 pm - 6:15 pm	**Break**					
6:15 pm - 7:30 pm	**Rumelhart Memorial Session and Plenary Talk** **Learning Natural Language Semantics, Michael I. Jordan** (University of California, Berkeley) Bayshore Ballroom					
7:30 pm - 8:00 pm	**Break**					
8:00 pm - 10:00 pm	**Banquet** Gateway Ballroom					

Thursday, August 4, 2011

	Cedar	Pine	Oak	Monterey	Carmel	Santa Clara
8:00 am - 9:30 am	**Featured Plenary Session: <u>The Emergence of Mind</u>** **The Making of the Mind through the Action-Perception Cycle - Walter J. Freeman** (University of California, Berkeley) **Conscious Experience and the Observing Ego: A Dynamic Global Workspace Hypothesis - Bernard J. Baars** (The Neurosciences Institute) **Social Cognition: Learning Gaze Following, Joint Attention, Imitation, and Tool Use - Stephen Grossberg** (Boston University)					
9:30 am - 10:00 am	**Coffee Break**					
10:00 am - 12:20 pm	Session Th1-1 Bioinformatics & Biomedical Applications	Session Th1-2 Spiking Neural Networks	Session Th1-3 Autonomous Machine Learning Panels I & II	Session Th1-4 Brain-Computer Interface & EEG	Session Th1-5 Pattern Analysis: Biology & Engineering	Session Th1-6 Robotics and Control
12:20 pm – 2:00 pm	**Lunch Break**					

Thursday, August 4, 2011: Workshops

	Monterey	Carmel	San Carlos	San Juan	San Martin	San Simeon
2:00 pm - 5:00 pm	**Workshop W-1: Autonomous Machine Learning** Organizers: N. Srinivasa and A. Roy	**Workshop W-2: Concept Drift & Learning in Non-Stationary Environments** Organizers: R. Polikar, C. Alippi, M. Roveri and H. He	**Workshop W-3: Cognition and the Fringe: Intuition, Feelings of Knowing, and Coherence** Organizers: B. Mangan, B.J. Baars and U. Awret	**Workshop W-4: Integral Biomathics** Organizers: P. Simeonov and A. Ehresmann	**Workshop W-7: Results and Methods for the Neural Network Grand Forecasting Challenge on Time-Series Prediction** Organizers: S. Crone and N. Kourentzes	**Workshop W-8: Future Perspectives of Neuromorphic Memristor Science and Technology** Organizers: R. Kozma and R. Pino

Friday, August 5, 2011: Workshops

	Monterey	Carmel
9:00 am - 12:00 noon	**Workshop W-5: Neuromorphic Hardware: VLSI Spiking Neural Networks (SNN) and Bio-Sensors,** Organizers: S. Renaud, G. Indiveri, H. Chen and E. Culurciello	**Workshop W-6: IJCNN Competitions,** Organizers: I. Guyon and S. Crone
12:00 noon – 1:30 pm	**Lunch Break**	
1:30 pm – 4:30 pm	**Workshop W-5: Neuromorphic Hardware: VLSI Spiking Neural Networks (SNN) and Bio-Sensors,** Organizers: S. Renaud, G. Indiveri, H. Chen and E. Culurciello	**Workshop W-6: IJCNN Competitions,** Organizers: I. Guyon and S. Crone

2012 IJCNN International Joint Conference on Neural Networks

The annual International Joint Conference on Neural Networks (IJCNN) will be held jointly with the IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) and the IEEE Congress on Evolutionary Computation (IEEE CEC) as part of the 2012 IEEE World Congress on Computational Intelligence (IEEE WCCI), June 10-15, 2012, Brisbane Convention & Exhibition Centre, Brisbane, Australia. Cross-fertilization of the three technical disciplines and newly emerging technologies is strongly encouraged.

Call for Contributed Papers

The annual IJCNN is the premier international conference in the field of neural networks. It covers all topics in neural networks including, but is not limited to:

Neural network theory & models
Learning and adaptation
Cognitive models
Brain-machine interfaces
Neural control
Evolutionary neural systems
Neurodynamics and complex systems
Neuroinformatics
Neural hardware
Neural network applications
Neuroengineering
Computational neuroscience
Pattern recognition
Machine vision and image processing
Collective intelligence
Hybrid systems
Self-aware systems
Data mining
Sensor networks and intelligent systems
Applications
Computational biology
Bioinformatics

IJCNN 2012 will feature a world-class conference that aims to bring together researchers and practitioners in the field of neural networks and computational intelligence from all around the globe. Technical exchanges within the research community will encompass keynote lectures, special sessions, tutorials and workshops, panel discussions as well as poster presentations. In addition, participants will be treated to a series of social functions, receptions, and networking to establish new connections and foster everlasting friendship among fellow counterparts.

Prospective authors are invited to contribute high-quality papers to IJCNN 2012. All papers are to be submitted electronically through the IEEE WCCI 2012 website http://www.ieee-wcci2012.org/.

For IJCNN inquiries please contact Conference Chair: Cesare Alippi at cesare.alippi@polimi.it
For Program inquiries please contact Program Chair: Kate Smith-Miles at kate.smith-miles@sci.monash.edu.au

Call for Special Sessions

The IJCNN 2012 Program Committee solicits proposals for special sessions within the technical scopes of the Congress. Special sessions, to be organized by international recognized experts, aim to bring together researchers in special focused topics. Papers submitted for special sessions are to be peer-reviewed with the same criteria used for the contributed papers. Proposals should include the session title, a brief description of the scope and motivation, biographic and contact information of the organizers. Researchers interested in organizing special sessions are invited to submit formal proposal to the Special Session Chair:

Brijesh Verma at b.verma@cqu.edu.au.

Call for Tutorials and Workshops

IJCNN 2012 will also feature pre-Congress tutorials and workshops, covering fundamental and advanced neural network topics. A tutorial or workshop proposal should include title, outline, expected enrollment, and presenter/organizer biography. We invite you to submit proposals to the Tutorial and Workshop Chair:

Toshio Fukuda at fukuda@mein.nagoya-u.ac.jp.

Call for Competitions

IJCNN 2012 will host competitions to stimulate research in neural networks, promote fair evaluations, and attract students. The proposals for new competitions should include descriptions of the problems addressed, motivations, expected impact on neural networks and machine learning, and established baselines, schedules, anticipated number of participants, and a biography of the main team members. We invite you to submit proposals to the Competitions Chair:

Sung-Bae Cho at sbcho@yonsei.ac.kr.

General Enquires for IEEE WCCI 2012 should be sent to the General Chair:
Hussein Abbass at hussein.abbass@gmail.com

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Important Dates

Competition proposals submission deadline
October 17, 2011

Special sessions proposal submission deadline
November 21, 2011

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January 23, 2012

Paper acceptance notification date
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Final paper submission deadline
April 2, 2012

Early registration
April 2, 2012

Conference dates
June 10-15, 2012

2012 IEEE International Conference on Fuzzy Systems

The annual IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) will be held jointly with the International Joint Conference on Neural Networks (IJCNN) and the IEEE Congress on Evolutionary Computation (IEEE CEC) as part of the 2012 IEEE World Congress on Computational Intelligence (IEEE WCCI), June 10-15, 2012, Brisbane Convention and Exhibition Centre, Brisbane, Australia. Cross-fertilization of the three technical disciplines and newly emerging technologies is strongly encouraged.

Call for Contributed Papers

The annual FUZZ-IEEE is one of the leading events in the field of fuzzy systems. It covers all topics in fuzzy systems including:

Fuzzy logic and fuzzy set theory
Lattice theory and multi-valued logics
Approximate reasoning
Type-2 fuzzy logic
Rough sets and random sets
Fuzzy mathematics
Possibility theory and imprecise probability
Fuzzy decision making and decision support systems
Fuzzy optimization and design
Fuzzy man-machine interfaces, emotional computing
Fuzzy computing with words, granular computing
Fuzzy systems for agent technology
Hybrid fuzzy systems (fuzzy-neuro-evolutionary)
Fuzzy image and multimedia processing
Medical, financial, industrial applications
Fuzzy document retrieval systems, text mining
Fuzzy systems for natural language processing
Fuzzy information processing
Fuzzy and rough data analysis, fuzzy statistics
Fuzzy data mining and forecasting
Fuzzy systems modeling and identification
Fuzzy control and intelligent systems
Fuzzy systems for robotics
Fuzzy pattern recognition
Fuzzy clustering
Fuzzy systems architectures and hardware
Fuzzy web intelligence
Fuzzy sets in bioinformatics
Fuzzy databases, fuzzy data summarization
Emerging areas

FUZZ-IEEE 2012 will feature a world-class conference that aims to bring together researchers and practitioners in the field of fuzzy systems and computational intelligence from all around the globe. Technical exchanges within the research community will encompass keynote lectures, special sessions, tutorials and workshops, panel discussions as well as poster presentations. In addition, participants will be treated to a series of social functions, receptions, and networking to establish new connections and foster everlasting friendship among fellow counterparts

Prospective authors are invited to contribute high-quality papers to FUZZ-IEEE 2010. All papers are to be submitted electronically through the IEEE WCCI 2012 website http://www.ieee-wcci2012.org/.

For FUZZ-IEEE inquiries, please contact Conference Chair Bernadette Bouchon-Meunier: Bernadette.Bouchon-Meunier@lip6.fr.
For Program inquiries please contact Program Chair James M. Keller: KellerJ@missouri.edu.

Call for Special Sessions

The FUZZ-IEEE 2012 Program Committee solicits proposals for special sessions within the technical scopes of the Congress. Special sessions, to be organized by international recognized experts, aim to bring together researchers in special focused topics. Papers submitted for special sessions are to be peer-reviewed with the same criteria used for the contributed papers. Proposals should include the session title, a brief description of the scope and motivation, biographic and contact information of the organizers. Researchers interested in organizing special sessions are invited to submit formal proposal to the Special Session Chair:

Laszlo T. Koczy at koczy@tmit.bme.hu.

Call for Tutorials and Workshops

FUZZ-IEEE 2012 will also feature pre-Congress tutorials and workshops, covering fundamental and advanced evolutionary computation topics. A tutorial or workshop proposal should include title, outline, expected enrollment, and presenter/organizer biography. We invite you to submit proposals to the Tutorial and Workshop Chair:

Scott Dick at dick@ee.ualberta.ca.

Call for Competitions

FUZZ-IEEE 2012 will host competitions to stimulate research in fuzzy systems, promote fair evaluations, and attract students. The proposals for new competitions should include descriptions of the problems addressed, motivations and expected impact on fuzzy systems, data description, evaluation procedures and established baselines, schedules, anticipated number of participants, and a biography of the main team members. We invite you to submit proposals to the Competitions Chair:

Simon Lucas at sml@essex.ac.uk.

General Enquires for IEEE WCCI 2012 should be sent to the General Chair:
Hussein Abbass at hussein.abbass@gmail.com

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IEEE Congress on Evolutionary Computation

The annual IEEE Congress on Evolutionary Computation (IEEE CEC) will be held jointly with the International Joint Conference on Neural Networks (IJCNN) and the IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) as part of the 2012 IEEE World Congress on Computational Intelligence (IEEE WCCI), June 10-15, 2012, Brisbane Convention and Exhibition Centre, Brisbane, Australia. Cross-fertilization of the three technical disciplines and newly emerging technologies is strongly encouraged.

Call for Contributed Papers

The annual IEEE CEC is one of the leading events in the field of evolutionary computation. It covers all topics in evolutionary computation including:

Ant colony optimization
Artificial life
Agent-based systems
Bioinformatics and bioengineering
Coevolution and collective behavior
Combinatorial and numerical optimization
Constraint and uncertainty handling
Evolutionary data mining
Evolutionary learning systems
Evolvable/adaptive hardware and systems
Evolving neural networks and fuzzy systems
Molecular and quantum computing
Particle Swarm Optimization
Artificial immune systems
Representation and operators
Industrial applications of EC
Evolutionary game theory
Cognitive systems and applications
Computational finance and economics
Estimation of distribution algorithms
Evolutionary design
Evolutionary scheduling

IEEE CEC 2012 will feature a world-class conference that aims to bring together researchers and practitioners in the field of evolutionary computation and computational intelligence from all around the globe. Technical exchanges within the research community will encompass keynote lectures, special sessions, tutorials and workshops, panel discussions as well as poster presentations. In addition, participants will be treated to a series of social functions, receptions, and networking to establish new connections and foster everlasting friendship among fellow counterparts.

Prospective authors are invited to contribute high-quality papers to IEEE CEC 2012. All papers are to be submitted electronically through the IEEE WCCI 2012 website http://www.ieee-wcci2012.org/.

For IEEE CEC inquiries please contact Conference Chair: Garry Greenwood at greenwood@ieee.org
For Program inquiries please contact Program Chair: Xiaodong Li at xiaodong.li@rmit.edu.au.

Call for Special Sessions

The IEEE CEC 2012 Program Committee solicits proposals for special sessions within the technical scopes of the Congress. Special sessions, to be organized by international recognized experts, aim to bring together researchers in special focused topics. Papers submitted for special sessions are to be peer-reviewed with the same criteria used for the contributed papers. Proposals should include the session title, a brief description of the scope and motivation, biographic and contact information of the organizers. Researchers interested in organizing special sessions are invited to submit formal proposal to the Special Session Chair:

Mengjie Zhang at mengjie.zhang@ecs.vuw.ac.nz.

Call for Tutorials and Workshops

IEEE CEC 2012 will also feature pre-Congress tutorials and workshops, covering fundamental and advanced evolutionary computation topics. A tutorial or workshop proposal should include title, outline, expected enrollment, and presenter/organizer biography. We invite you to submit proposals to the Tutorial and Workshop Chair:

Janet Wiles at janetw@itee.uq.edu.au.

Call for Competitions

IEEE CEC 2012 will host competitions to stimulate research in evolutionary computation, promote fair evaluations, and attract students. The proposals for new competitions should include descriptions of the problems addressed, motivations and expected impact on evolutionary computation, data description, evaluation procedures and established baselines, schedules, anticipated number of participants, and a biography of the main team members. We invite you to submit proposals to the Competitions Chair:

Philip Hingston at p.hingston@ecu.edu.au.

General Enquires for IEEE WCCI 2012 should be sent to the General Chair:
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PROGRAM

TUTORIALS

Sunday, July 31, 8:00AM-10:00AM

Tutorial T1: Signal Processing & Machine Learning Approaches in Brain-Machine Interfaces, Instructor: G. Garcia-Molina, Room: Cedar
Tutorial T2: Adaptive Critic Designs, Instructor: G.K. Veneyagamoorthy, Room: Monterey
Tutorial T3: Introduction to the Evaluation of Neural Networks and Other Decision Functions, Instructor: D. Brown, Room: Carmel
Tutorial T4: Dynamic Logic, Instructor: L. Perlovsky, Room: San Martin
Tutorial T5: Complex-Valued Neural Networks: New Trends & Applications, Instructors: I. Aizenberg, D. Mandic and A. Hirose, Room: San Simeon

Sunday, July 31, 10:30AM-12:30PM

Tutorial T6: Neuropercolation & Neurodynamics, Instructors: Walter Freeman and Robert Kozma, Room: Cedar
Tutorial T7: Advanced Computational and Learning Methods for Smart Grid, Instructor: G.K. Veneyagamoorthy, Room: Monterey
Tutorial T8: Evolving Neural Networks, Instructor: R. Miikkulainen, Room: Carmel
Tutorial T9: Computational Social Science I: Sociodynamics, Instructor: P. Erdi, Room: San Martin
Tutorial T10: Learning Deep Architectures and Applications, Instructor: K. Chen, Room: San Simeon

Sunday, July 31, 1:30PM-3:30PM

Tutorial T11: Cognitive Memory, Instructor: B. Widrow, Room: Cedar
Tutorial T12: Brain-Like Prediction, Decision and Control, Instructor: P. Werbos, Room: Monterey
Tutorial T13: Advanced Methodologies for Learning Sparse Data, Instructor: V. Cherkassky, Room: Carmel
Tutorial T14: Computational Social Science II: Social Systems, Instructor: P. Erdi, Room: San Martin
Tutorial T15: Conformal Predictions for Reliable Machine Learning, Instructors: V. Balasubraminian, S. Ho, S. Panchanathan, and V. Vovk , Room: San Simeon

Sunday, July 31, 4:00PM-6:00PM

Tutorial T16: Autonomous Machine Learning, Instructor: A. Roy, Room: Cedar
Tutorial T18: Ensemble Learning through Diversity Management, Instructor: H. Chen and X. Yao, Room: Carmel
Tutorial T19: Effective Modeling of the Time Domain in Neural Networks, Instructors: A. R. Rao and G.A. Cecchi, Room: San Martin
Tutorial T20: Stochastic Artificial Neurons and Neural Networks, Instructor: R. Windecker, Room: San Simeon

RESEARCH PRESENTATIONS

Monday, August 1, 8:00AM-9:00AM

Plenary Talk Mo-Plen1: Plenary Session, Chair: Kenji Doya, Room: Oak **33**
8:00AM *Learning Motor Skills in Humans and Humanoids*
Stefan Schaal (University of Southern California)

Monday, August 1, 9:30AM-11:30AM

Special Session Mo1-1: Embodied and Developmental Robotics, Chair: Pitoyo Hartono and Ryo Saegusa, Room: Cedar **33**

9:30AM *Innovative Embodiment of Job Interview in Emotionally Aware Communication Robot* [no. 326]
Rajiv Khosla, Mei-Tai Chu, K.G. Yamada, K. Kunieda and S. Oga

9:50AM *Application of Hybrid Learning Strategy for Manipulator Robot* [no. 507]
Shingo Nakamura and Shuji Hashimoto

10:10AM *A Hybrid Fuzzy Q Learning algorithm for robot navigation* [no. 537]
Sean Gordon, Napoleon Reyes and Andre Barczak

10:30AM *Active Perception for Action Mirroring* [no. 595]
Ryo Saegusa, Lorenzo Natale, Giorgio Metta and Giulio Sandini

10:50AM *Adaptive Self-Protective Motion based on Reflex Control* [no. 594]
Toshihiko Shimizu, Ryo Saegusa, Shuhei Ikemoto, Ishiguro Hiroshi and Giorgio Metta

11:10AM *Problems of Temporal Granularity in Robot control: Levels of Adaptation and a Necessity of Self-Confidence* [no. 547]
Hiroaki Wagatsuma and Yousuke Tomonaga

Session Mo1-2: Recurrent Networks, Chair: Simona Doboli, Room: Pine **34**

9:30AM *Relational Reinforcement Learning and Recurrent Neural Network with State Classification to Solve Joint Attention* [no. 269]
Renato da Silva and Roseli Romero

9:50AM *Robust Jordan Network for Nonlinear Time Series Prediction* [no. 521]
Qing Song

10:10AM *A Memetic Framework for Cooperative Coevolution of Recurrent Neural Networks* [no. 157]
Rohitash Chandra, Marcus Frean and Mengjie Zhang

10:30AM *Continuous Time Recurrent Neural Network Designed for KWTA Operation* [no. 44]
Ruxandra Liana Costea and Corneliu Marinov

10:50AM *Distributed Parameter Bioprocess Plant Identification and I-Term Control Using Centralized Recurrent Neural Network Models* [no. 78]
Ieroham Baruch, Eloy Saldierna and Oscar Castillo

11:10AM *Dynamics of fractional-order neural networks* [no. 147]
Eva Kaslik and Seenith Sivasundaram

Special Session Mo1-3: Autonomous and Incremental Learning (AIL), Chair: Vincent Lemaire, José García-Rodríguez and Isabelle Guyon, Room: Oak **35**

Organized under the auspices of the INNS Autonomous Machine Learning SIG

9:30AM *Unsupervised and Transfer Learning Challenge* [no. 178]
Isabelle Guyon, Gideon Dror, Vincent Lemaire, Graham Taylor and David Aha

9:50AM *Learning with few examples: an empirical study on leading classifiers* [no. 220]
Christophe Salperwyck and Vincent Lemaire

10:10AM *Pruning with Replacement and Automatic Distance Metric Detection in Limited General Regression Neural Networks* [no. 198]
Koichiro Yamauchi

10:30AM *Fast Autonomous Growing Neural Gas* [no. 167]
Jose Garcia-Rodriguez, Anastassia Angelopoulou, Juan Manuel Garcia, Alexandra Psarrou, Sergio Orts and Vicente Morell

10:50AM *Using 3D GNG-Based Reconstruction for 6DoF Egomotion* [no. 229]
Diego Viejo, Jose Garcia, Miguel Cazorla, David Gil and Magnus Johnsson

11:10AM *Parameter Selection for Smoothing Splines using Stein's Unbiased Risk Estimator (SURE)* [no. 561]
Sepideh Seifzadeh, Mohammad Rostami, Ali Ghodsi and Fakhreddine Karray

Monday, August 1, 11:40AM-12:40PM

Special Session Mo2-1: Hybrid Intelligent Systems, Chair: Patricia Melin, Room: Cedar **40**

11:40AM *Genetic Optimization of Ensemble Neural Networks for Complex Time Series Prediction* [no. 64]
Martha Pulido, Patricia Melin and Oscar Castillo

12:00PM *Parallel Genetic Algorithms for Optimization of Modular Neural Networks in Pattern Recognition* [no. 86]
Fevrier Valdez, Patricia Melin and Herman Parra

12:20PM *Hierarchical genetic optimization of modular neural networks and their type-2 fuzzy response integrators for human recognition based on multimodal biometry* [no. 278]
Daniela Sanchez, Patricia Melin and Oscar Castillo

Session Mo2-2: Models of Neurobiological Disorders, Chair: Todd Leen, Room: Pine **40**

11:40AM *Effects of Compensation, Connectivity and Tau in a Computational Model of Alzheimer's Disease* [no. 136]
Mark Rowan

12:00PM *Simulating Parkinson's disease patient deficits using a COVIS-based computational model* [no. 67]
Sebastien Helie, Erick J. Paul and F. Gregory Ashby

12:20PM *Modeling Prosopagnosia Using Dynamic Artificial Neural Networks* [no. 430]
Robyn Vandermeulen, Laurence Morissette and Sylvain Chartier

Special Session Mo2-3: Neuro-Cognitive Modelling of Auditory Perception, Learning, and Speech Understanding, Chair: Harry Erwin, Room: Oak **41**

Organized under the auspices of the INNS Autonomous Machine Learning SIG

11:40AM *Attention Driven Computational Model of the Auditory Midbrain for Sound Localization in Reverberant Environments* [no. 275]
Jindong Liu, Harry Erwin and Guang-Zhong Yang

12:00PM *A Comparison of Sound Localisation Techniques using Cross-Correlation and Spiking Neural Networks for Mobile Robotics* [no. 414]
Julie Wall, Thomas McGinnity and Liam Maguire

12:20PM *Biologically-inspired neural coding of sound onset for a musical sound classification task* [no. 301]
Michael Newton and Leslie Smith

Session Mo2-4: Neurocontrol II: Applications, Chair: Edgar Sanchez, Room: Monterey **42**

11:40AM *Discrete-Time Neural Identifier for Electrically Driven Nonholonomic Mobile Robots* [no. 234]
Alma Y. Alanis, Lopez-Franco Michel, Arana-Daniel Nancy and Lopez-Franco Carlos

12:00PM *Discrete-Time Neural Block Control for a Doubly Fed Induction Generator* [no. 388]
Riemann Ruiz, Edgar Sanchez and Alexander Loukianov

12:20PM *Nonlinear Adaptive Flight Control Using Sliding Mode Online Learning* [no. 602]
Thomas Krueger, Philipp Schnetter, Robin Placzek and Peter Voersmann

Session Mo2-5: Clustering, Chair: Donald Wunsch, Room: Carmel **42**

11:40AM *Structured Clustering with Automatic Kernel Adaptation* [no. 288]
Weike Pan and James Kwok

12:00PM *A Low-Order Model of Biological Neural Networks for Hierarchical or Temporal Pattern Clustering, Detection and Recognition* [no. 35]
James Lo

12:20PM *A Hierarchical Approach to Represent Relational Data Applied to Clustering Tasks* [no. 644]
Joao Carlos Xavier Junior, Anne Canuto, Alex Freitas, Luiz Goncalves and Carlos Silla Jr.

Monday, August 1, 1:50PM-2:50PM

Monday, August 1, 3:20PM-5:20PM

Special Session Mo3-3: Brain-Mind Architectures and Learning Mechanisms, Chair: John Weng and Asim Roy, Room: Oak **46**

Organized under the auspices of the INNS Autonomous Machine Learning SIG

3:20PM *The Schizophrenic Brain: A Broken Hermeneutic Circle. Some New Insights and Results* [no. 633]
Peter Erdi, Mihaly Banyai, Vaibhav Diwadkar and Balazs Ujfalussy

3:40PM *A theory of the brain - the brain uses both distributed and localist (symbolic) representation* [no. 68]
Asim Roy

4:00PM *Three Theorems: Brain-like Networks Logically Reason and Optimally Generalize* [no. 626]
Juyang Weng

4:20PM *Mental Saccades in Control of Cognitive Process* [no. 126]
Janusz Starzyk

4:40PM *CHARISMA: A Context Hierarchy-based Cognitive Architecture for Self-Motivated Social Agents* [no. 399]
Matthew Conforth and Yan Meng

5:00PM *A Neural Model of Motor Synergies* [no. 622]
Kiran Byadarhaly, Mithun Perdoor and Ali Minai

Session Mo3-4: Bayesian Systems, Chair: Thomas Caudell, Room: Monterey **47**

3:20PM *Belief Function Model for Reliable Optimal Set Estimation of Transition Matrices in Discounted Infinite-Horizon Markov Decision Processes* [no. 263]
Baohua Li and Jennie Si

3:40PM *Topic Model with Constrainted Word Burstiness Intensities* [no. 40]
Shaoze Lei, Jianwen Zhang, Shifeng Weng and Changshui Zhang

4:00PM *Phase diagrams of a variational Bayesian approach with ARD prior in NIRS-DOT* [no. 271]
Atsushi Miyamoto, Kazuho Watanabe, Kazushi Ikeda and Masa-aki Sato

4:20PM *Triply Fuzzy Function Approximation for Bayesian Inference* [no. 655]
Bart Kosko, Osonde Osoba and Sanya Mitaim

4:40PM *Simultaneous Learning of Several Bayesian and Mahalanobis Discriminant Functions by a Neural Network with Additional Nodes* [no. 168]
Yoshifusa Ito, Hiroyuki Izumi and Cidambi Srinivasan

5:00PM *Turning Bayesian Model Averaging Into Bayesian Model Combination* [no. 545]
Kristine Monteith, James Carroll, Kevin Seppi and Tony Martinez

Session Mo3-5: Visualization, Chair: Ke Chen, Room: Carmel **49**

3:20PM *Quest for Efficient Option Pricing Prediction model using Machine Learning Techniques* [no. 154]
B.V. Phani, Chandra Bala and Vijay Raghav

3:40PM *3D Modeling of Virtualized Reality Objects Using Neural Computing* [no. 453]
Andres F. Serna-Morales, Flavio Prieto, Eduardo Bayro-Corrochano and Edgar N. Sanchez

4:00PM *CAVE-SOM: Immersive Visual Data Mining Using 3D Self-Organizing Maps* [no. 509]
Dumidu Wijayasekara, Ondrej Linda and Milos Manic

4:20PM *Visualisation of Network Forensics Traffic Data with a Self-Organising Map for Qualitative Features* [no. 367]
Esteban Jose Palomo, John North, David Elizondo, Rafael Marcos Luque and Tim Watson

4:40PM *Coupling Clustering and Visualization for Knowledge Discovery from Data* [no. 443]
Guenael Cabanes and Younes Bennani

5:00PM *Accelerated Learning of Generalized Sammon Mappings* [no. 621]
Yinjie Huang, Michael Georgiopoulos and Georgios Anagnostopoulos

Session Mo3-6: Signal Processing in Biology and Engineering, Chair: Yoonsuck Choe, Room: Santa Clara **50**

3:20PM *Exploring Retrograde Signaling via Astrocytes as a Mechanism for Self Repair* [no. 663]
John Wade, Liam McDaid, Jim Harkin, Vincenzo Crunelli, Scott Kelso and Valeriu Beiu

3:40PM *Evaluating dependence in spike train metric spaces* [no. 542]
Sohan Seth, Austin Brockmeier, John Choi, Mulugeta Semework, Joseph Francis and Jose Principe

4:00PM *A Texture-based Method for Classifying Cracked Concrete Surfaces from Digital Images using Neural Networks* [no. 540]
ZhiQiang Chen, Reza Derakhshani, Ceki Halmen and John Kevern

4:20PM *Versatile Neural Network Method for Recovering Shape from Shading by Model Inclusive Learning* [no. 673]
Yasuaki Kuroe and Hajimu Kawakami

4:40PM *Text to Phoneme Alignment and Mapping for Speech Technology: A Neural Networks Approach* [no. 150]
John Bullinaria

5:00PM *B-spline neural network based digital baseband predistorter solution using the inverse of De Boor algorithm* [no. 34]
Xia Hong, Yu Gong and Sheng Chen

Monday, August 1, 5:30PM-6:30PM

Special Session Mo4-1: Intelligent Embedded Systems, Chair: Manuel Roveri, Room: Cedar **51**

5:30PM *Embedded Power Quality Monitoring System based on Independent Component Analysis and SVMs* [no. 462]
Marta Ruiz-Llata, Guillermo Guarnizo and Carlos Boya

5:50PM *Neural Classification of Infrasonic Signals Associated with Hazardous Volcanic Eruptions* [no. 93]
Ajay Iyer, Fredric Ham and Milton Garces

6:10PM *A Hierarchical, Nonparametric, Sequential Change-Detection Test* [no. 601]
Cesare Alippi, Giacomo Boracchi and Manuel Roveri

Session Mo4-2: Reinforcement Learning II, Chair: Anthony Kuh, Room: Pine **52**

5:30PM *Direct Heuristic Dynamic Programming with Augmented States* [no. 656]
Jian Sun, Feng Liu, Jennie Si and Shengwei Mei

5:50PM *Reinforcement Active Learning Hierarchical Loops* [no. 631]
Goren Gordon and Ahissar Ehud

6:10PM *Connectionist Reinforcement Learning for Intelligent Unit Micro Management in StarCraft* [no. 379]
Amirhosein Shantia, Eric Begue and Marco Wiering

Special Session Mo4-3: Autonomous Learning of Object Representation and Control, Chair: Rolf Wurtz and Janusz Starzyk, Room: Oak **53**

Organized under the auspices of the INNS Autonomous Machine Learning SIG

5:30PM *An insect brain inspired neural model for object representation and expectation* [no. 400]
Paolo Arena, Luca Patane' and Pietro Savio Termini

5:50PM *Autonomous learning of a human body model* [no. 97]
Thomas Walther and Rolf P. Wurtz

6:10PM *Motivated Learning In Autonomous Systems* [no. 145]
Pawel Raif and Janusz Starzyk

Panel Session Mo4-5: Undergraduate Education in Cognitive Science and NN, Chairs: Peter Erdi, Simona Doboli, Room: Carmel **53**

Panelists: Simona Doboli, Péter Érdi, Daniel Levine, Irwin King, Aluizio F. R. Araujo and Robert Kozma,

Session Mo4-4: Cognitive Systems, Chair: Lokendra Shastri, Room: Monterey **53**

5:30PM *Recognition Model of Cerebral Cortex based on Approximate Belief Revision Algorithm* [no. 102]
Yuuji Ichisugi

5:50PM *How the Core Theory of CLARION Captures Human Decision-Making* [no. 59]
Sebastien Helie and Ron Sun

6:10PM *Interacting Maps for Fast Visual Interpretation* [no. 174]
Matthew Cook, Luca Gugelmann, Florian Jug, Christoph Krautz and Angelika Steger

Session Mo4-6: Neuromorphic Engineering, Chair: Eros Pasero, Room: Santa Clara **54**

5:30PM *Implementation of Signal Processing Tasks on Neuromorphic Hardware* [no. 248]
Olivier Temam and Rodolphe Heliot

5:50PM *Pulse-Type Hardware Inhibitory Neural Networks for MEMS Micro Robot Using CMOS Technology* [no. 337]
Ken Saito, Kazuto Okazaki, Kentaro Sakata, Tatsuya Ogiwara, Yoshifumi Sekine and Fumio Uchikoba

6:10PM *Memristor synaptic dynamics influence on synchronous behavior of two Hindmarsh-Rose neurons* [no. 495]
Fernando Corinto, Alon Ascoli, Valentina Lanza and Marco Gilli

Monday, August 1, 7:30PM-9:00PM

Poster Session Mo-PA: Poster Session A, Chair: Michael Georgiopoulos, Room: Bayshore Ballroom **54**

P101 *Evaluating the Training Dynamics of a CMOS based Synapse* [no. 256]
Arfan Ghani, Liam McDaid, Ammar Belatreche, Peter Kelly, Steve Hall, Tom Dowrick, Shou Huang, John Marsland and Andy Smith

P102 *Stability analysis of neural plasticity rules for implementation on memristive neuromorphic hardware* [no. 524]
Zlatko Vasilkoski, Heather Ames, Ben Chandler, Anatoli Gorchetchnikov, Jasmin Leveille, Gennady Livitz, Ennio Mingolla and Massimiliano Versace

P103 *A Digital Implementation of the Nucleus Laminaris* [no. 314]
Enrico Heinrich, Ralf Joost and Ralf Salomon

P104 *Development of large-scale neural network hardware for practical applications* [no. 680]
Iman Mohtashemi, Babak Azimi, Dimitri Kitariev and Charles Dickinson

P105 *A Digital Bit Serial Dynamical System Implementation of a Silicon Neuron* [no. 687]
Sharayu Kulkarni, Eric Basham and David W. Parent

P106 *Memristor based brain-like computing system* [no. 697]
Marius-Tudor Benea

P107 *Object recognition and localization in a virtual animat: large-scale implementation in dense memristive* memory devices [no. 458]
Jasmin Leveille, Heather Ames, Anatoli Gorchetchnikov, Ben Chandler and Massimiliano Versace

P108 *Percolation in Memristive Networks* [no. 567]
Giovanni E. Pazienza, Robert Kozma and Jordi Albo-Canals

P109 *The Visually-Guided Adaptive Robot (ViGuAR)* [no. 620]
Gennady Livitz, Heather Ames, Ben Chandler, Anatoli Gorchetchnikov and Jasmin Leveille

P110 *Distributed Configuration of Massively-Parallel Simulation on SpiNNaker Neuromorphic Hardware* [no. 243]
Thomas Sharp, Cameron Patterson and Steve Furber

P111 *Neuroevolution of Hierarchical Nonlinearities in a Production Environment* [no. 529]
Anya Getman, Side Zhao, Chenyao Chen, Chuck Rathke, Alex Morin and Clayton Wilson

P112 *Short-Term Load Forecasting for Electrical Regional of a Distribution Utility Considering Temperature* [no. 419]
Ronaldo Aquino, Aida Ferreira, Milde Lira, Otoni Nobrega Neto, Priscila Amorim, Carlos Diniz and Tatiana Silveira

P113 *Hospital Foundation Actions: Neural Network Model Variable Importance* [no. 451]
Mary Malliaris and Maria Pappas

P114 *Toward Constructive Methods for Sigmoidal Neural Networks - Function Approximation in Engineering Mechanics Applications* [no. 517]
Jin-Song Pei, Joseph Wright, Sami Masri, Eric Mai and Andrew Smyth

P115 *A Novel Multilayer Neural Network Model for Heat Treatment of Electroless Ni-P Coatings* [no. 640]
Sayed Yousef Monir Vaghefi and Sayed Mahmoud Monir Vaghefi

P116 *Selecting Syntactic Attributes for Authorship Attribution* [no. 58]
Paulo Varela, Edson Justino and Luiz Oliveira

P139 *Proving the Efficacy of Complementary Inputs for Multilayer Neural Networks* [no. 428]
Timothy Andersen

P140 *A New Sensitivity-Based Pruning Technique for Feed-Forward Neural Networks That Improves Generalization* [no. 445]
Iveta Mrazova and Zuzana Reitermanova

P141 *Boundedness and Convergence of MPN for Cyclic and Almost Cyclic Learning with Penalty* [no. 50]
Jian Wang, Wei Wu and Jacek Zurada

P142 *PCA and Gaussian Noise in MLP Neural Network Training Improve Generalization in Problems with Small and Unbalanced Data Sets* [no. 546]
Icamaan Silva and Paulo Adeodato

P143 *Parameterized Online quasi-Newton Training for High-Nonlinearity Function Approximation using Multilayer Neural Networks* [no. 571]
Hiroshi Ninomiya

P144 *Towards a generalization of decompositional approach of rules extraction from Network* [no. 328]
Norbert Tsopze, Engelbert Mephu Nguifo and Gilbert Tindo

P145 *Experimental Studies with a Hybrid Model of Unsupervised Neural Networks* [no. 353]
Sato Kazuhito, Madokoro Hirokazu, Otani Toshimitsu and Kadowaki Sakura

P146 *A SOM combined with KNN for Classification Task* [no. 488]
Leandro A. Silva and Emilio Del-Moral-Hernandez

P147 *A Hybrid PCA-LDA Model for Dimesion Reduction* [no. 452]
Zhao Nan, Mio Washington and Liu Xiuwen

P148 *Hybrid Neural-Evolutionary Model for Electricity Price Forecasting* [no. 666]
Dipti Srinivasan, Guofan Zhang, Abbas Khosravi, Saeid Nahavandi and Doug Creighton

P149 *Evolving Clonal Adaptive Resonance Theory based on ECOS Theory* [no. 425]
Jose Alexandrino, Cleber Zanchettin and Edson Carvalho Filho

P150 *A Distributed, Bio-Inspired Coordination Strategy for Multiple Agent Systems Applied to Surveillance Tasks in Unknown Environments* [no. 713]
Rodrigo Calvo, Janderson Oliveira, Mauricio Figueiredo and Roseli Romero

P151 *Hybrid Learning Based on Multiple Self-organizing Maps and Genetic Algorithm* [no. 480]
Qiao Cai, Haibo He and Hong Man

P152 *Forecasting Time Series with a Logarithmic Model for the Polynomial Artificial Neural Networks* [no. 560]
Carlos Luna, Eduardo Gomez-Ramirez, Kaddour Najim and Enso Ikonen

P153 *Ensemble of Perceptrons with Confidence Measure for Piecewise Linear Decomposition* [no. 153]
Pitoyo Hartono

P154 *A Method For Dynamic Ensemble Selection Based on a Filter and an Adaptive Distance to Improve the Quality of the Regions of Competence* [no. 249]
Rafael Cruz, George Cavalcanti and Tsang Ren

P155 *Ensemble Classifier Composition: Impact on Feature Based Offline Cursive Character Recognition* [no. 179]
Ashfaqur Rahman and Brijesh Verma

P156 *Probabilistic Self-Organizing Maps for Multivariate Sequences* [no. 186]
Rakia Jaziri, Mustapha Lebbah, Nicoleta Rogovschi and Younes Bennani

P157 *Combining Different Ways to Generate Diversity in Bagging Models: An Evolutionary Approach* [no. 463]
Diego Silveira Costa Nascimento, Anne Magaly de Paula Canuto, Ligia Maria Moura e Silva and Andre Luis Vasconcelos Coelho

P158 *Information Coding with Neural Ensembles for a Mobile Robot* [no. 183]
Daniel Calderon, Tatiana Baidyk and Ernst Kussul

P159 *Comparison of Neural Networks-based ANARX and NARX Models by application of correlation tests* [no. 439]
Sven Nomm and Ulle Kotta

P160 *An Online Actor-Critic Learning Approach with Levenberg-Marquardt Algorithm* [no. 483]
Zhen Ni, Haibo He, Prokhorov Danil and Fu Jian

P161 *Development of a Mix-Design Based Rapid Chloride Permeability Assessment Model Using Neuronets* [no. 566]
Hakan Yasarer and Yacoub Najjar

P162 *Hierarchical Discriminative Sparse Coding via Bidirectional Connections* [no. 586]
Zhengping Ji, Wentao Huang, Garrett Kenyon and Luis Bettencourt

P163 *Lag Selection for Time Series Forecasting using Particle Swarm Optmization* [no. 501]
Gustavo Ribeiro, Paulo Neto, George Cavalcanti and Ing Ren Tsang

P164 *Metamodeling for Large-Scale Optimization Tasks Based on Object Networks* [no. 605]
Ludmilla Werbos, Robert Kozma, Rodrigo Silva-Lugo, Giovanni E. Pazienza and Paul Werbos

P165 *A weighted image reconstruction based on PCA for pedestrian detection* [no. 420]
Guilherme Carvalho, Lailson Moraes, George Cavalcanti and Ing Ren Tsang

P166 *Partitioning Methods used in DBS Treatments Analysis Results - paper upload* [no. 378]
Oana Geman and Cornel Turcu

P167 *A Tool to Implement Probabilistic Automata in RAM-based Neural Networks* [no. 232]
Marcilio de Souto

P168 *Global Stability Analysis Using the Method of Reduction of Dissipativity Domain* [no. 522]
Reza Jafari and Martin Hagan

P169 *Decentralized Neural Block Control for an Industrial PA10-7CE Robot Arm* [no. 575]
Ramon Garcia, Edgar Sanchez, Victor Santibanez and Jose Antonio Ruz

P170 *Object Permanence: Growing Humanoid Robot through the Human Cognitive Development Stages* [no. 117]
Jun-Cheol Park, Seungkyu Nam and Dae-Shik Kim

P171 *Image Segmentation Based on Local Spectral Histograms and Linear Regression* [no. 124]
Jiangye Yuan, DeLiang Wang and Rongxing Li

P172 *Power Wind Mill Fault Detection via one-class nu-SVM Vibration Signal Analysis* [no. 130]
David Martinez-Rego, Oscar Fontenla-Romero and Amparo Alonso-Betanzos

P173 *Improved Image Super-Resolution by Support Vector Regression* [no. 161]
Le An and Bir Bhanu

P174 *A Statistical Parametric Method for the Extraction of Stimulus Dependent Activity from Intrinsic Optical Signals* [no. 204]
Gang Wang, Katsutoshi Miyahara and Masaru Kuroiwa

P175 *Realizing Video Time Decoding Machines with Recurrent Neural Networks* [no. 223]
Aurel A. Lazar and Yiyin Zhou

P176 *Blind Signal Separation in Distributed Space-Time Coding Systems Using the FastICA Algorithm* [no. 614]
Xianxue Fan, Jorge Igual, Raul Llinares, Addisson Salazar and Gang Wu

P177 *The Role of Orientation Diversity in Binocular Vergence Control* [no. 471]
Chao Qu and Bertram Shi

P178 *PAC learnability versus VC dimension: a footnote to a basic result of statistical learning* [no. 251]
Vladimir Pestov

P179 *Instance Selection Algorithm based on a Ranking Procedure* [no. 496]
Cristiano Pereira and George Cavalcanti

P180 *Learning to Rank Relational Objects Based on the Listwise Approach* [no. 384]
Yuxin Ding, Di Zhou, Min Xiao and Li Dong

P181 *Fast AdaBoost Training using Weighted Novelty Selection* [no. 273]
Mojtaba Seyedhosseini, Antonio Paiva and Tolga Tasdizen

P182 *Multiple Distribution Data Description Learning Method for Novelty Detection* [no. 481]
Trung Le, Dat Tran, Phuoc Nguyen, Wanli Ma and Dharmendra Sharma

P183 *Weight of evidence as a tool for attribute transformation in the preprocessing stage of supervised learning algorithms* [no. 60]
Eftim Zdravevski, Petre Lameski and Andrea Kulakov

P184 *On Improving Trust-Region Variable Projection Algorithms for Separable Nonlinear Least Squares Learning* [no. 107]
Eiji Mizutani and James Demmel

P185 *ITR-Score Algorithm: a New Efficient Trace Ratio Criterion based Algorithm for Supervised Dimensionality Reduction* [no. 53]
MIngbo Zhao, Zhao Zhang and Tommy W.S. Chow

P186 *Supervised Link Prediction in Weighted Networks* [no. 473]
Hially Sa and Ricardo Prudencio

P187 *Variations to incremental growing neural gas algorithm based on label maximization* [no. 209]
Jean-Charles Lamirel, Raghvendra Mall, Pascal Cuxac and Ghada Safi

P188 *Robust Locally Linear Embedding using Penalty Functions* [no. 477]
Manda Winlaw, Leila Samimi Dehkordy and Ali Ghodsi

P189 *On the Clustering of Large-scale Data: A Matrix-based Approach* [no. 52]
Lijun Wang and Ming Dong

P190 *A Fast Optimized Semi-Supervised Non-Negative Matrix Factorization Algorithm* [no. 514]
Noel Lopes and Bernardete Ribeiro

P191 *Density and Neighbor Adaptive Information Theoretic Clustering* [no. 72]
Baoyuan Wu and Baogang Hu

P192 *Entropy Penalized Learning for Gaussian Mixture Models* [no. 429]
Boyu Wang, Feng Wan, Peng Un Mak, Pui In Mak and Mang I Vai

P193 *Model-based clustering with Hidden Markov Model regression for time series with regime changes* [no. 579]
Chamroukhi Faicel, Same Allou, Aknin Patrice and Govaert Gerard

P194 *Tangent Space Guided Intelligent Neighbor Finding* [no. 535]
Michael Gashler and Tony Martinez

P195 *Controlled Consensus Time for Community Detection in Complex Networks* [no. 85]
Jean Huertas and Liang Zhao

P196 *New Approaches for Solving Permutation Indeterminacy and Scaling Ambiguity in Frequency Domain Separation of Convolved Mixtures* [no. 201]
Zhitang Chen and Laiwan Chan

P197 *On the Structure of Algorithm Spaces* [no. 155]
Adam Peterson, Tony Martinez and George Rudolph

P198 *Feature selection of pathway markers for microarray-based disease classification using negatively correlated feature sets* [no. 725]
Jonathan Chan, Pitak Sootanan and Ponlavit Larpeampaisarl

Tuesday, August 2, 8:00AM-9:00AM

Plenary Talk Tu-Plen1: Plenary Session: From Brains to Machines A, Chair: Peter Erdi, Room: Oak **73**

8:00AM *Brains, Machines and Buildings*
Michael Arbib (University of Southern California)
This talk is part of the NSF-sponsored symposium: From Brains to Machines

Tuesday, August 2, 9:30AM-11:30AM

Special Session Tu1-1: Computational Intelligence in Patient Care, Chair: Jim DeLeo and Adam Gaweda, Room: Cedar **73**

9:30AM *Spectral decomposition methods for the analysis of MRS information from human brain tumors* [no. 722]
Sandra Ortega-Martorell, Alfredo Vellido, Paulo J.G. Lisboa, Margarida Julia-Sape and Carles Arus

9:50AM *PLANN-CR-ARD model predictions and Non-parametric estimates with Confidence Intervals* [no. 327]
Arsene Corneliu and Lisboa Paulo

10:10AM *Magnetic Resonance Estimation of Longitudinal Relaxation Time (T1) in Spoiled Gradient Echo Using an Adaptive Neural Network* [no. 523]
Hassan Bagher-Ebadian, Rajan Jain, Ramesh Paudyal, Siamak Nejad-Davarani, Jayant Narang, Quan Jiang, Tom Mikkelsen and James Ewing

10:30AM *Optimizing Drug Therapy with Reinforcement Learning: The Case of Anemia Management* [no. 433]
Jordan Malof and Adam Gaweda

10:50AM *Alzheimer's Disease Detection Using A Self-adaptive Resource Allocation Network Classifier* [no. 404]
Mahanand B. S., Suresh S., Sundararajan N. and Aswatha Kumar M.

11:10AM *Neural Model of Blood Glucose Level for Type 1 Diabetes Mellitus Patients* [no. 422]
Alma Y. Alanis, Edgar N. Sanchez, Eduardo Ruiz-Velazquez and Blanca S. Leon

Session Tu1-2: Self Organization, Chair: Emilio Del Moral Hernandez, Room: Pine **74**

9:30AM *BSOM network for pupil segmentation* [no. 555]
Gabriel Vasconcelos, Carlos Bastos, Ing Ren Tsang and George Cavalcanti

9:50AM *A Self-Organizing Neural Scheme for Road Detection in Varied Environments* [no. 643]
Usman Ali Malik, Syed Usman Ahmed and Faraz Kunwar

10:10AM *A Batch Self-Organizing Maps Algorithm Based on Adaptive Distances* [no. 475]
Luciano D. S. Pacifico and Francisco de A. T. De Carvalho

10:30AM *Magnification in divergence based neural maps* [no. 113]
Thomas Villmann and Sven Haase

10:50AM *Cooperation Control and Enhanced Class structure in Self-Organizing Maps* [no. 160]
Ryotaro Kamimura

11:10AM *Fast Online Incremental Transfer Learning for Unseen Object Classification Using Self-Organizing Incremental Neural Networks* [no. 170]
Aram Kawewong, Sirinart Tangruamsub, Pichai Kankuekul and Osamu Hasegawa

Special Track Tu1-3: From Brains to Machines I, Chair: Steven Bressler, Room: Oak **75**
This session is part of the NSF-sponsored symposium: From Brains to Machines

9:30AM *Neural networks underlying top-down enhancement and suppression of visual processing*
Adam Gazzaley (invited talk)

10:10AM *The effects of aging on functional connectivity during cognitive tasks and at rest*
Cheryl Grady (invited talk)

10:50AM *New insights into the cortical neural substrate for goal-directed cognitive control*
Jennie Si (invited talk)

Special Session Tu1-5: Consciousness-Driven Vision: Toward a Breakthrough in Bio-Inspired Computer Vision, Chair: Chao-Hui Huang and Daniel Racoceanu, Room: Carmel **76**

9:30AM *Consciousness-driven Model for Visual Attention* [no. 233]
Pierre Cagnac, Noel Di Noia, Chao-Hui Huang, Daniel Racoceanu and Laurent Chaudron

9:50AM *A Neurophysiologically Inspired Hippocampus Based Associative-ART Artificial Neural Network* Architecture [no. 437]
Craig Vineyard, Stephen Verzi, Michael Bernard, Shawn Taylor and Wendy Shaneyfelt

10:10AM *Where-What Network 5: Dealing with Scales for Objects in Complex Backgrounds* [no. 576]
Xiaoying Song, Wenqiang Zhang and Juyang Weng

10:30AM *A Hybrid System with What-Where-Memory for Multi-Object Recognition* [no. 396]
Yuhua Zheng and Yan Meng

10:50AM *ECoG Patterns in short-term (STM) vs. long-term (LTM) Memory Formation* [no. 61]
Walter J Freeman

11:10AM *The temporality of consciousness: computational principles of a single Information Integration-Propagation Process (I2P2)* [no. 369]
Jean-Christophe Sarrazin, Vanessa Gonzalez, Bruno Berberian and Arnaud Tonnelier

Session Tu1-4: Kernel Methods and SVM I, Chair: David Casasent, Room: Monterey **77**

9:30AM *Out-of-Sample Eigenvectors in Kernel Spectral Clustering* [no. 485]
Carlos Alzate and Johan A.K. Suykens

9:50AM *Multi-task Beta Process Sparse Kernel Machines* [no. 54]
Junbin Gao

10:10AM *In-sample Model Selection for Support Vector Machines* [no. 255]
Davide Anguita, Alessandro Ghio, Luca Oneto and Sandro Ridella

10:30AM *Kernel Principal Subspace Mahalanobis Distances for Outlier Detection* [no. 519]
Cong Li, Michael Georgiopoulos and Georgios Anagnostopoulos

10:50AM *Kernel Adaptive Filtering with Maximum Correntropy Criterion* [no. 421]
Songlin Zhao, Badong Chen and Jose Principe

11:10AM *Parallel Semiparametric Support Vector Machines* [no. 123]
Roberto Diaz-Morales, Harold Y. Molina-Bulla and Angel Navia-Vazquez

Session Tu1-6: Feed-Forward Networks, Chair: Seiichi Ozawa, Room: Santa Clara **78**

9:30AM *RANSAC Algorithm with Sequential Probability Ratio Test for Robust Training of Feed-Forward Neural Networks* [no. 714]
Moumen El-Melegy

9:50AM *Advances on Criteria for Biological Plausibility in Artificial Neural Networks: Think of Learning Processes* [no. 303]
Alberione Silva and Joao Luis Rosa

10:10AM *Efficient Levenberg-Marquardt Minimization of the Cross-Entropy Error Function* [no. 21]
Amar Saric (Sarich) and Jing Xiao

10:30AM *Learning Algorithms for a Specific Configuration of the Quantron* [no. 140]
Simon de Montigny and Richard Labib

10:50AM *Optimizing The Quality of Bootstrap-based Prediction Intervals* [no. 647]
Abbas Khosravi, Saeid Nahavandi, Doug Creighton and Dipti Srinivasan

11:10AM *The impact of preprocessing on forecasting electrical load: an empirical evaluation of segmenting time series into subseries* [no. 723]
Sven F. Crone and Nikolaos Kourentzes

Tuesday, August 2, 11:40AM-12:40PM

Special Session Tu2-1: Automated Supervised and Unsupervised Learning, Chair: Nistor Grozavu and Shogo Okada, Room: Cedar **80**

11:40AM *Training a network of mobile neurons* [no. 356]
Bruno Apolloni, Simone Bassis and Lorenzo Valerio

12:00PM *Incremental 2-Directional 2-Dimensional Linear Discriminant Analysis for Multitask Pattern Recognition* [no. 606]
Chunyu Liu, Young-Min Jang, Seiichi Ozawa and Minho Lee

12:20PM *Online Incremental Clustering with Distance Metric Learning for High Dimensional Data* [no. 426]
Okada Shogo and Nishida Toyoaki

Session Tu2-2: Deep Learning, Chair: Marley Vellasco, Room: Pine **80**

11:40AM *Modular Deep Belief Networks that do not Forget* [no. 260]
Leo Pape, Faustino Gomez, Mark Ring and Juergen Schmidhuber

12:00PM *Scalable Low-Power Deep Machine Learning with Analog Computation* [no. 200]
Itamar Arel and Holleman Jeremy

12:20PM *Exploring Speaker-Specific Characteristics with Deep Learning* [no. 47]
Ahmad Salman and Ke Chen

Special Track Tu2-3: From Brains to Machines I (cont.), Chair: Steven Bressler, Room: Oak **81**

This session is part of the NSF-sponsored symposium: From Brains to Machines

11:40AM *Dynamical functional organization of the human brain*
Vinod Menon (invited talk)

12:20PM *Discussion - Part I*
Michael Arbib, Adam Gazzaley, Cheryl Grady, Vinod Menon and Jennie Si

Special Session Tu2-5: Biologically Inspired Computational Vision, Chair: Khan Iftekharuddin, Room: Carmel **82**

11:40AM *Modeling Dopamine and Serotonin Systems in a Visual Recognition Network* [no. 632]
Stephen Paslaski, Courtland VanDam and Juyang Weng

12:00PM *Image Compression based on Growing Hierarchical Self-Organizing Maps* [no. 345]
Esteban J. Palomo and Enrique Dominguez

12:20PM *GPGPU Acceleration of Cellular Simultaneous Recurrent Networks Adapted for Maze Traversals* [no. 558]
Kenneth Rice, Tarek Taha, Khan Iftekharuddin, Keith Anderson and Teddy Salan

Session Tu2-4: Information Retrieval, Chair: Irwin King, Room: Monterey **82**

11:40AM *Unified Perception-Prediction Model for Context Aware Text Recognition on a Heterogeneous Many-Core Platform* [no. 362]
Qinru Qiu, Qing Wu and Richard Linderman

12:00PM *Improving Question Retrieval in Community Question Answering* [no. 96]
Wei Wang, Baichuan Li and Irwin King

12:20PM *Cell Assemblies for Query Expansion in Information Retrieval* [no. 138]
Isabel Volpe, Viviane P. Moreira and Christian Huyck

Session Tu2-6: Evolutionary Learning, Chair: Carlo Franscesco Morabito, Room: Santa Clara **83**

11:40AM *A Self-Organizing Neural Network Using Hierarchical Particle Swarm Optimization* [no. 181]
Cheng-Jian Lin, Chin-Ling Lee and Chun-Cheng Peng

12:00PM *Modularity Adaptation in Cooperative Coevolution of Feedforward Neural Networks* [no. 158]
Rohitash Chandra, Marcus Frean and Mengjie Zhang

12:20PM *Automatic Design of Neural Networks with L-Systems and Genetic Algorithms - A Biologically Inspired Methodology* [no. 261]
Lidio Campos, Mauro Roisenberg and Roberto Oliveira

Tuesday, August 2, 1:50PM-2:50PM

Plenary Talk Tu-Plen2: Plenary Session: From Brains to Machines B, Chair: Jose Principe, Room: Oak **84**

1:50PM *Cognitive Computing: Neuroscience, Supercomputing, Nanotechnology*
Dharmendra Modha (IBM Almaden Research Center)
This talk is part of the NSF-sponsored symposium: From Brains to Machines

Tuesday, August 2, 3:20PM-5:20PM

Special Session Tu3-1: Smart Grid and Energy Applications I, Chair: Ganesh K. Venayagamoorthy and Lingfeng Wang, Room: Cedar **84**

3:20PM *Characterization and Modeling of a Grid-Connected Photovoltaic System Using a Recurrent Neural Network* [no. 371]
Daniel Riley and Ganesh Venayagamoorthy

3:40PM *Real-time State Estimation on Micro-grids* [no. 300]
Ying Hu, Anthony Kuh, Aleksandar Kavcic and Dora Nakafuji

4:00PM *Optimal Operation via a Recurrent Neural Network of a Wind- Solar Energy System* [no. 460]
Manuel Gamez, Edgar Sanchez and Luis Ricalde

4:20PM *Widely Linear Adaptive Frequency Estimation In Three-Phase Power Systems Under Unbalanced Voltage Sag Conditions* [no. 360]
Yili Xia, Scott Douglas and Danilo Mandic

4:40PM *Inferring Cascading Network-Power Disruptions and Sustainability* [no. 645]
Supaporn Erjongmanee, Chuanyi Ji and James Momoh

5:00PM *Composite Power System Reliability Evaluation Using Support Vector Machines on a Multicore Platform* [no. 528]
Robert Green II, Lingfeng Wang and Mansoor Alam

Session Tu3-2: Fuzzy Methods, Chair: Carlo Franscesco Morabito, Room: Pine **85**

3:20PM *Traffic Flow Breakdown Prediction using Feature Reduction through Rough-Neuro Fuzzy Networks* [no. 407]
Carlos Affonso, Renato Sassi and Ricardo Ferreira

3:40PM *A Sequential Learning Algorithm for Meta-Cognitive Neuro-Fuzzy Inference System for Classification Problems* [no. 516]
Suresh Sundaram and Kartick Subramanian

4:00PM *Guided fuzzy clustering with multi-prototypes* [no. 499]
Shenglan Ben, Zhong Jin and Jingyu Yang

4:20PM *Adaptive Neuro-Fuzzy Control of Dynamical Systems* [no. 557]
Alok Kanti Deb and Alok Juyal

4:40PM *A Rough-Fuzzy Hybrid Approach on a Neuro-Fuzzy Classifier for High Dimensional Data* [no. 570]
Chang Su Lee

5:00PM *Neuro-fuzzy Dynamic Pole Placement Control of Nonlinear Discrete-time Systems* [no. 330]
Juri Belikov and Eduard Petlenkov

Special Track Tu3-3: From Brains to Machines II, Chair: Steven Bressler, Room: Oak **86**

This session is part of the NSF-sponsored symposium: From Brains to Machines

3:20PM *Neural adaptations to a brain-machine interface*
Jose Carmena (invited talk)

4:00PM *Cyborg Beetles: Building Interfaces Between Synthetic and Multicellular*
Michel Maharbiz (invited talk)

4:40PM *Biomimetic Models and Microelectronics for Neural Prosthetic Devices that Support Memory Systems of the Brain*
Theodore Berger (invited talk)

Special Session Tu3-5: Competition: Machine Learning for Traffic Sign Recognition, Chair: Johannes Stallkamp, Room: Carmel **87**

3:20PM *The German Traffic Sign Recognition Benchmark: A multi-class classification competition* [no. 312]
Johannes Stallkamp, Marc Schlipsing, Jan Salmen and Christian Igel

3:40PM *Traffic Sign Classification using K-d trees and Random Forests* [no. 446]
Fatin Zaklouta, Bogdan Stanciulescu and Omar Hamdoun

4:00PM *Traffic Sign Recognition with Multi-Scale Convolutional Networks* [no. 578]
Pierre Sermanet and Yann Lecun

4:20PM *A Committee of Neural Networks for Traffic Sign Classification* [no. 402]
Dan Ciresan, Ueli Meier, Jonathan Masci and Juergen Schmidhuber

Session Tu3-4: Kernel Methods and SVM II, Chair: Vladimir Cherkassky, Room: Monterey **88**

3:20PM *An Outpost Vector Placement Evaluation of an Incremental Learning Algorithm for Support Vector Machine* [no. 76]
Piyabute Fuangkhon and Thitipong Tanprasert

3:40PM *Extended Kalman Filter Using a Kernel Recursive Least Squares Observer* [no. 304]
Pingping Zhu, Badong Chen and Jose Principe

4:00PM *Adaptive Tree Kernel by Multinomial Generative Topographic Mapping* [no. 352]
Davide Bacciu, Alessio Micheli and Alessandro Sperduti

4:20PM *Momentum Sequential Minimal Optimization: an Accelerated Method for Support Vector Machine training* [no. 99]
Alvaro Barbero and Jose R. Dorronsoro

4:40PM *Nonlinear Extension of Multiobjective Multiclass Support Vector Machine Based on the One-against-all Method* [no. 329]
Keiji Tatsumi, Masato Tai and Tetsuzo Tanino

5:00PM *Convergence of Algorithms for Solving the Nearest Point Problem in Reduced Convex Hulls* [no. 109]
Jorge Lopez and Jose R. Dorronsoro

Session Tu3-6: Applications I, Chair: Leonid Perlovsky, Room: Santa Clara **89**

3:20PM *Learning Random Subspace Novelty Detection Filters* [no. 472]
Fatma Hamdi and Younes Bennani

3:40PM *The Application of Evolutionary Neural Network for Bat Echolocation Call Recognition* [no. 246]
Golrokh Mirzaei, Mohammad Wadood Majid, Mohsin Jamali, Jeremy Ross and Joseph Frizado

4:00PM *Neural Network Estimation of Photovoltaic I-V Curves under Partially Shaded Conditions* [no. 295]
Jacques Dolan, Ritchie Lee, Yoo-Hsiu Yeh, Chiping Yeh, Daniel Nguyen, Ben-Menehem Shahar and Ishihara Abraham

4:20PM *Gradient-based Morphological Approach for Software Development Cost Estimation* [no. 143]
Ricardo Araujo, Adriano Oliveira, Sergio Soares and Silvio Meira

4:40PM *Yearly and Seasonal Models for Electricity Load Forecasting* [no. 316]
Irena Koprinska, Mashud Rana and Vassilios Agelidis

5:00PM *A MLP-SVM Hybrid Model for Cursive Handwriting Recognition* [no. 185]
Washington Azevedo and Cleber Zanchettin

Tuesday, August 2, 5:30PM-6:30PM

Special Session Tu4-1: Smart Grid and Energy Applications II, Chair: Danilo Mandic and Lingfeng Wang, Room: Cedar **90**

5:30PM *Back to Basics: Operationalizing Data Mining and Visualization Techniques for Utilities* [no. 651]
Dora Nakafuji, Thomas Aukai, Lisa Dangelmaier, Chris Reynolds, Jennifer Yoshimura and Ying Hu

5:50PM *Neural Network Identification for Biomass Gasification Kinetic Model* [no. 398]
Rocio Carrasco, Edgar Sanchez and Salvador Carlos-Hernandez

6:10PM *Application of Neural Networks in the Classification of Incipient Faults in Power Transformers: A Study of Case* [no. 653]
Luciana Castanheira, Joao Vasconcelos, Agnaldo Reis, Paulo Magalhaes and Savio Silva

Session Tu4-2: Radial Basis Functions, Chair: Alessandro Sperduti, Room: Pine **91**

5:30PM *Selective Adjustment of Rotationally-Asymmetric Neuron Sigma-Widths* [no. 309]
Nathan Rose

5:50PM *An Improved Geometric Radial Basis Function Network for Hand-Eye Calibration* [no. 286]
Eduardo Vazquez-Santacruz and Eduardo Bayro-Corrochano

6:10PM *Radial Basis Function Network for Well Log Data Inversion* [no. 239]
Kou-Yuan Huang, Liang-Chi Shen and Li-Sheng Weng

Special Track Tu4-3: From Brains to Machines II (cont.), Chair: Steven Bressler, Room: Oak **91**
This session is part of the NSF-sponsored symposium: From Brains to Machines

5:30PM *How to Work Towards a Mathematical Understanding of the Brain*
Dileep George (invited talk)

6:10PM *Discussion - Part II*
Theodore Berger, Jose Carmena, Dileep George, Michel Maharbiz and Dharmendra Modha

Special Session Tu4-5: Computational Intelligence Research in Driver Fatigue and Distraction, Chair: Dev Kochhar and Mahmoud Abou-Nasr, Room: Carmel **92**

5:30PM *Genetic Feature Selection in EEG-Based Motion Sickness Estimation* [no. 98]
Chun-Shu Wei, Li-Wei Ko, Shang-Wen Chuang, Tzyy-Ping Jung and Chin-Teng Lin

5:50PM *EEG-based Brain Dynamics of Driving Distraction* [no. 319]
Chin-Teng Lin, Shi-An Chen, Li-Wei Ko and Yu-Kai Wang

6:10PM *Audio Visual Cues in Driver Affect Characterization: Issues and Challenges in Developing Robust Approaches* [no. 628]
Ashish Tawari and Mohan Trivedi

Session Tu4-4: Information Theoretic Methods, Chair: Bruno Apolloni, Room: Monterey **92**

5:30PM *A Nonparametric Information Theoretic Approach for Change Detection in Time Series* [no. 281]
Songlin Zhao and Jose Principe

5:50PM *Adaptive Background Estimation using an Information Theoretic Cost for Hidden State Estimation* [no. 125]
Goktug Cinar and Jose Principe

6:10PM *Closed-form Cauchy-Schwarz pdf Divergence for Mixture of Gaussians* [no. 526]
Kittipat Kampa, Erion Hasanbelliu and Jose Principe

Session Tu4-6: Classification, Chair: Marley Vellasco, Room: Santa Clara **93**

5:30PM *Incremental Object Classification Using Hierarchical Generative Gaussian Mixture and Topology Based Feature Representation* [no. 203]
Sungmoon Jeong and Minho Lee

5:50PM *Multinomial Squared Direction Cosines Regression* [no. 634]
Naveed Iqbal and Georgios Anagnostopoulos

6:10PM *Online-Learned Classifiers for Robust Multitarget Tracking* [no. 279]
Shuqing Zeng and Yanhua Chen

Tuesday, August 2, 7:30PM-9:00PM

Poster Session Tu-PB: Poster Session B, Chair: Cesare Alippi, Room: Bayshore Ballroom **94**

P301 *Synapse Maintenance in the Where-What Network* [no. 580]
Yuekai Wang, Xiaofeng Wu and Juyang Weng

P302 *Learning confidence exchange in Collaborative Clustering* [no. 190]
Nistor Grozavu, Mohamad Ghassany and Younes Bennani

P303 *Neuromorphic Motivated Systems* [no. 607]
James Daly, Jacob Brown and Juyang Weng

P304 *A Solution to Harmonic Frequency Problem: Frequency and Phase Coding-Based Brain-Computer Interface* [no. 440]
Chi Man Wong, Boyu Wang, Feng Wan, Peng Un Mak, Pui In Mak and Mang I Vai

P305 *An Improved BCI Paradigm of Motor Imagery for Real-Time Dynamic System Control* [no. 694]
Jun Jiang, Jingwei Yue, Nan Zhang, Zongtan Zhou and Dewen Hu

P306 *A brain-computer interface (BCI) using two components of event-related potentials: P300 and transient visual evoked potential* [no. 695]
Xianpeng Meng, Ming Zhang, Yu Ge, Zongtan Zhou and Dewen Hu

P307 *Semi-supervised feature extraction with local temporal regularization for EEG Classification* [no. 42]
Wenting Tu and Shiliang Sun

P308 *Performance and Features of Multi-Layer Perceptron with Impulse Glial Network* [no. 520]
Chihiro Ikuta, Yoko Uwate and Yoshifumi Nishio

P309 *Autoassociative Pyramidal Neural Network for Face Verification* [no. 338]
Bruno Fernandes, George Cavalcanti and Tsang Ren

P310 *Nomen Meum Earl : Teaching Machines to Imitate* [no. 90]
Chris Lanz

P311 *Cooperation between reinforcement and procedural learning in the basal ganglia* [no. 187]
Nishal Shah and Frederic Alexandre

P312 *Multiple Declarative Memory Systems: Classification with Machine Learning Techniques* [no. 373]
Asaf Gilboa, Hananel Hazan, Ester Koilis, Larry Manevitz and Tali Sharon

P313 *Categorization by Competitive Learning Networks with Spiking Neurons: Design Rules for Converting Rate into Spiking Neural Networks* [no. 133]
Suhas E. Chelian, Narayan Srinivasa, Gail A. Carpenter and Stephen Grossberg

P314 *Pattern Separation with Polychronous Spiking* [no. 476]
Rajan Bhattacharyya, Larry M. Kite and Michael J. Daily

P315 *Learning sameness is difficult for Simple Recurrent neworks: an exploration using TLU networks* [no. 177]
Juan Valle-Lisboa

P316 *Modeling Knowledge Representation in Neuronal Networks* [no. 701]
Garrett Evans and John Collins

P317 *How do little hippocampal neurons learn to code big spaces? Coordinated learning of entorhinal grid cells and hippocampal place cells* [no. 116]
Praveen Pilly and Stephen Grossberg

P318 *Dynamic of Neural Plasticity in a Brain Control Task, Prediction from Modeling.* [no. 500]
Frederic Simard and Sam Musallam

P319 *An Improved Architecture for Probabilistic Neural Networks* [no. 202]
Bala Chandra and Venkata Naresh Babu Kuppili

P320 *Utilizing Hubel Wiesel Models for Semantic Associations and Topics Extraction from Unstructured Text* [no. 196]
Sandeep Tiwari and Kiruthika Ramanathan

P321 *A Novel Neural Network Inspired from Neuroendocrine-Immune System* [no. 492]
Bao Liu, Junhong Wang and Huachao Qu

P322 *Chaotic Complex-valued Multidirectional Associative Memory with Variable Scaling Factor --- One-to-Many Association Ability* [no. 282]
Akio Yoshida and Yuko Osana

P323 *A Multi-state Model of Cortical Memory* [no. 51]
Jean-Philippe Thivierge, Frederic Dandurand and Denis Cousineau

P324 *A Hubel Wiesel Model of Early Concept Generalization Based on Local Correlation of Input Features* [no. 165]
Sepideh Sadeghi and Kiruthika Ramanathan

P325 *Modeling the Cholinergic Innervation in the Infant Cortico-Hippocampal System and its Contribution to Early Memory Development and Attention* [no. 305]
Alexandre Pitti and Yasuo Kuniyoshi

P326 *Bio-Inspired Balanced Tree Structure Dynamic Network* [no. 71]
Fengchen Liu, Yongsheng Ding and Weixun Gao

P327 *Cellular Neural Networks with Switching Two Types of Templates* [no. 308]
Yoshihiro Kato, Yasuhiro Ueda, Yoko Uwate and Yoshifumi Nishio

P328 *Adaptive Spiking Neural Networks with Hodgkin-Huxley Neurons and Hebbian Learning* [no. 57]
Lyle Long

P329 *A General Framework for Development of the Cortex-like Visual Object Recognition System: Waves of Spikes, Predictive Coding and Universal Dictionary of Features* [no. 322]
Sergey Tarasenko

P330 *Comparative Study on Dimension Reduction Techniques for Cluster Analysis of Microarray Data* [no. 387]
Daniel Araujo, Adriao Doria Neto, Allan Martins and Jorge Melo

P331 *Application of Cover's Theorem to the Evaluation of the Performance of CI Observers* [no. 221]
Frank Samuelson and David Brown

P332 *The Time Course of Gamma-band Responses to Subjective Contour in Different Task Paradigms* [no. 434]
Evgeniya Belova

P333 *Self-segmentation Based on Predictability Measure in Multimodal Autonomous System* [no. 211]
Jae Hyun Lim, Jae Heon Yoo, Soo-Young Lee and Dae-Shik Kim

P334 *Two-way MLP* [no. 118]
Tiago B. A. de Carvalho

P335 *Overriding Racial Stereotypes: A Multilevel Neural Network Implementation of the Iterative Reprocessing Model of Social Evaluation* [no. 698]
Stephen Read and Phillip Ehret

P336 *Retrospective Learning of Spatial Invariants During Object Classification by Embodied Autonomous Neural Agents* [no. 444]
Thomas Caudell, Cheir Burch, Mustafa Zengin, Nathan Gauntt and Michael Healy

P337 *Integrating multi-sensory input in the body model - a RNN approach to connect visual features and motor control* [no. 585]
Malte Schilling

P338 *Discovery of Pattern Meaning from Delayed Rewards by Reinforcement Learning with a Recurrent Neural Network* [no. 311]
Katsunari Shibata and Hiroki Utsunomiya

P339 *A Neural Circuit Model for nCRF's Dynamic Adjustment and its Application on Image Representation* [no. 111]
Hui Wei and Xiao-Mei Wang

P340 *Attention Selection Model Using Weight Adjusted Topological Properties and Quantification Evaluating Criterion* [no. 92]
Yu Fang, Xiaodong Gu and Yuanyuan Wang

P341 *Natural Language Generation Using Automatically Constructed Lexical Resources* [no. 214]
Naho Ito and Masafumi Hagiwara

P342 *Neural Model for Counting and Subitizing* [no. 242]
Zong-En Yu, Shyh-Kang Jeng and Michael Arbib

P343 *Neuromorphic vision for intelligent transportation system* [no. 696]
Woo Joon Han and Il Song Han

P344 *Implementation of the COVIS theory of categorization with a Feature Extracting Bidirectionnal Associative Memory with Self-Organizing Maps* [no. 686]
Laurence Morissette, Sylvain Chartier and Denis Cousineau

P345 *Artificial Neural Network Performance Degradation Under Network Damage: Stuck-At Faults* [no. 114]
Robert Nawrocki and Richard Voyles

P346 *Reinforcement Learning and Dimensionality Reduction: a model in Computational Neuroscience* [no. 184]
Nishal Shah and Frederic Alexandre

P347 *A Novel Facial Feature Extraction Method Based on ICM Network for Affective Recognition* [no. 415]
Fania Mokhayeri and Mohammad Reza Akbarzadeh-T

P348 *New Insights into the Cortical Neural Substrate for Goal-Directed Cognitive Control* [no. 457]
Jennie Si

P349 *Do Basal Ganglia amplify willed action by stochastic resonance? A model.* [no. 691]
Srinivasa Chakravarthy

P350 *Predictive neural fields for improved tracking and attentional properties* [no. 346]
Jean-Charles Quinton and Bernard Girau

P351 *Visual attention using spiking neural maps* [no. 449]
Roberto Vazquez, Bernard Girau and Jean-Charles Quinton

P352 *Reconstructing the Stochastic Evolution Diagram of Dynamic Complex Systems* [no. 254]
Navid Bazzazzadeh, Benedikt Brors and Roland Eils

P353 *Bayesian Inference by Spiking Neurons: A model of optimal state estimation in the vestibulo-cerebellum.* [no. 685]
Mike Paulin and Larry Hoffman

P354 *A Manifold Representation of Aging in Human Brain using Resting-State Functional Connectivity MRI* [no. 682]
Lubin Wang, Hui Shen, Zongtan Zhou, Yadong Liu and Dewen Hu

P355 *Biological Validation of the Compartmental Model of Nitric Oxide Diffusion* [no. 689]
Carmen Paz Suarez Araujo, Pablo Fernandez Lopez and Patricio Garcia Baez

P356 *Artificial neural networks to investigate the significance of PAPP-A and b-hCG for the prediction of chromosomal abnormalities* [no. 409]
Costas Neocleous, Kypros Nicolaides, Kleanthis Neokleous, Christos Schizas and Andreas Neocleous

P357 *Neural Networks Based Minimal or Reduced Model Representation for Control of Nonlinear MIMO Systems* [no. 361]
Kristina Vassiljeva, Juri Belikov and Eduard Petlenkov

P358 *Explorations on System Identification via Higher-Level Application of Adaptive-Critic Approximate Dynamic Programming* [no. 152]
Joshua Hughes and George Lendaris

P359 *A system for segmentation and follow-up of brain tumors in MRI scans* [no. 670]
Lior Weizman, Liat Ben Sira, Leo Joskowicz, Ben Shofty and Shlomi Constantini

P360 *Abnormal brain oscillations in Alzheimer's disease: a study using a neural mass computational model* [no. 721]
Basabdatta Sen Bhattacharya, Damien Coyle, Liam Maguire and Martin McGinnity

P361 *Hyperlearning: A Hypothesis of Dopamine and Storytelling in Schizophrenia* [no. 710]
Uli Grasemann, Risto Miikkulainen and Ralph Hoffman

P362 *Modeling Normal/Epileptic Brain Dynamics with Potential Application in Titration Therapy* [no. 650]
Mark Myers and Robert Kozma

P363 *Synchronization of a class of partially unknown chaotic systems with integral observer basing orthogonal neural networks* [no. 654]
Yuye Wang, Shen Wei, Jingwen Wang and Guangrui Xu

P364 *Estimation of Input Information Applied to Neurons by Local Adaptive Kernel Density Function* [no. 706]
Kaori Kuroda and Tohru Ikeguchi

P365 *An Analog Circuit Silicon Neuron Developed Using Dynamical Systems Theory Approach* [no. 709]
Eric Basham, Aravind Sheshadri and Parent David

P366 *Ion-Channel and Synaptic Noise in a Cortical Neuromorphic Circuit* [no. 293]
Mohammad Mahvash and Alice C Parker

P367 *Why NeuroElectroDynamics is Better than Spike timing Models?* [no. 679]
Dorian Aur and Mandar Jog

P368 *Chaotic Simulated Annealing in Feed-Forward Neural Networks with Varying Learning Rates* [no. 213]
Lipo Wang

P369 *Functional Roles of Coherence Resonance in an Inhibitory Network Model of Stellatte Cells* [no. 608]
Kazuki Nakada

P370 *Large-Scale Simulations of Hippocampal and Prefrontal Activity during a Spatial Navigation Task* [no. 705]
Corey Thibeault, Laurence Jayet Bray, Joshua Hegie, Gareth Ferneyhough and Kevin Cassiday

P371 *Neuronal networks biochemical reactions discrete chaotic dynamics and brain creativity mathematical modeling* [no. 661]
Vladimir Gontar and Olga Grechko

P372 *The CARMEN Project and Neuroinformatics* [no. 89]
Leslie Smith, Jim Austin, Tom Jackson, Paul Watson and Colin Ingram

P373 *Knife-Edge Scanning Microscopy for Connectomics Research* [no. 469]
Yoonsuck Choe, David Mayerich, Jaerock Kwon, Daniel Miller, Ji Ryang Chung, Chul Sung, John Keyser and Louise Abbott

P374 *An Optimal Construction and Training of Second Order RBF Network for Approximation and Illumination invariant Image Segmentation* [no. 657]
Xun Cai, Kanishka Tyagi and Michael Manry

P375 *On Combination of SMOTE and Particle Swarm Optimization based Radial Basis Function for Imbalanced Problems* [no. 252]
Ming Gao, Xia Hong, Sheng Chen and Chris Harris

P376 *Some Experimental Results on Sparsely Connected Autoassociative Morphological Memories for the Reconstruction of Color Images Corrupted by Either Impulsive or Gaussian Noise* [no. 79]
Marcos Eduardo Valle and Daniela Maria Grande Vicente

P377 *Prosody Dependent Mandarin Speech Recognition* [no. 63]
Chong-Jia Ni, Wen-Ju Liu and Bo Xu

P378 *A Spiking Neural Network for Tactile Form Based Object Recognition* [no. 191]
Sivalogeswaran Ratnasingam and Martin McGinnity

P379 *Smart Recognition and Synthesis of Emotional Speech for Embedded Systems with Natural User Interfaces* [no. 189]
Malcangi Mario

P380 *Temporal Nonlinear Dimensionality Reduction* [no. 410]
Michael Gashler and Tony Martinez

P381 *An Electrosensory Virtual Reality* [no. 582]
Todd Leen, Patrick Roberts, John Hunt, Amy Boyle, Nathaniel Sawtell and Karina Scalise

P382 *Generative Mechanisms During Testing: How the Brain May Recognize Mixtures of Patterns.* [no. 718]
Tsvi Achler, Zhengping Ji and Luis Bettencourt

P383 *Representing and Decoding Rank Order Codes Using Polychronization in a Network of Spiking Neurons* [no. 207]
Francesco Galluppi and Steve Furber

P384 *A Training Algorithm for SpikeProp Improving Stability of Learning Process* [no. 208]
Toshiki Wakamatsu, Haruhiko Takase, Hiroharu Kawanaka and Shinji Tsuruoka

P385 *Optimization of Spiking Neural Networks with Dynamic Synapses for Spike Sequence Generation using PSO* [no. 623]
Ammar Mohemmed, Satoshi Matsuda, Stefan Schliebs, Kshitij Dhoble and Nikola Kasabov

P386 *Local learning rules for spiking neurons with dendrite.* [no. 459]
Olivier Manette

P387 *Are Probabilistic Spiking Neural Networks Suitable for Reservoir Computing?* [no. 664]
Stefan Schliebs, Mohemmed Ammar and Nikola Kasabov

P388 *Temporal and rate decoding in spiking neurons with dendrites* [no. 43]
Olivier Manette

P389 *Foraging Behavior in a 3-D Virtual Sea Snail Having a Spiking Neural Network Brain* [no. 45]
David Olmsted

P390 *Comparing Evolutionary Methods for Reservoir Computing Pre-training* [no. 81]
Aida Ferreira and Teresa Ludermir

P391 *Reference time in SpikeProp* [no. 238]
Ioana Sporea and Andre Gruning

P392 *Selecting the Hypothesis Space for Improving the Generalization Ability of Support Vector Machines* [no. 257]
Davide Anguita, Alessandro Ghio, Luca Oneto and Sandro Ridella

P393 *Modularity-based model selection for kernel spectral clustering* [no. 391]
Rocco Langone, Carlos Alzate and Johan A. K. Suykens

P394 *Sparseness and a Reduction from Totally Nonnegative Least Squares to SVM* [no. 403]
Vamsi Potluru, Sergey Plis, Shuang Luan, Vince Calhoun and Thomas Hayes

P395 *Handwritten Chinese Character Identification with Bagged One-Class Support Vector Machines* [no. 56]
Hong-Wei Hao, Cui-Xia Mu, Xu-Cheng Yin and Zhi-Bin Wang

P396 *Designing Associative Memories Implemented via Recurrent Neural Networks for Pattern Recognition* [no. 541]
Jose A. Ruz-Hernandez, Maria U. Suarez-Duran, Ramon Garcia-Hernandez, Evgen Shelomov and Edgar N. Sanchez

Poster Session Tu-PC: Poster Session C: Competitions, Chair: Sven Crone and Isabelle Guyon, Room: Bayshore Ballroom 117

P501 *A Hybrid System Ensemble Based Time Series Signal Classification on Driver Alertness Detection* [no. 435]
Shen Xu, Ruoqian Liu, Dai Li and Yi Lu Murphey

P502 *Exploring the relationship between degrees of self similarity and altered driving states* [no. 669]
Sekou Remy

P503 *Graph-based Features for Supervised Link Prediction* [no. 272]
William Cukierski, Benjamin Hamner and Bo Yang

P504 *Link Prediction by De-anonymization: How We Won the Kaggle Social Network Challenge* [no. 385]
Arvind Narayanan, Elaine Shi and Benjamin Rubinstein

P505 *A Support Vector Machines Network for Traffic Sign Recognition* [no. 456]
Fabio Boi and Lorenzo Gagliardini

P506 *Coherence Vector of Oriented Gradients for Traffic Sign Recognition using Neural Networks* [no. 199]
Rajesh R., Rajeev K., Suchithra K., Lekhesh V.P., Ragesh N.K. and Gopakumar V.

Wednesday, August 3, 8:00AM-9:00AM

Plenary Talk We-Plen1: Plenary Session, Chair: David Casasent, Room: Oak **118**

8:00AM *Challenges for Computational Vision: From Random Dots to the Wagon Wheel Illusion*
Leon Glass (McGill University, Canada)

Wednesday, August 3, 9:30AM-11:30AM

Special Session We1-1: Memristor Minds I, Chair: Robert Kozma and Giovanni Pazienza, Room: Cedar **118**

9:30AM *Neuromorphic hardware, memristive memory, and photonic interconnect* [no. 683]
Greg Snider (invited talk)

10:10AM *Biologically-inspired schemes with memory circuit elements* [no. 91]
Massimiliano Di Ventra (invited talk)

10:50AM *Brain-Inspired Computing with Memristive Technology* [no. 84]
Anatoli Gorchetchnikov and Massimiliano Versace (invited talk)

Special Session We1-2: From Neuroscience to Robotics and Human-Computer Interfaces, Chair: Hava Siegelmann, Room: Pine **119**

This session is dedicated to the memory of Philip Goodman (1954 - 2010)

9:30AM *Fuzzy Bio-Interface: Indicating Logicality from Living Neuronal Network and Learning Control of Bio-Robot* [no. 497]
Isao Hayashi, Megumi Kiyotoki, Ai Kiyohara, Minori Tokuda and Suguru N. Kudoh

9:50AM *The Effects of Neuromodulation on Human-Robot Interaction in Games of Conflict and Cooperation* [no. 432]
Derrik Asher, Andrew Zaldivar, Brian Barton, Alyssa Brewer and Jeffrey Krichmar

10:10AM *Expanding the Go/NoGo depiction of the action of Basal Ganglia Pathways* [no. 690]
Sanjeeva Kumar, Maithreye Rengaswamy, Neelima Gupte and Srinivasa Chakravarthy

10:30AM *Functional and Physical Constraints for Evolving Small-World Structure in Embodied Networks* [no. 486]
Derek Harter

10:50AM *Modeling Oxytocin Induced Neurorobotic Trust and Intent Recognition in Human-Robot Interaction* [no. 700]
Sridhar Anumandla, Laurence Jayet Bray, Corey Thibeault, Roger Hoang and Sergiu Dascalu

11:10AM *A Spiking Neuronal Network Model of the Dorsal Raphe Nucleus* [no. 333]
KongFatt Wong-Lin, Girijesh Prasad and T. Martin McGinnity

Special Session We1-3: Neural Modeling of Socio-Cultural and Linguistic Phenomena: Neural network and neural modeling fields approaches, Chair: José Fontanari, Room: Oak **120**

9:30AM *Towards the Grounding of Abstract Words: A Neural Network Model for Cognitive Robots* [no. 122]
Francesca Stramandinoli, Angelo Cangelosi and Davide Marocco

9:50AM *From Neural Activation to Symbolic Alignment: A Network-Based Approach to the Formation of Dialogue Lexica* [no. 132]
Alexander Mehler, Andy Luecking and Peter Menke

10:10AM *A Low-Power Memristive Neuromorphic Circuit Utilizing a Global/Local Training Mechanism* [no. 431]
Garrett Rose, Robinson Pino and Qing Wu

10:30AM *Aquila: An Open-Source GPU-Accelerated Toolkit for Cognitive and Neuro-Robotics Research* [no. 370]
Martin Peniak, Anthony Morse, Christopher Larcombe, Salomon Ramirez-Contla and Angelo Cangelosi

10:50AM *A Neural Network model for spatial mental imagery investigation: A study with the humanoid robot platform iCub* [no. 454]
Alessandro Di Nuovo, Davide Marocco, Santo Di Nuovo and Angelo Cangelosi

11:10AM *Emotions of Cognitive Dissonance* [no. 46]
Jose Fontanari, Leonid Perlovsky, Marie-Claude Bonniot-Cabanac and Michel Cabanac

Session We1-4: Unsupervised Learning I, Chair: Georgios Anagnostopoulos, Room: Monterey **122**

9:30AM *Sparse Kernelized Vector Quantization with Local Dependencies* [no. 325]
Frank-Michael Schleif

9:50AM *Network-Based Learning Through Particle Competition for Data Clustering* [no. 37]
Thiago Silva and Liang Zhao

10:10AM *Observed Stent's anti-Hebbian Postulate on Dynamic Stochastic Computational Synapses* [no. 290]
Subha Danushika Fernando, Koichi Yamada and Ashu Marasinghe

10:30AM *Expectation-Maximization Approach to Boolean Factor Analysis* [no. 139]
Alexander Frolov, Dusan Husek and Pavel Polyakov

10:50AM *Non-Gaussian Component Analysis using Density Gradient Covariance Matrix* [no. 210]
Nima Reyhani and Erkki Oja

11:10AM *Finding Dependent and Independent Components from Two Related Data Sets* [no. 121]
Juha Karhunen and Tele Hao

Session We1-5: Applications II, Chair: Anya Getman, Room: Carmel **123**

9:30AM *A Hardware Suitable Integrated Neural System for Autonomous Vehicles - Road Structuring and Path Tracking* [no. 423]
Udhay Ravishankar and Milos Manic

9:50AM *Real Time Vehicle Speed Prediction using a Neural Network Traffic Model* [no. 627]
Jungme Park, Dai Li, Yi L Murphey, Johannes Kristinsson and Ryan McGee

10:10AM *Forecasting tropospheric ozone concentrations with adaptive neural networks* [no. 392]
Eros Pasero, Luca Mesin, Fiammetta Orione and Riccardo Taormina

10:30AM *Wiener Systems for Reconstruction of Missing Seismic Traces* [no. 231]
Gonzalo Safont, Addisson Salazar, Luis Vergara, Raul Llinares and Jorge Igual

10:50AM *Discrete Synapse Recurrent Neural Network with Time-Varying Delays for Nonlinear System Modeling and Its Application on Seismic Signal Classification* [no. 489]
Hyung O. Park, Alireza A. Dibazar and Theodore W. Berger

11:10AM *Application of SOM to Analysis of Minnesota Soil Survey Data.* [no. 151]
Sauptik Dhar and Vladimir Cherkassky

Session We1-6: Time Series Modeling and Prediction, Chair: Sven Crone, Room: Santa Clara **124**

9:30AM *Prediction of Electric Power Consumption for Commercial Buildings* [no. 156]
Vladimir Cherkassky, Sohini Roy Chowdhury, Volker Landenberger, Saurabh Tewari and Paul Bursch

9:50AM *GA-PAT-KNN: Framework for Time Series Forecasting* [no. 487]
Armando Goncalves, Igor Alencar, Ing-Ren Tsang and George Cavalcanti

10:10AM *Hybrid Model Incorporating Multiple Scale dynamics for Time Series Forecasting* [no. 708]
Vishal Sharma and Dipti Srinivasan

10:30AM *Predictions Tasks with Words and Sequences: Comparing a Novel Recurrent Architecture with the Elman Network* [no. 262]
David Gil, Jose Garcia, Miguel Cazorla and Magnus Johnsson

10:50AM *Designing Dilation-Erosion Perceptrons with Differential Evolutionary Learning for Air Pressure Forecasting* [no. 144]
Ricardo Araujo, Adriano Oliveira, Sergio Soares and Silvio Meira

11:10AM *Semi-supervised monitoring of electric load time series for unusual patterns* [no. 588]
Nikolaos Kourentzes and Sven Crone

Wednesday, August 3, 11:40AM-12:40PM

Special Session We2-1: Memristor Minds II, Chair: Robert Kozma and Giovanni Pazienza, Room: Cedar **125**

11:40AM *Computational Intelligence and Neuromorphic Computing Architectures* [no. 668]
Robinson Pino

12:00PM *Memristor Crossbar for System Architecture* [no. 711]
Chris Yakopcic, Tarek Taha, Guru Subramanyam, Stanley Rogers and Robinson Pino

12:20PM *Phase Change Memory for Synaptic Plasticity Application in Neuromorphic Systems* [no. 149]
Manan Suri, Veronique Sousa, Luca Perniola, Dominique Vuillaume and Barbara DeSalvo

Special Session We2-2: Mining the Brain: Better Neural Networks Inspired by Neurobiology, Chair: Fred Harris, Room: Pine **126**

This session is dedicated to the memory of Philip Goodman (1954 - 2010)

11:40AM *Bio-inspired Models of Memory Capacity, Recall Performance and Theta Phase Precession in the Hippocampus* [no. 662]
Vassilis Cutsuridis, Bruce P. Graham, Stuart Cobb and Michael E. Hasselmo

12:00PM *Evolving Recurrent Neural Networks are Super-Turing* [no. 681]
Jeremie Cabessa and Hava Siegelmann

12:20PM *A forecast-based biologically-plausible STDP learning rule* [no. 383]
Sergio Davies, Alexander Rast, Francesco Galluppi and Steve Furber

Special Session We2-3: Autonomous Social Learning and Knowledge Representation, Chair: Yan Meng and Angelo Cangelosi, Room: Oak **126**

11:40AM *Embodied Cognition, Language, and Mirror Neuron System* [no. 141]
Leonid Perlovsky

12:00PM *Creative Brain and Abstract Art: a quantitative study on Kandinskij paintings* [no. 493]
Francesco Carlo Morabito, Matteo Cacciola and Gianluigi Occhiuto

12:20PM *Self-Reorganizing Knowledge Representation for Autonomous Learning in Social Agents* [no. 397]
Matthew Conforth and Yan Meng

Special Session We2-5: Concept Drift and Learning in Dynamic Environments, Chair: Robi Polikar, Room: Carmel **127**

11:40AM *A Supervised Approach for Change Detection in Data Streams* [no. 131]
Alexis Bondu and Marc Boulle

12:00PM *An effective just-in-time adaptive classifier for gradual concept drifts* [no. 355]
Cesare Alippi, Giacomo Boracchi and Manuel Roveri

12:20PM *Semi-supervised Learning in Nonstationary Environments* [no. 563]
Gregory Ditzler and Robi Polikar

Session We2-4: Unsupervised Learning II, Chair: Carlos Alzate, Room: Monterey **128**

11:40AM *Evolutionary Spectral Co-Clustering* [no. 235]
Nathan Green, Manjeet Rege, Xumin Liu and Reynold Bailey

12:00PM *Independent Component Analysis with Graphical Correlation: Applications to Multi-Vision Coding* [no. 162]
Ryota Yokote, Toshikazu Nakamura and Yasuo Matsuyama

12:20PM *Discriminative Hat Matrix : a new tool for outlier identification and linear regression* [no. 175]
Franck Dufrenois and Jean Charles Noyer

Session We2-6: Financial Applications, Chair: Li-Wei Ko, Room: Santa Clara **128**

11:40AM *Forecasting Exchange Rate with Deep Belief Networks [no. 276]*
Jing Chao, Furao Shen and Jinxi Zhao

12:00PM *A Simulation Environment for Volatility Analysis of Developed and in Development Markets* [no. 505]
Paulo Mattos Neto, Tiago Ferreira and George Cavalcanti

12:20PM *Graph Weighted Subspace Learning Models in Bankruptcy* [no. 427]
Bernardete Ribeiro and Ning Chen

Wednesday, August 3, 1:50PM-2:50PM

Plenary Talk We-Plen2: Plenary Session, Chair: Risto Miikkulainen, Room: Oak **129**

1:50PM *Deep Learning and Unsupervised Feature Learning*
Andrew Ng (Stanford University)

Wednesday, August 3, 3:20PM-4:20PM

Special Session We3-1.1: Memristor Minds III, Chair: Robert Kozma and Giovanni Pazienza, Room: Cedar **129**

3:20PM *Simulation of a Memristor-Based Spiking Neural Network Immune to Device Variations* [no. 376]
Damien Querlioz, Olivier Bichler and Christian Gamrat

3:40PM *An Implementation of a Chalcogenide based, Ion-Conducting Field Programmable Memristor Array (FPMA)* [no. 119]
Terry Gafron, Jennifer Regner and Kristy Campbell

4:00PM *Class of all i-v dynamics for memristive elements in Pattern Recognition Systems* [no. 474]
Fernando Corinto, Alon Ascoi and Marco Gilli

Wednesday, August 3, 4:20PM-6:00PM

Panel Session We3-1.2: Is the Memristor the Future of AI?, Chair: Robert Kozma and Giovanni Pazienza, Room: Cedar **130**
Panelists: Leon Chua, Kristy Campbell, Max DiVentra, Anatoli Gorchetchnikov, Carlo Morabito, Steven Kang, Robinson Pino, Greg Snider, Tarek Taha, Paul Werbos and Don Wunsch

Wednesday, August 3, 3:20PM-6:00PM

Special Session We3-2: Advances towards Natural Human-Computer Interfaces, Chair: Jeff Krichmar, Room: Pine **130**
This session is dedicated to the memory of Philip Goodman (1954 - 2010)

3:20PM *A Comparative Study of Classification Methods for Gesture Recognition using a 3-axis Accelerometer* [no. 510]
Fahad Moiz, Prasad Natoo, Reza Derakhshani and Walter Leon-Salas

3:40PM *Gaze Tracking Based On Pupil Estimation Using Multilayer Perception* [no. 551]
Kim Sangwook, Hwang Byunghun and Lee Minho

4:00PM *Recognition of Human Physical Activity based on a novel Hierarchical Weighted Classification scheme* [no. 455]
Oresti Banos, Miguel Damas, Hector Pomares and Ignacio Rojas

4:20PM *Emotional State Recognition from Speech via Soft-Competition on Different Acoustic Representations* [no. 401]
Arslan Shaukat and Ke Chen

4:40PM *Study on Gesture Recognition System Using Posture Classifier and Jordan Recurrent Neural Network* [no. 108]
Hiroomi Hikawa and Araga Yusuke

5:00PM *Communicated Somatic Markers Benefit Both the Individual and the Species* [no. 719]
Kyle Harrington, Megan Olsen and Hava Siegelmann

5:20PM *Spiking Neural Networks based Cortex-Like Mechanism: A Case Study for Facial Expression Recognition* [no. 348]
Siyao Fu, Guosheng Yang and Zengguang Hou

5:40PM *A New Efficient SVM and Its Application to Real-time Accurate Eye Localization* [no. 518]
Shuo Chen and Chengjun Liu

Special Session We3-3: Neural Network Models and Human Nature, Chair: Dan Levine, Room: Oak **132**

3:20PM *Creativity and Thinking according to Cognition-Language-Music Model* [no. 112]
Leonid Perlovsky

3:40PM *Connectivity and Creativity in Semantic Neural Networks* [no. 659]
Nagendra Marupaka and Ali Minai

4:00PM *A stochastic model of the role of semantic networks in individual and group idea generation* [no. 717]
Simona Doboli and Vincent Brown

4:20PM *Neurodynamics and the mind* [no. 704]
Wlodzislaw Duch

4:40PM *Neural Networks As a Path to Self-Awareness* [no. 716]
Paul Werbos

5:00PM *The Pitfalls of Doing the Right Thing for the Wrong Reason* [no. 193]
Daniel Levine

5:20PM *Mental Disorders within a Cognitive Architecture* [no. 101]
Ron Sun, Nick Wilson and Robert Mathews

Special Session We3-5: Complex-Valued Neural Networks, Chair: Igor Aizenberg, Danilo Mandic, Akira Hirose and Jacek Zurada, Room: Carmel **133**

3:20PM *On Retrieval Performance of Associative Memory by Complex-valued Synergetic Computer* [no. 296]
Kimura Masaaki, Isokawa Teijiro, Nishimura Haruhiko and Matsui Nobuyuki

3:40PM *Fully Complex-valued ELM Classifiers for Human Action Recognition* [no. 577]
Venkatesh Babu Radhakrishnan and Suresh Sundaram

4:00PM *A Class of Fast Quaternion Valued Variable Stepsize Stochastic Gradient Learning Algorithms for Vector Sensor Processes* [no. 574]
Mingxuan Wang, Clive Cheong Took and Danilo Mandic

4:20PM *Classification of Blurred Textures using Multilayer Neural Network Based on Multi-Valued Neurons* [no. 289]
Igor Aizenberg, Jacob Jackson and Shane Alexander

4:40PM *Complex-Valued Functional Link Network Design by Orthogonal Least Squares Method for Function Approximation Problems* [no. 318]
Md. Faijul Amin, Ramasamy Savitha, Muhammad Ilias Amin and Kazuyuki Murase

5:00PM *A Fast Learning Fully Complex-valued Relaxation Network* (FCRN) [no. 297]
Suresh Sundaram, Savitha Ramasamy and Sundararajan Narasimhan

5:20PM *Models of Clifford Recurrent Neural Networks and Their Dynamics* [no. 228]
Yasuaki Kuroe

5:40PM *A Fast Learning Complex-valued Neural Classifier for Real-valued Classification Problems* [no. 467]
Savitha Ramasamy, Suresh Sundaram and Sundararajan Narasimhan

Session We3-4: Optimization, Chair: Robi Polikar, Room: Monterey **135**

3:20PM *Ant Colony Optimization Changing the Rate of Dull Ants and its Application to QAP* [no. 581]
Sho Shimomura, Haruna Matsushita and Yoshifumi Nishio

3:40PM *Solving a Real Large Scale Mid-term Scheduling for Power Plants via Hybrid Intelligent Neural Networks Systems* [no. 176]
Ronaldo Aquino, Otoni Nobrega Neto, Milde Lira and Manoel Carvalho Jr.

4:00PM *Water Quantity Prediction Based on Particle Swarm Optimization and Evolutionary Algorithm Using Recurrent Neural Networks* [no. 450]
Nian Zhang and Shuhua Lai

4:20PM *Chaotic Routing Strategy with Load-Balanced Effects for Communication Networks* [no. 349]
Takayuki Kimura and Tohru Ikeguchi

4:40PM *Computational Intelligence Methods for Helicopter Loads Estimation* [no. 395]
Julio J. Valdes, Catherine Cheung and Weichao Wang

5:00PM *Optimization of Wavelet Neural Networks for Nonlinear System Identification* [no. 630]
Juan Cordova and Wen Yu

5:20PM *Solving Traveling Salesman Problem by a Hybrid Combination of PSO and Extremal Optimization* [no. 320]
Saeed Khakmardan, Hanieh Poostchi and Mohammad -R Akbarzadeh -T

5:40PM *Multi-Objective Evolutionary Optimization of Exemplar-Based Classifiers: A PNN Test Case* [no. 365]
Talitha Rubio, Tiantian Zhang, Michael Georgiopoulos and Assem Kaylani

Session We3-6: Learning and Neural Dynamics, Chair: Emilio Del Moral Hernandez, Room: Santa Clara **136**

3:20PM *The effects of feedback and lateral connections on perceptual processing: a study using oscillatory networks* [no. 258]
A. Ravishankar Rao and Guillermo Cecchi

3:40PM *Perturbation Theory for Stochastic Learning Dynamics* [no. 424]
Todd Leen and Robert Friel

4:00PM *An Echo State Network Architecture Based on Volterra Filtering and PCA with Application to the Channel Equalization Problem* [no. 142]
Levy Boccato, Amauri Lopes, Romis Attux and Fernando Jose Von Zuben

4:20PM *Sparse Analog Associative Memory via L1-Regularization and Thresholding* [no. 416]
Rakesh Chalasani and Jose Principe

4:40PM *Latent Learning - What your net also learned* [no. 287]
Steven Gutstein, Olac Fuentes and Eric Freudenthal

5:00PM *Preliminary Studies on Parameter Aided EKF-CRTRL Equalizer Training for Fast Fading Channels* [no. 504]
Pedro Gouvea Coelho and Luiz Biondi Neto

5:20PM *Stability Analysis of Layered Digital Dynamic Networks Using Dissipativity Theory* [no. 357]
Nam Nguyen and Martin Hagan

5:40PM *A Neurodynamical Model of Context-Dependent Category Learning* [no. 625]
Laxmi Iyer and Ali Minai

Wednesday, August 3, 6:15PM-7:30PM

Plenary Talk We-DR: David Rumelhart Memorial Plenary Session, Chair: Hava Siegelmann, Room: Bayshore Ballroom **138**

6:15PM *Learning Natural Language Semantics*
Michael Jordan (University of California Berkeley)

Thursday, August 4, 8:00AM-9:30AM

Plenary Talks Th-Plen1: Featured Plenary Session: The Emergence of Mind, Chair: Steven Bressler, Room: Oak **138**

8:00AM *The Making of Mind through the Action-Perception Cycle*
Walter J. Freeman (University of California Berkeley)

8:30AM *Conscious Experience and the Observing Ego: A Dynamic Global Workspace Hypothesis*
Bernard J. Baars (The Neurosciences Institute)

9:00AM *Social Cognition: Learning Gaze Following, Joint Attention, Imitation, and Tool Use*
Stephen Grossberg (Boston University)

Thursday, August 4, 10:00AM-12:20PM

Session Th1-1: Bioinformatics and Biomedical Applications, Chair: Li-Wei Ko, Room: Cedar **139**

10:00AM *Sparse Bayesian Prediction of Disordered Residues and Disordered Regions Based on Amino-Acid Composition* [no. 341]
Gavin Cawley, Steven Hayward, Gareth Janacek and Geoff Moore

10:20AM *Inferring method of the Gene Regulatory Networks using Neural Networks Adopting a Majority Rule* [no. 618]
Yasuki Hirai, Masahiro Kikuchi and Hiroaki Kurokawa

10:40AM *Chaos of Protein Folding* [no. 408]
Jacques Bahi, Nathalie Cote and Christophe Guyeux

11:00AM *Optimistic bias in the assessment of high dimensional classifiers with a limited dataset* [no. 554]
Weijie Chen and David Brown

11:20AM *Fetal Electrocardiogram Extraction and R-Peak Detection for Fetal Heart Rate Monitoring using Artificial Neural Network and Correlation* [no. 24]
M.A. Hasan, M.B.I. Reaz and M.I. Ibrahimy

11:40AM *An Innovative Positional Pattern Detection Tool Applied to GAL4 Binding Sites in Yeast* [no. 506]
Heike Sichtig and Alberto Riva

12:00PM *Magnetic Resonance Imaging Estimation of Longitudinal Relaxation Rate Change in Dual Gradient Echo Sequences Using an Adaptive Model* [no. 515]
Hassan Bagher-Ebadian, Siamak Nejad-Davarani, Meser Ali, Stephen Brown, Malek Makki, Quan Jiang, Douglas Noll and James Ewing

Session Th1-2: Spiking Neural Networks, Chair: Nikola Kasabov, Room: Pine **141**

10:00AM *Neuronal Avalanche Induced by Multiplicative Spike-Timing-Dependent Plasticity* [no. 323]
Shuhei Ohno, Hideyuki Kato and Tohro Ikeguchi

10:20AM *Simulation of Large Neuronal Networks with Biophysically Accurate Models on Graphics Processors* [no. 672]
Mingchao Wang, Boyuan Yan, Jingzhen Hu and Peng Li

10:40AM *An Extended Evolving Spiking Neural Network Model for Spatio-Temporal Pattern Classification* [no. 544]
Haza Nuzly Abdull Hamed, Nikola Kasabov, Siti Mariyam Shamsuddin, Harya Widiputra and Kshitij Dhoble

11:00AM *A Novel Asynchronous Digital Spiking Neuron Model and its Various Neuron-like Bifurcations and Responses* [no. 169]
Takashi Matsubara and Hiroyuki Torikai

11:20AM *A Novel Piece-Wise Constant Analog Spiking Neuron Model and its Neuron-like Excitabilities* [no. 166]
Yutaro Yamashita and Hiroyuki Torikai

11:40AM *Lateral Inhibitory Networks: Synchrony, Edge Enhancement, and Noise Reduction* [no. 218]
Cornelius Glackin, Liam Maguire, Liam McDaid and John Wade

12:00PM *Unsupervised Features Extraction from Asynchronous Silicon Retina through Spike-Timing-Dependent Plasticity* [no. 188]
Olivier Bichler, Damien Querlioz, Simon J. Thorpe, Jean-Philippe Bourgoin and Christian Gamrat

Thursday, August 4, 10:00AM-11:20AM

Panel Session Th1-3.1: Autonomous Machine Learning Panel I, Chairs: John Weng and Asim Roy, Room: Oak **142**
Panelists: Bruno Apolloni, Wlodek Duch, Walter Freeman, Ali Minai, Carlo Francesco Morabito, Leonid Perlovsky, Juyang Weng and Asim Roy

Thursday, August 4, 11:20AM-12:20PM

Panel Session Th1-3.2: Autonomous Machine Learning Panel II, Chairs: Asim Roy and John Weng, Room: Oak **142**
Panelists: Janusz Starzyk, Ron Sun, Bernard Widrow, Asim Roy and Juyang Weng

Thursday, August 4, 10:00AM-12:20PM

Session Th1-4: Brain Computer Interface & EEG, Chair: Jose Principe, Room: Monterey **142**

10:00AM *A Two-fold classification for composite decision about localized arm movement from EEG by SVM and QDA techniques* [no. 291]
Anwesha Khasnobish, Saugat Bhattacharyya, Amit Konar, Dewakinandan Tibarewala and Atulya Nagar

10:20AM *Classification of EEG During Imagined Mental Tasks by Forecasting with Elman Recurrent Neural Networks* [no. 564]
Elliott Forney and Charles Anderson

10:40AM *Analysis of absence seizure EEG via Permutation Entropy spatio-temporal clustering* [no. 306]
Nadia Mammone and Francesco C. Morabito

11:00AM *A Brain-Computer Interface for classifying EEG correlates of chronic mental stress* [no. 171]
Reza Khosrowabadi, Chai Quek, Kai Keng Ang, Sau Wai Tung and Michel Heijnen

11:20AM *EEG denoising with a Recurrent Quantum Neural Network for a Brain-Computer Interface* [no. 331]
Vaibhav Gandhi, Vipul Arora, Laxmidhar Behera, Girijesh Prasad, Damien Coyle and Martin McGinnity

11:40AM *Filter Bank Feature Combination (FBFC) approach for Brain-Computer Interface* [no. 294]
Zheng Yang Chin, Kai Keng Ang, Cuntai Guan, Chuanchu Wang and Haihong Zhang

12:00PM *Filter Bank Common Spatial Pattern (FBCSP) algorithm using online adaptive and semi-supervised learning* [no. 105]
Kai Keng Ang, Zheng Yang Chin, Haihong Zhang and Cuntai Guan

Session Th1-5: Pattern Analysis: Biology and Engineering, Chair: Hiroomi Hikawa, Room: Carmel **144**

10:00AM *Computational Intelligence Methods for Underwater Magnetic-based Protection Systems* [no. 74]
Decherchi Sergio, Leoncini Davide, Gastaldo Paolo, Zunino Rodolfo and Faggioni Osvaldo

10:20AM *Perfect Recall from Noisy Input Patterns with a Dendritic Lattice Associative Memory* [no. 127]
Gerhard X. Ritter and Gonzalo Urcid

10:40AM *Finding Patterns in Labeled Graphs Using Spectrum Feature Vectors in a SOM Network* [no. 259]
Rigoberto Fonseca, Pilar Gomez-Gil, Jesus Gonzalez and Ivan Olmos

11:00AM *Improving Classification Accuracy by Identifying and Removing Instances that Should Be Misclassified* [no. 553]
Michael Smith and Tony Martinez

11:20AM *A New Evaluation Measure for Learning from Imbalanced Data* [no. 134]
Nguyen Thai-Nghe, Zeno Gantner and Lars Schmidt-Thieme

11:40AM *Discriminant Kernels derived from the Optimum Nonlinear Discriminant Analysis* [no. 83]
Takio Kurita

12:00PM *Fast pattern matching with time-delay neural networks* [no. 498]
Heiko Hoffmann, Michael Howard and Michael Daily

Session Th1-6: Robotics and Control, Chair: Zeng Guang Hou, Room: Santa Clara **145**

10:00AM *A Neuromorphic Architecture From Single Transistor Neurons With Organic Bistable Devices For Weights* [no. 115]
Robert Nawrocki, Sean Shaheen and Richard Voyles

10:20AM *Two-phase GA parameter tunning method of CPGs for quadruped gaits* [no. 372]
Jose Hugo Barron-Zambrano and Cesar Torres-Huitzil

10:40AM *A Neural Network Classifier for Notch Filter Classification of Sound-Source Elevation in a Mobile Robot* [no. 172]
John Murray and Harry Erwin

11:00AM *Evolution of Robotic Neurocontrollerswith Intrinsic Noiseand their Behavior in Noisy Environments* [no. 413]
Helmut Mayer

11:20AM	*Unsupervised Feature Selection and Category Formation for Mobile Robot Vision* [no. 88] Hirokazu Madokoro, Masahiro Tsukada and Kazuhito Sato
11:40AM	*Neural PD control with second-order sliding mode compensation for robot manipulators* [no. 494] Debbie Hernandez, Yu Wen and Marco Moreno-Armendariz
12:00PM	*Robot Control with a Fully Tuned Growing Radial Basis Function Neural Network* [no. 94] Yi Luo, Yoo Hsiu Yeh and Abraham Ishihara

POST-CONFERENCE WORKSHOPS

Thursday, August 4, 2:00PM-5:00PM

Workshop W-1: Autonomous Machine Learning, Organizers: N. Srinivasa and A. Roy, Room: Monterey

Workshop W-2: Concept Drift & Learning in Non-Stationary Environments, Organizers: R. Polikar, C. Alippi, M. Roveri and H. He, Room: Carmel

Workshop W-3: Cognition and the Fringe: Intuition, Feelings of Knowing, and Coherence, Organizers: B. Mangan, B.J. Baars and U. Awret, Room: San Carlos

Workshop W-4: Integral Biomathics, Organizers: P. Simeonov and A. Ehresmann, Room: San Juan

Workshop W-7: Results and Methods for the Neural Network Grand Forecasting Challenge on Time-Series Prediction, Organizers: S. Crone and N. Kourentzes, Room: San Simeon

Workshop W-8: Future Perspectives of Neuromorphic Memristor Science and Technology, Organizers: R. Kozma and R. Pino, Room: San Martin

Friday, August 5, 9:00AM-12:00noon & 1:30PM-4:30PM

Workshop W-5: Neuromorphic Hardware: VLSI Spiking Neural Networks (SNN) and Bio-Sensors, Organizers: S. Renaud, G. Indiveri, H. Chen and E. Culurciello, Room: Monterey

Workshop W-6: IJCNN Competitions, Organizers: I. Guyon and S. Crone, Room: Carmel

DETAILED PROGRAM

Monday, August 1, 8:00AM-9:00AM

Plenary Talk Mo-Plen1: Plenary Session

Monday, August 1, 8:00AM-9:00AM, Room: Oak, Chair: Kenji Doya

8:00AM *Learning Motor Skills in Humans and Humanoids*

Stefan Schaal, University of Southern California, United States

Skillful and goal-directed interaction with a dynamically changing world is among the hallmarks of human perception and motor control. Understanding the mechanisms of such skills and how they are learned is a long-standing question in both neuroscience and technology, and will be a crucial ingredient towards developing truly autonomous robots. This talk develops a general framework of how motor skills can be learned. At the heart of our work are several key ingredients, including a general representation of motor skills in terms of move-ment primitives as nonlinear attractor systems, the ability to generalize a motor skill to novel situations and to adjust it to sudden perturbations, and the ability to employ imitation learning, trial-and-error learning with path integral rein-forcement learning, inverse reinforcement learning, and model-based learning to improve planning and control of a motor skill. Our framework has close connec-tions to known phenomena in behavioral and neurosciences. We evaluate our approach in various studies with anthropomorphic and humanoid robots as well as behavioral studies.

Monday, August 1, 9:30AM-11:30AM

Special Session Mo1-1: Embodied and Developmental Robotics

Monday, August 1, 9:30AM-11:30AM, Room: Cedar, Chair: Pitoyo Hartono and Ryo Saegusa

9:30AM *Innovative Embodiment of Job Interview in Emotionally Aware Communication Robot [no. 326]*

Rajiv Khosla, Mei-Tai Chu, K.G. Yamada, K. Kunieda and S. Oga, La Trobe University, Australia; CCIL, NEC, Japan

Emotions form an important component of human behavior and decision making. This paper reports on the embodiment of emotions and other human attributes like gestures, speech and motion in a communication robot for conducting a job interview and measuring emotional and cultural fitness of a candidate for a sales job. The contributions include enhanced information quality for managerial decision making, customization of follow up face to face interviews, and enhancement of social interaction between people and communication robot in interview situations.

9:50AM *Application of Hybrid Learning Strategy for Manipulator Robot [no. 507]*

Shingo Nakamura and Shuji Hashimoto, Waseda University, Japan

Generally, the bottom-up learning approaches, such as neural-networks, are implemented to obtain the optimal controller of target task for mechanical system. However, they must face a problem including huge number of trials, which require much time and give stress against the hardware. To avoid such issues, a simulator is often built and performed with a learning method. However, there are also problems that how simulator is constructed and how accurate it performs. In this study, we are considering a construction of simulator directly from the actual robot. Afterward a constructed simulator is used for learning target task and the obtained optimal controller is applied to the actual robot. In this work, we deal a manipulator robot, and gives a ball tracking task to learn. The construction of a simulator is performed by neural-networks and the optimal controller is obtained by reinforcement learning method. Both processes are implemented without using the actual robot after the data sampling, therefore, load against the hardware gets sufficiently smaller, and the objective controller can be obtained faster than using only actual one. And we consider that our proposed method can be a basic learning strategy to obtain the optimal controller of mechanical systems.

10:10AM *A Hybrid Fuzzy Q Learning algorithm for robot navigation [no. 537]*

Sean Gordon, Napoleon Reyes and Andre Barczak, Institute of Information and Mathematical Science, Massey University, New Zealand

In the field of robot navigation, a number of different approaches have been proposed. One of these is \ac{HFA}, which uses the A* algorithm to determine the long term path from the robot to some target, and fuzzy logic to move the robot to each waypoint along the path. This algorithm has been shown to be fast and effective in simulation, however A* is limited in the variables it can consider and the challenges it can be applied to. We propose replacing A* with Q-learning, which does not suffer from these limitations. We demonstrate the ability of \ac{HFQL} to navigate a robot to a given target and then apply the algorithm to a different challenge where the robot needs to balance reaching the target quickly against picking up as many subgoals as possible.

10:30AM *Active Perception for Action Mirroring [no. 595]*

Ryo Saegusa, Lorenzo Natale, Giorgio Metta and Giulio Sandini, Italian Institute of Technology, Italy

The paper describes a constructive approach on active perception for anthropomorphic robots. The key idea is that a robot tries to identify a human's action as an own action based on the observation of action effects for objects. In the proposed framework, the active perception is decomposed into the three phases; First, a robot voluntarily generates actions to discover the own body and objects. Second, the robot characterizes its own action with the effect for the objects.

Third, the robot identifies the human action with the own action. The mirrored perception of the own action and the human's action allows the robot to share the goal-directed behavior with humans. The proposed framework of active perception was experimentally validated with the integrated sensory modalities of vision, proprioception and touch.

10:50AM *Adaptive Self-Protective Motion based on Reflex Control [no. 594]*
Toshihiko Shimizu, Ryo Saegusa, Shuhei Ikemoto, Ishiguro Hiroshi and Giorgio Metta, Osaka Univ., Japan; IIT, Japan; Osaka Univ, Japan; IIT, Italy

This paper describes a self-protective whole-body control method for humanoid robots. A set of postural reactions are used to create whole-body movements. A set of reactions is merged to cope with a general falling down direction, while allowing the upper limbs to contact safely with obstacles. The collision detection is achieved by force sensing. We verified that our method generates the self-protective motion in real time, and reduced the impact energy in multiple situations by simulator. We also verified that our systems works adequately in real-robot.

11:10AM *Problems of Temporal Granularity in Robot control: Levels of Adaptation and a Necessity of Self-Confidence [no. 547]*
Hiroaki Wagatsuma and Yousuke Tomonaga, Department of Brain Science and Engineering, Graduate School of Life Science and Systems Engineering, Kyushu Institute of Technology, Japan

The granularity of action within a system is highly depending on the internal representation for the task, or intention of what to do if it is a biological system. In the same time, there are several levels of adaptation when the system tries to complete a mission. The problem of choosing the right level of action representation is essential for robot controls as well as in learning paradigms. Both tend to use low-granularity and transfer the processed information to upper levels constructively. However the system never guarantees the completion time of the mission if the system is composed of stiff functional blocks with a specific temporal granularity at the bottom level. However, we biological system have an ability to manage the global time for scheduling and reorganization of tasks to finish by the deadline. Brain-inspired robotics allows us to investigate a distributed parallel information system, the brain, with the ability of time management as a real time control system of the physical body through flexible planning of necessary actions by interacting with the real environment. It is an extension of subsumption approaches that fixed a set of behaviors as the basic unit of action in the viewpoint of temporal property. By focusing on the temporal granularity as a consequence of coordination among multiple levels, a self-confident robot control may arise from a coupling between top-down or purpose-oriented decomposition of the purpose to primitive functions with flexible time windows and bottom-up of sensori-motor reactions in dynamic environments.

Session Mo1-2: Recurrent Networks

Monday, August 1, 9:30AM-11:30AM, Room: Pine, Chair: Simona Doboli

9:30AM *Relational Reinforcement Learning and Recurrent Neural Network with State Classification to Solve Joint Attention [no. 269]*
Renato da Silva and Roseli Romero, University of Sao Paulo, Brazil

Shared attention is an important non verbal communication learned by humans in a period of childhood. One learning method has been explored to provide this learning ability in robots is known as reinforcement learning. However, the use of this method using a Markov Decision Process model has problems. In this article, we have enhanced our robotic architecture, which is inspired on behavior analysis, to provide to the robot or agent, the capacity of sharing attention using combination of relational reinforcement learning and recurrent neural network with state classification. We have incorporated this improvement as learning mechanism in our architecture to simulate shared attention. Then, a set of empirical evaluations has been conducted in the social interactive simulator for performing the task of shared attention. The performance of this algorithm have been compared with the QLearning algorithm, contingency learning algorithm and ETG algorithm. The experimental results show that this new method is better than other algorithms evaluated by us for shared attention problem.

9:50AM *Robust Jordan Network for Nonlinear Time Series Prediction [no. 521]*
Qing Song, Nanyang Technological University, Singapore

We propose a robust initialization of Jordan network with recurrent constrained learning (RIJNRCL) algorithm for multilayered recurrent neural networks (RNNs). This novel algorithm is based on the constrained learning concept of Jordan network with recurrent sensitivity and weight convergence analysis to obtain a tradeoff between training and testing errors. In addition to use classical techniques of the adaptive learning rate and adaptive dead zone, RIJNRCL uses a recurrent constrained parameter matrix to switch off excessive contribution of the hidden layer neurons based on weight convergence and stability conditions of the the multilayered RNNs. It is well known that a good response of hidden layer neurons with a proper initialization plays the dominant role to avoid local minimum of multilayered RNNs. The new RIJNRCL algorithm solves the intertwined problem of weight initialization and selection of hidden layer neurons via a novel recurrent sensitivity ratio (RSR) analysis. We provide detailed steps to use RIJNRCL in a benchmark sunspot time series prediction problem, in which the proposed algorithm achieves superior generalization performance.

10:10AM *A Memetic Framework for Cooperative Coevolution of Recurrent Neural Networks [no. 157]*
Rohitash Chandra, Marcus Frean and Mengjie Zhang, School of Engineering and Computer Science, Victoria University of Wellington, New Zealand

Memetic algorithms and cooperative coevolution are emerging fields in evolutionary computation which have shown to be powerful tools for real-world application problems and for training neural networks. Cooperative coevolution decomposes a problem into subcomponents that evolve independently. Memetic algorithms provides further enhancement to evolutionary algorithms with local refinement. The use of crossover-based local refinement has gained attention in memetic computing. This paper employs a cooperative coevolutionary framework that utilises the strength of local refinement via crossover. The framework is evaluated by training recurrent neural networks on grammatical inference problems. The results show that the proposed approach can achieve better performance than the standard cooperative coevolution framework.

10:30AM *Continuous Time Recurrent Neural Network Designed for KWTA Operation [no. 44]*
Ruxandra Liana Costea and Corneliu Marinov, Polytechnic University of Bucharest, Romania

The paper shows rigorously how to build a KWTA selector from a classical neural Hopfield network in continuous time. The analytical relations between parameters result in a step-by-step accurate and flexible procedure to calculate the amplifiers gain, the processing and the resetting thresholds and the bias current.

10:50AM *Distributed Parameter Bioprocess Plant Identification and I-Term Control Using Centralized Recurrent Neural Network Models [no. 78]*
Ieroham Baruch, Eloy Saldierna and Oscar Castillo, CINVESTAV-IPN, Mexico; Tijuana Institute of Technology, Mexico

The paper proposed to use a recurrent neural network model, and a real-time Levenberg-Marquardt algorithm of its learning for centralized data-based modeling, identification and control of an anaerobic digestion bioprocess, carried out in a fixed bed and a recirculation tank of a wastewater treatment system. The analytical model of the digestion bioprocess, used as process data generator, represented a distributed parameter system, which is reduced to a lumped system using the orthogonal collocation method, applied in four collocation points plus one- in the recirculation tank. The paper proposed to use three types of I-term adaptive control: direct adaptive integral plus states neural control, indirect adaptive I-term sliding mode control and real-time I-term optimal control. The comparative graphical simulation results of the digestion wastewater treatment system control, exhibited a good convergence and precise reference tracking, giving slight priority to the direct control with respect to the other methods of control applied.

11:10AM *Dynamics of fractional-order neural networks [no. 147]*
Eva Kaslik and Seenith Sivasundaram, Institute e-Austria Timisoara, Romania; Embry-Riddle Aeronautical University, United States

In this paper we discuss the stability analysis for fractional-order neural networks of Hopfield type. The stability domain of a steady state is completely characterized with respect to some characteristic parameters of the system, in the case of a two-dimensional network and of a network of $n\geq 3$ neurons with ring structure. The values of the characteristic parameters for which Hopf bifurcations occur are identified. Numerical simulations are given which substantiate the theoretical findings and suggest possible routes towards chaos when the fractional order of the system increases.

Special Session Mo1-3: Autonomous and Incremental Learning (AIL)

Monday, August 1, 9:30AM-11:30AM, Room: Oak, Chair: Vincent Lemaire, José García-Rodríguez and Isabelle Guyon

9:30AM *Unsupervised and Transfer Learning Challenge [no. 178]*
Isabelle Guyon, Gideon Dror, Vincent Lemaire, Graham Taylor and David Aha, Clopinet, United States; Yahoo! Labs Haifa, Israel; Orange Labs, France; New York University, United States; Naval Research Laboratory, United States

We organized a data mining challenge in "unsupervised and transfer learning" (the UTL challenge), in collaboration with the DARPA Deep Learning program. The goal of this year's challenge was to learn good data representations that can be re-used across tasks by building models that capture regularities of the input space. The representations provided by the participants were evaluated by the organizers on supervised learning "target tasks", which were unknown to the participants. In a first phase of the challenge, the competitors were given only unlabeled data to learn their data representation. In a second phase of the challenge, the competitors were also provided with a limited amount of labeled data from "source tasks", distinct from the "target tasks". We made available large datasets from various application domains: handwriting recognition, image recognition, video processing, text processing, and ecology. The results indicate that learned data representation yield results significantly better than what can be achieved with raw data or data preprocessed with standard normalizations and functional transforms. The UTL challenge is part of the IJCNN 2011 competition program (http://www.ijcnn2011.org/competitions.php). The website of the challenge remains open for submission of new methods beyond the termination of the challenge as a resource for students and researchers (http://clopinet.com/ul).

9:50AM *Learning with few examples: an empirical study on leading classifiers [no. 220]*
Christophe Salperwyck and Vincent Lemaire, Orange Labs, France

Learning algorithms proved their ability to deal with large amount of data. Most of the statistical approaches use defined size learning sets and produce static models. However in specific situations: active or incremental learning, the learning task starts with only very few data. In that case, looking for algorithms able to produce models with only few examples becomes necessary. The literature's classifiers are generally evaluated with criterion such as: accuracy, ability to order data (ranking)... But this classifiers' taxonomy can dramatically change if the focus is on the ability to learn with just few examples. To our knowledge, just few studies were performed on this problem. The study presented in this paper aims to study a larger panel of both algorithms (9 different kinds) and data sets (17 UCI bases).

10:10AM *Pruning with Replacement and Automatic Distance Metric Detection in Limited General Regression Neural Networks [no. 198]*
Koichiro Yamauchi, Chubu University, Department of Information Science, Japan

In this paper, we propose a limited general regression neural network (LGRNN) for embedded systems. The LGRNN is an improved version of general regression neural network that continues incremental learning under a fixed number of hidden units. Initially, the LGRNN learns new samples incrementally by allocating new hidden units. If the number of hidden units reaches the upper bound, the LGRNN has to remove one useless hidden unit to learn a new sample. However, there are cases in which the adverse effects of removing a useless unit are greater than the positive effects of learning the new sample. In this case, the LGRNN should refrain from learning the new sample. To achieve this, the LGRNN predicts the effects of several learning options (e.g., ignore or learning) before the learning process begins, and chooses the best learning option to be executed. Meanwhile, the LGRNN optimizes a hyper parameter for determining the distance metric automatically. Experimental results show that the method successfully reduces errors even when the number of hidden units is limited to a certain upper bound.

10:30AM *Fast Autonomous Growing Neural Gas [no. 167]*
Jose Garcia-Rodriguez, Anastassia Angelopoulou, Juan Manuel Garcia, Alexandra Psarrou, Sergio Orts and Vicente Morell, University of Alicante, Spain; University of Westminster, United Kingdom

This paper aims to address the ability of self-organizing neural network models to manage real-time applications. Specifically, we introduce fAGNG (fast Autonomous Growing Neural Gas), a modified learning algorithm for the incremental model Growing Neural Gas (GNG) network. The Growing Neural Gas network with its attributes of growth, flexibility, rapid adaptation, and excellent quality of representation of the input space makes it a suitable model for real time applications. However, under time constraints GNG fails to produce the optimal topological map for any input data set. In contrast to existing algorithms the proposed fAGNG algorithm introduces multiple neurons per iteration. The number of neurons inserted and input data generated is controlled autonomous and dynamically based on a priory learnt model. Comparative experiments using topological preservation measures are carried out to demonstrate the effectiveness of the new algorithm to represent linear and non-linear input spaces under time restrictions.

10:50AM *Using 3D GNG-Based Reconstruction for 6DoF Egomotion [no. 229]*
Diego Viejo, Jose Garcia, Miguel Cazorla, David Gil and Magnus Johnsson, University of Alicante, Spain; Lund University Cognitive Science, Sweden

Several recent works deal with 3D data in mobile robotic problems, e.g. mapping. Data come from any kind of sensor (time of flight cameras and 3D lasers) providing a huge amount of unorganized 3D data. In this paper we detail an efficient method to build complete 3D models from a Growing Neural Gas (GNG). We show that the use of GNG provides better results than other approaches. The GNG obtained is then applied to a sequence. From GNG structure, we propose to calculate planar patches and thus obtaining a fast method to compute the movement performed by a mobile robot by means of a 3D models registration algorithm. Final results of 3D mapping are also shown.

11:10AM *Parameter Selection for Smoothing Splines using Stein's Unbiased Risk Estimator (SURE) [no. 561]*
Sepideh Seifzadeh, Mohammad Rostami, Ali Ghodsi and Fakhreddine Karray, University of Waterloo, Canada

A challenging problem in smoothing spline regression is determining a value for the smoothing parameter. The parameter establishes the tradeoff between the closeness of the data, versus the smoothness of the regression function. This paper proposes a new method of finding the optimum smoothness value based on Stein's Unbiased Risk Estimator (SURE). This approach employs Newton's method to solve for the optimal value directly, while minimizing the true error of the regression. Experimental results demonstrate the effectiveness of this method, particularly for small datasets.

Session Mo1-4: Neurocontrol I: Methods

Monday, August 1, 9:30AM-11:30AM, Room: Monterey, Chair: Derong Liu

9:30AM *Dynamic Learning Rate for Recurrent High Order Neural Observer (RHONO): Anaerobic Process Application [no. 377]*
Kelly Gurubel, Edgar Sanchez and Salvador Carlos-Hernandez, CINVESTAV-IPN, Unidad Guadalajara, Mexico; CINVESTAV-IPN, Unidad Saltillo, Mexico

In this paper, a dynamic learning rate, for recurrent high order neural observer (RHONO), is proposed. The dynamic learning rate depends on the pH on-line measurement. The main objective is to improve learning of the neuronal network in presence of disturbances, which is obtained by increasing the performance of the neuronal observer by means of the dynamic learning rate. The learning algorithm is based on an extended Kalman filter. The applicability of the proposed dynamic rate is illustrated via simulation, as applied to a RHONO for an anaerobic process.

9:50AM *Neural Networks for Model Predictive Control [no. 48]*
Petia Georgieva and Sebastiao Feyo de Azevedo, University of Aveiro, Portugal; University of Porto, Portugal

This paper is focused on developing a model predictive control (MPC) based on recurrent neural network (NN) models. Two regression NN models suitable for prediction purposes are proposed. In order to reduce their computational complexity and to improve their prediction ability, issues related with optimal NN structure (lag space selection, number of hidden nodes), pruning techniques and identification strategies are discussed. The NN-based MPC and the traditional PI (Proportional-Integral) control are tested in the presence of process disturbances on a crystallizer dynamic simulator.

10:10AM *Neural Image Thresholding with SIFT-Controlled Gabor Feature [no. 438]*
Ahmed Othman and Hamid Tizhoosh, University of Waterloo, Canada

Image thresholding is a very important phase in the image analysis process. In all traditional segmentation schemes, statically calculated thresholds or initial points are used to binarize images. Because of the differences in images characteristics, these techniques may generate high segmentation accuracy for some images and low accuracy for other images. Intelligent segmentation by "dynamic" determination of threshold based on image properties may be a more robust solution. In this paper, we use the Gabor filter to generate a features from regions of interest (ROIs) detected by the the SIFT technique (Shift- Invariant Feature Transform). These features are used to train a neural network for the task of image thresholding. The average of segmentation accuracies for a set of test images is calculated by comparing every segmented image with its gold standard image.

10:30AM *Self-Organizing Neural Population Coding for Improving Robotic Visuomotor Coordination [no. 310]*
Tao Zhou, Piotr Dudek and Bertram Shi, Hong Kong University of Science and Technology, Hong Kong; University of Manchester, United Kingdom

We present an extension of Kohonen's Self Organizing Map (SOM) algorithm called the Self Organizing Neural Population Coding (SONPC) algorithm. The algorithm adapts online the neural population encoding of sensory and motor coordinates of a robot according to the underlying data distribution. By allocating more neurons towards area of sensory or motor space which are more frequently visited, this representation improves the accuracy of a robot system on a visually guided reaching task. We also suggest a Mean Reflection method to solve the notorious border effect problem encountered with SOMs for the special case where the latent space and the data space dimensions are the same.

10:50AM *Robust Model Predictive Control of Nonlinear Affine Systems Based on a Two-layer Recurrent Neural Network [no. 29]*
Zheng Yan and Jun Wang, The Chinese University of Hong Kong, Hong Kong

A robust model predictive control (MPC) method is proposed for nonlinear affine systems with bounded disturbances.The robust MPC technique requires on-line solution of a minimax optimal control problem. The minimax strategy means that worst-case performance with respect to uncertainties is optimized. The minimax optimization problem involved in robust MPC is reformulated to a minimization problem and then is solved by using a recurrent neural network. Numerical examples are included to illustrate the effectiveness of the proposed method.

11:10AM *Battery State of Charge Estimation Based on a Combined Model of Extended Kalman Filter and Neural Networks [no. 447]*
Zhihang Chen, Shiqi Qiu, M.Abul Masrur and Yi Lu Murphey, The University of Michigan-Dearborn, United States; U.S. Army RDECOM-TARDE, United States

This paper presents our research in battery State of Charge (SOC) estimation for intelligent battery management. Our research focus is to investigate online dynamic SOC estimation using a combination of Kalman filtering and a neural network. First, we developed a method to model battery hysteresis effects using Extended Kalman Filter (EKF). Secondly, we designed a SOC estimation model, NN-EKF model, that incorporates the estimation made by the EKF into a neural network. The proposed methods have been evaluated using real data acquired from two different batteries, a lithium-ion battery U1-12XP and a NiMH battery with 1.2V and 3.4 Ah. Our experiments show that our EKF method developed to model battery hysteresis based on separated charge and discharge Open Circuit Voltage (OCV) curves gave the top performances in estimating SOC when compared with other advanced methods. Secondly, the NN-EKF model for SOC estimation gave the best SOC estimation with and without temperature data.

Session Mo1-5: Supervised, Unsupervised and Ensemble Learning

Monday, August 1, 9:30AM-11:30AM, Room: Carmel, Chair: Haibo He

9:30AM *Nonlinear Multi-model Ensemble Prediction Using Dynamic Neural Network with Incremental Learning [no. 598]*
Michael Siek and Solomatine Dimitri, UNESCO-IHE Institute for Water Education, Netherlands

This paper introduces several nonlinear multi-model ensemble techniques for multiple chaotic models in high-dimensional phase space by means of artificial neural networks. A chaotic model is built by way of the time-delayed phase space reconstruction of the time series from observables. Several predictive global and local models, including Multi-layered Perceptron Neural Network (MLP-NN), are constructed and a number of multi-model ensemble techniques are implemented to produce more accurate hybrid models. One of these techniques is the nonlinear multi-model ensemble using one kind of dynamic neural network so-called Focused Time Delay Neural Network (FTDNN) with batch and incremental learning algorithms. The proposed techniques were used and tested for predicting storm surge dynamics in the North Sea. The results showed that the accuracy of multi-model ensemble predictions is generally improved in comparison to the one by single models. An FTDNN with incremental learning is more desirable for real-time operation, however in our experiments it was less accurate than batch learning.

9:50AM *A Semi-supervised Clustering Algorithm that Integrates Heterogeneous Dissimilarities and Data Sources [no. 366]*
Manuel Martin-Merino, University Pontificia of Salamanca, Spain

Clustering algorithms depend strongly on the dissimilarity considered to evaluate the sample proximities. In real applications, several dissimilarities are available that may come from different object representations or data sources. Each dissimilarity provides usually complementary information about the problem. Therefore, they should be integrated in order to reflect accurately the object proximities. In many applications, the user feedback or the a priory knowledge about the problem provide pairs of similar and dissimilar examples. In this paper, we address the problem of learning a linear combination of dissimilarities using side information in the form of equivalence constraints. The minimization of the error function is based on a quadratic optimization algorithm. A smoothing term is included that penalizes the complexity of the family of distances and avoids overfitting. The experimental results suggest that the method proposed outperforms a standard metric learning algorithm and improves classification and clustering results based on a single dissimilarity and data source.

10:10AM *Uncertainty Sampling Methods to Select Datasets for Active Meta-Learning [no. 237]*
Ricardo Prudencio, Carlos Soares and Teresa Ludermir, UFPE, Brazil; Universidade do Porto, Portugal

Several meta-learning approaches have been developed for the problem of algorithm selection. In this context, it is of central importance to collect a sufficient number of datasets to be used as meta-examples in order to provide reliable results. Recently, some proposals to generate datasets have addressed this issue with successful results. These proposals include datasetoids, which is a simple manipulation method to obtain new datasets from existing ones. However, the increase in the number of datasets raises another issue: in order to generate meta-examples for training, it is necessary to estimate the performance of the algorithms on the datasets. This typically requires running all candidate algorithms on all datasets, which is computationally very expensive. In a recent paper, active meta-learning has been used to address this problem. An uncertainty sampling method for the k-NN algorithm using a least confidence score based on a distance measure was employed. Here we extend that work, namely by investigating three hypotheses: 1) is there advantage in using a frequency-based least confidence score over the distance-based score? 2) given that the meta-learning problem used has three classes, is it better to use a margin-based score? and 3) given that datasetoids are expected to contain some noise, are better results achieved by starting the search with all datasets already labeled? Some of the results obtained are unexpected and should be further analyzed. However, they confirm that active meta-learning can significantly reduce the computational cost of meta-learning with potential gains in accuracy.

10:30AM *Supervised Learning in a Single Layer Dynamic Synapses Neural Network [no. 468]*
Ali Yousefi, Alireza A. Dibazar and Theodore W. Berger, University of Southern California, United States

The main focus of this paper is to introduce a new supervised learning algorithm for spiking neural networks. The learning algorithm minimizes the overall differences between spike times of target and test spike trains by utilizing a new quantitative similarity measure which has been defined in this work. The actual membrane potential of a post-synaptic neuron is adjusted at the time of spikes based on what has been measured from similarity measure in order to generate the desired membrane potential. Finally, by utilizing gradient descent algorithm, the parameters of the spiking neural network are tuned to generate the desired output membrane potential. The proposed algorithm was applied to tune the facilitation, depression, and synaptic weight constants of the Dynamic Synapses Neural Network - DSNN - for the aim of input-output functional mapping. The simulation results show that the system identification task converges to the global optimum. The rate-to- time coding simulation performs with more than 75 percent accuracy. The performance of both system identification and rate-to-time coding is due to adaptation of short and long term synaptic parameters which cannot be accomplished if only synaptic weight is adapted.

10:50AM *Supervised Matrix Factorization with Sparseness Constraints and Fast Inference [no. 212]*
Markus Thom, Roland Schweiger and Guenther Palm, Daimler AG, Germany; University of Ulm, Germany

Non-negative Matrix Factorization is a technique for decomposing large data sets into bases and code words, where all entries of the occurring matrices are non-negative. A recently proposed technique also incorporates sparseness constraints, in such a way that the amount of nonzero entries in both bases and code words becomes controllable. This paper extends the Non-negative Matrix Factorization with Sparseness Constraints. First, a modification of the optimization criteria ensures fast inference of the code words. Thus, the approach is real-time capable for use in time critical applications. Second, in case a teacher signal is associated with the samples, it is considered in order to ensure that inferred code words of different classes can be well distinguished. Thus, the derived bases generate discriminative code words, which is a crucial prerequisite for training powerful classifiers. Experiments on natural image patches show, similar to recent results in the field of sparse coding algorithms, that Gabor-like filters are minimizing the reconstruction error while retaining inference capabilities. However, applying the approach with incorporation of the teacher signal to handwritten digits yields morphologically completely different bases, while achieving superior classification results.

11:10AM *Conditional Multi-Output Regression [no. 62]*
Chao Yuan, Siemens Corporate Research, United States

In multi-output regression, the goal is to establish a mapping from inputs to multivariate outputs that are often assumed unknown. However, in practice, some outputs may become available. How can we use this extra information to improve our prediction on the remaining outputs? For example, can we use the job data released today to better predict the house sales data to be released tomorrow? Most previous approaches use a single generative model to model the joint predictive distribution of all outputs, based on which unknown outputs are inferred conditionally from the known outputs. However, learning such a joint distribution for all outputs is very challenging and also unnecessary if our goal is just to predict each of the unknown outputs. We propose a conditional model to directly model the conditional probability of a target output on both inputs and all other outputs. A simple generative model is used to infer other outputs if they are unknown. Both models only consist of standard regression predictors, for example, Gaussian process, which can be easily learned.

Session Mo1-6: Feature Extraction

Monday, August 1, 9:30AM-11:30AM, Room: Santa Clara, Chair: Seiichi Ozawa

9:30AM *Bio-inspired Meta-heuristic as feature selector in Ensemble Systems: A Comparative Analysis [no. 247]*

Laura Santana, Anne Canuto and Ligia Silva, Federal University of RN, Brazil

Committees of classifiers, also known as ensemble systems, are composed of individual classifiers, organized in a parallel way and their output are combined in a combination method, which provides the final output of the system. In the context of these systems, feature selection methods can be used to provide different subsets of attributes for the individual classifiers, aiming to reduce redundancy among the attributes of a pattern and to increase the diversity in such systems. Since the problem of feature selection can be reduced to a search problem and that an exhaustive search for the subsets of attributes can be considered NP-hard, heuristic search can be adopted for solving this problem. This paper aims to introduce two important optimization techniques (Ant-colony and particle swarm) as a method to select attributes in an ensemble system as well as to compare their performance with Genetic Algorithm, whose research is well established in this area. These three algorithms have in common the fact that they bio-inspired meta-heuristics, since their search rules aim to simulate some aspects of the behavior of living beings.

9:50AM *Group Lasso Regularized Multiple Kernel Learning for Heterogeneous Feature Selection [no. 525]*

Yi-Ren Yeh, Yung-Yu Chung, Ting-Chu Lin and Yu-Chiang Frank Wang, Academia Sinica, Taiwan; Iowa State University, United States

We propose a novel multiple kernel learning (MKL) algorithm with a group lasso regularizer, called group lasso regularized MKL (GL-MKL), for heterogeneous feature selection. We extend the existing MKL algorithm and impose a mixed L1 and L2 norm constraint (known as group lasso) as the regularizer. The optimal base kernels including the associated weights and kernel parameters can be determined by our GL-MKL, which results in a compact set of features for comparable or improved recognition performance. The use of our GL-MKL avoids the problem of choosing the proper technique to normalize the feature attributes when they are collected from heterogeneous domains and thus different properties and distribution ranges. Our approach does not need to exhaustively search for the entire feature space when performing feature selection like prior sequential-based feature selection methods did, and we do not require any prior knowledge on the optimal size of the feature subset either. Comparisons with existing MKL or sequential-based feature selection methods on a variety of datasets confirm the effectiveness of our method in selecting a compact feature subset for comparable or improved classification performance.

10:10AM *GA-based Feature Selection Approach in Biometric Hand Systems [no. 75]*

Rafael Marcos Luque, David Elizondo, Ezequiel Lopez-Rubio and Esteban Jose Palomo, University of Malaga, Malaga, Spain; De Monfort University, Leicester, United Kingdom

In this paper, a novel methodology for using feature selection in hand biometric systems, based on genetic algorithms and mutual information is presented. A hand segmentation algorithm based on adaptive threshold and active contours is also applied, in order to deal with complex backgrounds and non-homogeneous illumination. The aim of this methodology is two-fold. On the one hand, getting robust features in biometric systems with no restriction in the hand-pose and in its orientation with regard to the camera. On the other hand, providing a subset of features which reduce the complexity of the identification process and maximize the generalization rate of the classifiers. By using the IITD Palmprint Database, which is an example of such free hand-pose biometric systems, the experimental results show that it is not always necessary to apply sophisticated classification methods to obtain good accuracy results. Simple classifiers such as kNN and LDA together with this feature selection approach, get even better generalisation rates than other more elaborate and complex methods.

10:30AM *On the Behavior of Feature Selection Methods Dealing with Noise and Relevance over Synthetic Scenarios [no. 324]*

Veronica Bolon-Canedo, Noelia Sanchez-Marono and Amparo Alonso-Betanzos, University of Corunna, Spain

Adequate identification of relevant features is fundamental in real world scenarios. The problem is specially important when the datasets have a much larger number of features than samples. However, in most cases, the relevant features in real datasets are unknown. In this paper several synthetic datasets are employed to test the effectiveness of different feature selection methods over different artificial classification scenarios, such as altered features (noise), presence of a crescent number of irrelevant features and a small ratio between number of samples and number of features. Six filters and two embedded methods are tested over five synthetic datasets, so as to be able to choose a robust and noise tolerant method, paving the way for its application to real datasets in the classification domain.

10:50AM *A Fast Incremental Kernel Principal Component Analysis for Learning Stream of Data Chunks [no. 600]*

Takaomi Tokumoto and Seiichi Ozawa, Kobe University, Japan

In this paper, a new incremental learning algorithm of Kernel Principal Component Analysis (KPCA) is proposed for online feature extraction in pattern recognition problems. The proposed algorithm is derived by extending the Takeuchi et al.'s Incremental KPCA (T-IKPCA) that can learn a new data incrementally without keeping past training data. However, even if more than two data are given in a chunk, T-IKPCA should learn them individually; that is, in order to update the eigen-feature space, the eigenvalue decomposition should be performed for every data in the chunk. To alleviate this problem, we extend T-IKPCA such that an eigen-feature space learning is conducted by performing the eigenvalue decomposition only once for a chunk of given data. In the proposed IKPCA, whenever a new chunk of training data are given, linearly independent data are first selected based on the cumulative proportion. Then, the eigenspace augmentation is conducted by calculating the coefficients for the selected linearly independent data, and the eigen-feature space is rotated based on the rotation matrix that can be obtained by solving a kernel eigenvalue problem. To verify the effectiveness of the proposed IKPCA, the learning time and the accuracy of eigenvectors are evaluated using the three UCI benchmark data sets. From the experimental results, we confirm that the proposed IKPCA can learn an eigen-feature space very fast without sacrificing the recognition accuracy.

11:10AM *A Cortex-like Model for Rapid Object Recognition Using Feature-Selective Hashing [no. 216]*
Yu-Ju Lee, Chuan-Yung Tsai and Liang-Gee Chen, National Taiwan University, Taiwan

Building models by mimicking the structures and functions of visual cortex has always been a major approach to implement a human-like intelligent visual system. Several feedforward hierarchical models have been proposed and perform well on invariant feature extraction. However, less attention has been given to the biologically plausible feature matching model which mimics higher levels of the ventral stream. In this work, with the inspirations from both neuroscience and computer science, we propose a framework for rapid object recognition and present the feature-selective hashing scheme to model the memory association in inferior temporal cortex. The experimental results on 1000-class ALOI dataset demonstrate its efficiency and scalability of learning on feature matching. We also discuss the biological plausibility of our framework and present a bio- plausible network mapping of the feature-selective hashing scheme.

Monday, August 1, 11:40AM-12:40PM

Special Session Mo2-1: Hybrid Intelligent Systems

Monday, August 1, 11:40AM-12:40PM, Room: Cedar, Chair: Patricia Melin

11:40AM *Genetic Optimization of Ensemble Neural Networks for Complex Time Series Prediction [no. 64]*
Martha Pulido, Patricia Melin and Oscar Castillo, Tijuana Institute of Technology, Mexico

This paper describes an optimization method for ensemble neural networks with fuzzy aggregation for forecasting complex time series using genetic algorithms. The time series under consideration for testing the hybrid approach is the Mackey-Glass, and results for the optimization of type-1 fuzzy system aggregation in the ensemble neural network are shown.

12:00PM *Parallel Genetic Algorithms for Optimization of Modular Neural Networks in Pattern Recognition [no. 86]*
Fevrier Valdez, Patricia Melin and Herman Parra, Tijuana Institute of Technology, Mexico

We described in this paper the use of Modular Neural Networks (MNN) for pattern recognition in parallel using a cluster of computers with a master-slave topology. In this paper, we are proposing the use of MNN to face recognition with large databases to validate this approach. Also, a parallel genetic algorithm to optimization architecture was used.

12:20PM *Hierarchical genetic optimization of modular neural networks and their type-2 fuzzy response integrators for human recognition based on multimodal biometry [no. 278]*
Daniela Sanchez, Patricia Melin and Oscar Castillo, Tijuana Institute of Technology, Mexico

In this paper we describe the application of a Modular Neural Network (MNN) for iris, ear and voice recognition for a benchmark database. The proposed MNN architecture consists of three modules; iris, ear and voice. Each module is divided into other three sub modules. Each sub module contains different information, this means one third of the database for each sub module. We considered the integration of each biometric measure separately. Later, we proceed to integrate these modules with a fuzzy integrator. Also, we performed optimization of the modular neural networks and the fuzzy integrators using genetic algorithms, and comparisons were made between optimized results and the results without optimization.

Session Mo2-2: Models of Neurobiological Disorders

Monday, August 1, 11:40AM-12:40PM, Room: Pine, Chair: Todd Leen

11:40AM *Effects of Compensation, Connectivity and Tau in a Computational Model of Alzheimer's Disease [no. 136]*
Mark Rowan, University of Birmingham, United Kingdom

This work updates an existing, simplistic computational model of Alzheimer's Disease (AD) to investigate the behaviour of synaptic compensatory mechanisms in neural networks with small-world connectivity, and varying methods of calculating compensation. It additionally introduces a method for simulating tau neurofibrillary pathology, resulting in a more dramatic damage profile. Small- world connectivity is shown to have contrasting effects on capacity, retrieval time, and robustness to damage, whilst the use of more easily-obtained remote memories rather than recent memories for synaptic compensation is found to lead to rapid network damage.

12:00PM *Simulating Parkinson's disease patient deficits using a COVIS-based computational model [no. 67]*
Sebastien Helie, Erick J. Paul and F. Gregory Ashby, University of California, Santa Barbara, United States

COVIS is a neurobiologically motivated model of perceptual category learning. It includes two competing systems: the hypothesis-testing system mediates learning and performance in tasks requiring explicit reasoning; the procedural system mediates learning and performance in tasks that are achieved procedurally through trial and error learning when no explicit rule/strategy exists. Here we describe a computational implementation of COVIS used to model the differential effects of dopamine depletion on performance in a perceptual category-learning task and the simplified Wisconsin Card Sorting Test (WCST).

12:20PM *Modeling Prosopagnosia Using Dynamic Artificial Neural Networks [no. 430]*

Robyn Vandermeulen, Laurence Morissette and Sylvain Chartier, University of Ottawa, Canada

Prosopagnosia is a brain disorder causing the inability to recognize faces. Previous studies have shown that the lesions producing the disorder can occur in diverse areas of the brain. However, the most common region is the "fusiform face area" (FFA). In order to model the basic properties of prosopagnosia two networks have been used concurrently: the Feature Extracting Bidirectional Associative Memory (FEBAM-SOM) and the Bidirectional Associative Memory (BAM). The FEBAM-SOM creates a 2D topological map from correlated inputs through the categorization of various exemplars (faces and various objects). This model has the advantage of using a sparse representation which encompass both localist and distributed encoding. This process simulates the FFA in the brain by exhibiting attractor-like behavior for the categorization of all faces. Once the faces have been learned, the BAM model associates specific faces (and objects) to their corresponding semantic labels. Simulations were performed to study the recall performance in function of the size of the lesions. Results show that the recall performance of the names associated with faces decrease with the size of lesion without affecting the performance of the objects.

Special Session Mo2-3: Neuro-Cognitive Modelling of Auditory Perception, Learning, and Speech Understanding

Monday, August 1, 11:40AM-12:40PM, Room: Oak, Chair: Harry Erwin

11:40AM *Attention Driven Computational Model of the Auditory Midbrain for Sound Localization in Reverberant Environments [no. 275]*

Jindong Liu, Harry Erwin and Guang-Zhong Yang, Imperial College London, United Kingdom; University of Sunderland, United Kingdom

In this paper, an auditory attention driven computational model of the auditory midbrain is proposed based on a spiking neural network in order to localize attended sound sources in reverberant environments. Both bottom-up attention driven by sensors and top-down attention driven by the cortex are modelled at the level of an auditory midbrain nucleus - the inferior colliculus (IC). Improvements of the model are made to increase biological plausibility. First, inter-neuron inhibitions are modelled among the IC neurons which have the same characteristic frequency but different spatial response. This is designed to mimic the precedence effect to produce localization results in reverberate environments. Secondly, descending projections from the auditory cortex (AC) to the IC are model to simulate the top-down attention so that focused sound sources can be better sensed in noise or multiple sound source situations. Our model is implemented on a mobile robot with a manikin head equipped with binaural microphones and tested in a real environment. The results shows that our attention driven model can give more accurate localization results than prior models.

12:00PM *A Comparison of Sound Localisation Techniques using Cross-Correlation and Spiking Neural Networks for Mobile Robotics [no. 414]*

Julie Wall, Thomas McGinnity and Liam Maguire, University of Ulster, United Kingdom

This paper outlines the development of a cross-correlation algorithm and a spiking neural network (SNN) for sound localisation based on real sound recorded in a noisy and dynamic environment by a mobile robot. The SNN architecture aims to simulate the sound localisation ability of the mammalian auditory pathways by exploiting the binaural cue of interaural time difference (ITD). The medial superior olive was the inspiration for the SNN architecture which required the integration of an encoding layer which produced biologically realistic spike trains, a model of the bushy cells found in the cochlear nucleus and a supervised learning algorithm. The experimental results demonstrate that biologically inspired sound localisation achieved using a SNN can compare favourably to the more classical technique of cross-correlation.

12:20PM *Biologically-inspired neural coding of sound onset for a musical sound classification task [no. 301]*

Michael Newton and Leslie Smith, University of Stirling, United Kingdom

A biologically-inspired neural coding scheme for the early auditory system is outlined. The cochlea response is simulated with a passive gammatone filterbank. The output of each bandpass filter is spike-encoded using a zero-crossing based method over a range of sensitivity levels. The scheme is inspired by the highly parallellised nature of the auditory nerve innervation within the cochlea. A key aspect of early auditory processing is simulated, namely that of onset detection, using leaky integrate-and-fire neuron models. Finally, a time-domain neural network (the echo state network) is used to tackle the what task of auditory perception using the output of the onset detection neurons alone. A set of interim results are presented.

Session Mo2-4: Neurocontrol II: Applications

Monday, August 1, 11:40AM-12:40PM, Room: Monterey, Chair: Edgar Sanchez

11:40AM *Discrete-Time Neural Identifier for Electrically Driven Nonholonomic Mobile Robots [no. 234]*

Alma Y. Alanis, Lopez-Franco Michel, Arana-Daniel Nancy and Lopez-Franco Carlos, CUCEI, University of Guadalajara, Mexico

A nonlinear discrete-time neural identifier for discrete-time unknown nonlinear systems, in presence of external and internal uncertainties are presented. This identifier is based on a discrete-time recurrent high order neural network (RHONN) trained with an extended Kalman filter (EKF)-based algorithm. Applicability of the scheme is illustrated via simulation for an electrically driven nonholonomic mobile robot.

12:00PM *Discrete-Time Neural Block Control for a Doubly Fed Induction Generator [no. 388]*

Riemann Ruiz, Edgar Sanchez and Alexander Loukianov, CINVESTAV-IPN, Unidad Guadalajara, Mexico; CINVESTAV-IPN, Unidad Saltillo, Mexico

This paper proposes a control scheme based on the discrete-time block control technique using sliding modes, for a doubly fed induction generator connected to an infinity bus. In order to obtain the generator mathematical model, it is proposed to use a recurrent high order neural network (RHONN) identifier, which is trained with an extended Kalman filter (EFK) algorithm. Parameter changes are applied to test the scheme robustness. Its performance is illustrated via simulations.

12:20PM *Nonlinear Adaptive Flight Control Using Sliding Mode Online Learning [no. 602]*

Thomas Krueger, Philipp Schnetter, Robin Placzek and Peter Voersmann, Technische Universitaet Braunschweig, Institute of Aerospace Systems, Germany

An expanded model inversion flight control strategy using sliding mode online learning is presented and implemented for an small unmanned aircraft system (UAS). These low-cost aircraft are very susceptible towards nonlinearities like atmospheric turbulence, model uncertainties or system failures, so adaptive flight control strategies possess a high potential to improve the degree of automation of such systems. The concept of feedback linearization is combined with feedforward neural networks to compensate for inversion errors and other nonlinearities. The backpropagation-based adaption laws of the network weights are extended with terms to take into account any approximation error and the so called e-modification. Within these adaption laws the standard gradient descent backpropagation algorithm is expanded with the concept of sliding mode control (SMC), which enables stable adaptivity of the learning rate and so tends to offer a higher speed of convergence. The definition of the sliding mode function assures convergence of the network's output error towards the sliding surface, while considering the system's stability. The SMC-based flight control strategy is tested and compared with the standard gradient descent backpropagation algorithm.

Session Mo2-5: Clustering

Monday, August 1, 11:40AM-12:40PM, Room: Carmel, Chair: Donald Wunsch

11:40AM *Structured Clustering with Automatic Kernel Adaptation [no. 288]*

Weike Pan and James Kwok, Hong Kong University of Science and Technology, Hong Kong

Clustering is an invaluable data analysis tool in a variety of applications. However, existing algorithms often assume that the clusters do not have any structural relationship. Hence, they may not work well in situations where such structural relationships are present (e.g., it may be given that the document clusters are residing in a hierarchy). Recently, the development of the kernel-based structured clustering algorithm CLUHSIC tries to alleviate this problem. But since the input kernel matrix is defined purely based on the feature vectors of the input data, it does not take the output clustering structure into account. Consequently, a direct alignment of the input and output kernel matrices may not assure good performance. In this paper, we reduce this mismatch by learning a better input kernel matrix using techniques from semi-supervised kernel learning. We combine manifold information and output structure information with pairwise clustering constraints that are automatically generated during the clustering process. Experiments on a number of data sets show that the proposed method outperforms existing structured clustering algorithms.

12:00PM *A Low-Order Model of Biological Neural Networks for Hierarchical or Temporal Pattern Clustering, Detection and Recognition [no. 35]*

James Lo, University of Maryland Baltimore County, United States

A low-order model (LOM) of biological neural networks, which is biologically plausible, is herein reported. LOM is a recurrent hierarchical network composed with novel models of dendritic trees for encoding information, spiking neurons for computing subjective probability distributions and generating spikes, nonspiking neurons for transmitting inhibitory graded signals to modulate their neighboring spiking neurons, unsupervised and supervised covariance learning and accumulation learning mechanisms, synapses, a maximal generalization scheme, and feedback connections with different delay durations. An LOM with a main network that learns without supervision and clusters similar patterns, and offshoot structures that learn with supervision and assign labels to clusters formed in the main network is proposed as a learning machine that learns and retrieves easily, generalizes maximally on corrupted, distorted and occluded temporal and spatial patterns, and utilizes fully the spatially and temporally associated information.

12:20PM *A Hierarchical Approach to Represent Relational Data Applied to Clustering Tasks [no. 644]*
Joao Carlos Xavier Junior, Anne Canuto, Alex Freitas, Luiz Goncalves and Carlos Silla Jr., Federal University of RN, Brazil; University of Kent, United Kingdom

Nowadays, the representation of many real word problems needs to use some type of relational model. As a consequence, information used by a wide range of systems has been stored in multi relational tables. However, from a data mining point of view, it has been a problem, since most of the traditional data mining algorithms have not been originally proposed to handle this type of data without discarding relationship information. Aiming to ameliorate this problem, we propose a hierarchical approach for handling relational data. In this approach the relational data is converted into a hierarchical structure (the main table as the root and the relations as the nodes). This hierarchical way to represent relational data can be used either for classification or clustering purposes. In this paper, we will use it in clustering algorithms. In order to do so, we propose a hierarchical distance metric to compute the similarity between the tables. In the empirical analysis, we will apply the proposed approach in two well-known clustering algorithms (k-means and agglomerative hierarchical). Finally, this paper also compares the effectiveness of our approach with one existing relational approach.

Session Mo2-6: Music Recognition & Generation

Monday, August 1, 11:40AM-12:40PM, Room: Santa Clara, Chair: Wlodzislaw Duch

11:40AM *Generation of composed musical structures through recurrent neural networks based on chaotic inspiration [no. 702]*
Andres Coca, Roseli Romero and Liang Zhao, USP, Brazil

In this work, an Elman recurrent neural network is used for automatic musical structure composition based on the style of a music previously learned during the training phase. Furthermore, a small fragment of a chaotic melody is added to the input layer of the neural network as an inspiration source to attain a greater variability of melodies. The neural network is trained by using the BPTT (back propagation through time) algorithm. Some melody measures are also presented for characterizing the melodies provided by the neural network and for analyzing the effect obtained by the insertion of chaotic inspiration in relation to the original melody characteristics. Specifically, a similarity melodic measure is considered for contrasting the variability obtained between the learned melody and each one of the composite melodies by using different quantities of inspiration musical notes.

12:00PM *A SOM-based Multimodal System for Musical Query-by-Content [no. 82]*
Kyle Dickerson and Dan Ventura, Brigham Young University, United States

The ever-increasing density of computer storage devices has allowed the average user to store enormous quantities of multimedia content, and a large amount of this content is usually music. We present a query-by-content system which searches the actual audio content of the music and supports querying in several styles using a Self-Organizing Map as its basis. Empirical results demonstrate the viability of this approach for musical query-by-content.

12:20PM *Identification of Key Music Symbols for Optical Music Recognition and On-Screen Presentation [no. 405]*
Tatiana Tambouratzis, University of Piraeus, Greece

A novel optical music recognition (OMR) system is put forward, where the on-line custom-made on-screen presentation of the music score (MS) is promoted via the recognition of key music symbols only. The proposed system does not require prior manuscript alignment or noise removal. Following the segmentation of each MS page into systems and the identification of staves, staff lines and measures, music symbol recognition is limited to the identification of the clefs, accidentals and time signatures. Consequently, significantly less computational effort than that required by classic OMR systems is necessary, without an observable compromise in the quality of the on-screen presentation of the MS. Identification of the aforementioned music symbols is performed via probabilistic neural networks (PNN's), which are trained on a small set of exemplars from the MS itself. Initial results are promising in terms of efficiency, identification accuracy and quality of viewing.

Monday, August 1, 1:50PM-2:50PM

Plenary Talk Mo-Plen2: Plenary Session

Monday, August 1, 1:50PM-2:50PM, Room: Oak, Chair: DeLiang Wang

1:50PM *Neural Network ReNNaissance*
Juergen Schmidhuber, Swiss Institute for Artificial Intelligence, Switzerland

Our fast deep recurrent neural nets recently achieved numerous 1st ranks in many pattern recognition competitions and benchmarks, without any unsupervised pre-training, sometimes (but not always) profiting from weight sharing and convolution, contrast enhancement, max-pooling, and sparse network connectivity. GPUs speed up learning by a factor of up to 50, thus contributing to the ongoing second Neural Network ReNNaissance. The future, however, will belong to active systems that learn to sequentially shift attention towards informative inputs, not only solving externally posed tasks, but also their own self-generated tasks designed to improve their understanding of the world according to our Formal Theory of Fun and Creativity, which requires two interacting modules: (1) an adaptive (possibly neural) predictor or compressor or model of the growing data history as the agent is interacting with its environment, and (2) a (possibly neural) reinforcement learner. The learning progress of (1) is the FUN or intrinsic reward of (2). That is, (2) is motivated to invent skills leading to interesting or surprising novel patterns that (1) does not yet know but can easily learn (until they become boring). We discuss how this principle explains science, art, music and humor.

Monday, August 1, 3:20PM-5:20PM

Special Session Mo3-1: Emerging Neuromorphic Hardware: Architectures and Applications

Monday, August 1, 3:20PM-5:20PM, Room: Cedar, Chair: Robinson Pino, Helen Li and Partha Dutta

3:20PM *Reconfigurable N-Level Memristor Memory Design [no. 642]*

Cory Merkel, Nakul Nagpal, Sindhura Mandalapu and Dhireesha Kudithipudi, RIT, United States

Memristive devices have gained significant research attention lately because of their unique properties and wide application spectrum. In particular, memristor-based resistive random access memory (RRAM) offers the high density, low power, and low volatility required for next-generation non-volatile memory. The ability to program memristive devices into several different resistance states has also led to the proposal of multilevel RRAM. This work analyzes the application of thin-film memristors as N-level RRAM elements. The tradeoffs between the number of memory levels and each RRAM element's reliability will be discussed. A metric is proposed to rate each RRAM element in the presence of process variations. A memory architecture is also presented which allows the number of memory levels to be reconfigured based on different application characteristics. The proposed architecture can achieve a write time speedup of 5.9 over other memristor memory architectures with 80% ion mobility degradation.

3:40PM *A Columnar V1/V2 Visual Cortex Model and Emulation using a PS3 Cell-BE Array [no. 354]*

Robinson Pino, Michael Moore, Jason Rogers and Qing Wu, AFRL, United States; ITT, United States; SUNY, United States

The United States Air Force Research Laboratory (AFRL) has been exploring the implementation of neurophysiological and psychological constructs to develop a hyper-parallel computing platform. This approach is termed neuromorphic computing. As part of that effort, the primary visual cortex (V1) has been modeled in high performance computing facility. The current columnar V1 model is being expanded to include binocular disparity and motion perception. Additionally, V2 thick and pale stripes are being added to produce a V1/V2 stereomotion and form perception system. Both the V1 and V2 models are based upon structures approximating neocortical minicolumns and functional columns. The neuromorphic strategies employed include columnar organization, integrate- and-fire neurons, temporal coding, point attraction recurrent networks, Reichardt detectors and "confabulation" networks. The interest is driven by the value of applications which can make use of highly parallel architectures we expect to see surpassing one thousand cores per die in the next few years. A central question we seek to answer is what the architecture of hyper-parallel machines should be. We also seek to understand computational methods akin to how a brain deals with sensation, perception, memory, attention decision- making.

4:00PM *Multiple Memristor Read and Write Circuit for Neuromorphic Applications [no. 548]*

Chris Yakopcic, Tarek Taha, Guru Subramanyam and Stanley Rogers, University of Dayton, United States; Air Force Research Laboratory, United States

A memristor based write circuit is presented that can update multiple memristors using a neuron spike generated by the Izhikevich model. A memristor read circuit is also presented that is capable of quantizing the resistance into 5 discrete values that could be digitally decoded. Together, these circuits provide the basic block for a memristor based neuromorphic architecture. The memristors were modeled using published device characterization data.

4:20PM *An Event-Driven Model for the SpiNNaker Virtual Synaptic Channel [no. 411]*

Alexander Rast, Francesco Galluppi, Sergio Davies, Luis Plana and Thomas Sharp, University of Manchester, United Kingdom

Neural networks present a fundamentally different model of computation from conventional sequential hardware, making it inefficient for very-large-scale models. Current neuromorphic devices do not yet offer a fully satisfactory solution even though they have improved simulation performance. SpiNNaker introduces a different approach, the "neuromimetic" architecture, that maintains the neural optimisation of dedicated chips while offering FPGA-like universal configurability. Central to this parallel multiprocessor is an asynchronous event-driven model that uses interrupt-generating dedicated hardware on the chip to support real-time neural simulation. In turn this requires an event-driven software model: a rethink as fundamental as that of the hardware. We examine this event-driven software model for an important hardware subsystem, the previously-introduced virtual synaptic channel. Using a scheduler-based system service architecture, the software can "hide" low-level processes and events from models so that the only event the model sees is "spike received". Results from simulation on-chip demonstrate the robustness of the system even in the presence of extremely bursty, unpredictable traffic, but also expose important model-level tradeoffs that are a consequence of the physical nature of the SpiNNaker chip. This event-driven subsystem is the first component of a library-based development system that allows the user to describe a model in a high-level neural description environment and be able to rely on a lower layer of system services to execute the model efficiently on SpiNNaker. Such a system realises a general-purpose platform that can generate an arbitrary neural network and run it with hardware speed and scale.

4:40PM *Review and Unification of Learning Framework in Cog Ex Machina Platform for Memristive Neuromorphic Hardware [no. 531]*

Anatoli Gorchetchnikov, Massimiliano Versace, Heather Ames, Ben Chandler and Jasmin Leveille, Boston University, United States

Realizing adaptive brain functions subserving perception, cognition, and motor behavior on biological temporal and spatial scales remains out of reach for even the fastest computers. Newly introduced memristive hardware approaches open the opportunity to implement dense, low-power synaptic memories of up to 10^{15} bits per square centimeter. Memristors have the unique property of ``remembering" the past history of their stimulation in their resistive state and do not require power to maintain their memory, making them ideal candidates to implement large arrays of plastic synapses supporting learning in neural models. Over the past decades, many learning rules have been proposed in the literature to explain how neural activity shapes synaptic connections to support adaptive behavior. To ensure an optimal implementation of a large variety of learning rules in hardware,

some general and easily parameterized form of learning rule must be designed. This general form learning equation would allow instantiation of multiple learning rules through different parameterizations, without rewiring the hardware. This paper characterizes a subset of local learning rules amenable to implementation in memristive hardware. The analyzed rules belong to four broad classes: Hebb rule derivatives with various methods for gating learning and decay, Threshold rule variations including the covariance and BCM families, Input reconstruction-based learning rules, and Explicit temporal trace-based rules.

5:00PM *Biologically Inspired Model for Crater Detection [no. 512]*
Yang Mu, Wei Ding, Dacheng Tao and Tomasz Stepinski, University of Massachusetts Boston, United States; University of Technology Sydney, Australia; University of Cincinnati, United States

Crater detection from panchromatic images has its unique challenges when comparing to the traditional object detection tasks. Craters are numerous, have large range of sizes and textures, and they continuously merge into image backgrounds. Using traditional feature construction methods to describe craters cannot well embody the diversified characteristics of craters. On the other hand, we are gradually revealing the secret of object recognition in the primate's visual cortex. Biologically inspired features, designed to mimic the human cortex, have achieved great performance on object detection problem. Therefore, it is time to reconsider crater detection by using biologically inspired features. In this paper, we represent crater images by utilizing the C1 units, which correspond to complex cells in the visual cortex, and pool over the S1 units by using a maximum operation to reserve only the maximum response of each local area of the S1 units. The features generated from the C1 units have the hallmarks of size invariance and location invariance. We further extract a set of improved Haar features on each C1 map which contain gradient texture information. We apply this biologically inspired based Haar feature to crater detection. Because the feature construction process requires a set of biologically inspired transformations, these features are embedded in a high dimension space. We apply a subspace learning algorithm to find the intrinsic discriminative subspace for accurate classification. Experiments on Mars impact crater dataset show the superiority of the proposed method.

Session Mo3-2: Reinforcement Learning I

Monday, August 1, 3:20PM-5:20PM, Room: Pine, Chair: Georgios Anagnostopoulos

3:20PM *A Reversibility Analysis of Encoding Methods for Spiking Neural Networks [no. 382]*
Cameron Johnson, Sinchan Roychowdhury and Ganesh-Kumar Venayagamoorthy, RTPIS Lab, Missouri University of Science and Technology, United States

There is much excitement surrounding the idea of using spiking neural networks (SNNs) as the next generation of function-approximating neural networks. However, with the unique mechanism of communication (neural spikes) between neurons comes the challenge of transferring real-world data into the network to process. Many different encoding methods have been developed for SNNs, most temporal and some spatial. This paper analyzes three of them (Poisson rate encoding, Gaussian receptor fields, and a dual-neuron n-bit representation) and tests to see if the information is fully transformed into the spiking patterns. An oft-neglected consideration in encoding for SNNs is whether or not the real-world data is even truly being introduced to the network. By testing the reversibility of the encoding methods in this paper, the completeness of the information's presence in the pattern of spikes to serve as an input to an SNN is determined.

3:40PM *Residential Energy System Control and Management using Adaptive Dynamic Programming [no. 49]*
Ting Huang and Derong Liu, University of Illinois at Chicago, United States

In this paper, we apply adaptive dynamic programming to the residential energy system control and management, with an emphasis on home battery use connected to power grids. The proposed scheme is built upon a selflearning architecture with only a single critic module instead of the action-critic dual module architecture. The novelty of the present scheme is its ability to improve the performance as it learns and gains more experience in real-time operations under uncertain changes of the environment. Simulation results demonstrate that the proposed scheme can achieve the minimum electricity cost for residential customers.

4:00PM *A Neural Architecture to Address Reinforcement Learning Problems [no. 615]*
Fernando Von Zuben and Rodrigo Arruda, LBic, UNICAMP. Senior Member, IEEE, Brazil; LBic, UNICAMP, Brazil

In this paper, the Reinforcement Learning problem is formulated equivalently to a Markov Decision Process. We address the solution of such problem using a novel Adaptive Dynamic Programming algorithm which is based on a Multi-layer Perceptron Neural Network composed of a parameterized function approximator called Wire-Fitting. Extending such established model, this work makes use of concepts of eligibility to conceive faster learning algorithms. The advantage of the proposed approach is founded on the capability to handle continuous environments and to learn a better policy while following another. Simulation results involving the automatic control of an inverted pendulum are presented to indicate the effectiveness of the proposed algorithm.

4:20PM *An Improved Neural Architecture for Gaze Movement Control in Target Searching [no. 484]*
Jun Miao, Lijuan Duan, Laiyun Qing and Yuanhua Qiao, Institute of Computing Technology, Chinese Academy of Sciences, China; Beijing University of Technology, China; Graduate University of the Chinese Academy of Sciences, China

This paper presents an improved neural architecture for gaze movement control in target searching. Compared with the four-layer neural structure proposed in [14], a new movement coding neuron layer is inserted between the third layer and the fourth layer in previous structure for finer gaze motion estimation and control. The disadvantage of the previous structure is that all the large responding neurons in the third layer were involved in gaze motion synthesis by transmitting weighted responses to the movement control neurons in the fourth layer. However, these large responding neurons may produce different groups of movement estimation. To discriminate and group these neurons' movement estimation in terms of grouped

connection weights form them to the movement control neurons in the fourth layer is necessary. Adding a new neuron layer between the third layer and the fourth lay is the measure that we solve this problem. Comparing experiments on target locating showed that the new architecture made the significant improvement.

4:40PM *Neural-Network-Based Optimal Control for a Class of Nonlinear Discrete-Time Systems With Control Constraints Using the Iterative GDHP Algorithm [no. 38]*
Derong Liu, Ding Wang and Zhao Dongbin, Chinese Academy of Sciences, China

In this paper, a neural-network-based optimal control scheme for a class of nonlinear discrete-time systems with control constraints is proposed. The iterative adaptive dynamic programming (ADP) algorithm via globalized dual heuristic programming (GDHP) technique is developed to design the optimal controller with convergence proof. Three neural networks are used to facilitate the implementation of the iterative algorithm, which will approximate at each iteration the cost function, the optimal control law, and the controlled nonlinear discrete-time system, respectively. A simulation study is carried out to demonstrate the effectiveness of the present approach in dealing with the nonlinear constrained optimal control problem.

5:00PM *Optimal Control for Discrete-Time Nonlinear Systems with Unfixed Initial State Using Adaptive Dynamic Programming [no. 39]*
Qinglai Wei and Derong Liu, Chinese Academy of Sciences, China

A new epsilon-optimal control algorithm based on the adaptive dynamic programming (ADP) is proposed to solve the finite horizon optimal control problem for a class of discretetime nonlinear systems with unfixed initial state. The proposed algorithm makes the performance index function converges iteratively to the greatest lower bound of all performance indices within an error bound according to epsilon with finite time. The number of optimal control steps can also be obtained by the proposed ADP approach for the situation when the initial state of the system is unfixed. A simulation example is given to show the performance of the present method.

Special Session Mo3-3: Brain-Mind Architectures and Learning Mechanisms

Monday, August 1, 3:20PM-5:20PM, Room: Oak, Chair: John Weng and Asim Roy

3:20PM *The Schizophrenic Brain: A Broken Hermeneutic Circle. Some New Insights and Results [no. 633]*
Peter Erdi, Mihaly Banyai, Vaibhav Diwadkar and Balazs Ujfalussy, 1: Center of Complex Systems Studies, Kalamazoo College, 2: KFKI Research Institute for Particle and Nuclear Physics of the Hungarian Academy of Sciences, Budapest, United States; 1: KFKI Research Institute for Particle and Nuclear Physics of the Hungarian Academy of Sciences, Budapest, 2: Center of Complex Systems Studies, Kalamazoo College, Kalamazoo, MI, Hungary; Dep. Behavioral Neuroscience and Psychiatry, Wayne State University School of Medicine, Detroit,, United States; KFKI Research Institute for Particle and Nuclear Physics of the Hungarian Academy of Sciences, Budapest, Hungary

Schizophrenia is often regarded as a set of symptoms caused by impairments in the cognitive control in macro-networks of the brain. To investigate this hypothesis, an fMRI study involving an associative learning task was conducted with schizophrenia patients and controls. A set of generative models of the BOLD signal generation were defined to describe the interaction of five brain regions (Primary Visual Cortex, Superior Parietal and Inferior Temporal Cortex, Hippocampus and Dorsal Prefrontal Cortex) and the experimental conditions. The models were fitted to the data using Bayesian model inversion. The comparison of different model connectivity structures lead to the finding that in schizophrenia, there are significant impairments in backward connections from prefrontal cortex to hippocampal and temporal regions in patients. These findings fit very well with the predictions of a neuron network model of encoding-recall switching dynamics we have described previously.

3:40PM *A theory of the brain - the brain uses both distributed and localist (symbolic) representation [no. 68]*
Asim Roy, Arizona State University, United States

The issue of whether objects and concepts are represented in the brain by single neurons or multiple ones, where the multiple ones are conceived to represent subconcepts or microfeatures, has plagued brain-related sciences for decades, spawning different scientific fields such as artificial intelligence (AI) and connectionism. It is also a source of dispute within some of these scientific fields. In connectionism, for example, there is never ending debate between the theories of localist (in a sense symbolic) and distributed representation. To resolve this conflict, we analyze a highly publicized class of models used by connectionists (distributed representation theorists) for complex cognitive processes and show that, contrary to their claim, they actually depend on localist (symbolic) representation of higher-level concepts in these models. We also find that these connectionist models use processes similar to symbolic computation. Based on this analysis and the accumulating evidence from single-unit recordings in neurophysiology that shows that single cells can indeed encode information about single objects (e.g. a Jennifer Aniston cell in our brains), we propose the theory that the brain uses both forms of representation, localist and distributed, and that both forms may be necessary, depending on the context. Our other conjecture is that the brain uses both forms of computation, symbolic and distributed (parallel). This theory should finally resolve the decades long conflict about representation and computational processes that has generated divisions within our fields and has stalled our progress towards creating brain-like learning systems.

4:00PM *Three Theorems: Brain-like Networks Logically Reason and Optimally Generalize [no. 626]*
Juyang Weng, Michigan State University, United States

Finite Automata (FA) is a base net for many sophisticated probability-based systems of artificial intelligence. However, an FA processes symbols, instead of images that the brain senses and produces (e.g., sensory images and motor images). Of course, many recurrent artificial neural networks process images. However, their non-calibrated internal states prevent generalization, let alone the feasibility of immediate and error-free learning. I wish to report a general-purpose Developmental Program (DP) for a new type of, brain-anatomy inspired, networks --- Developmental Networks (DNs). The new theoretical results here are summarized by three theorems. (1) From any complex FA that demonstrates human knowledge through its sequence of the symbolic inputs-outputs, the DP incrementally develops a corresponding DN through the image codes of the symbolic inputs-outputs of the FA. The DN learning from the FA is incremental, immediate and error-free. (2) After learning the FA, if the DN freezes its learning but runs, it generalizes optimally for infinitely many image inputs and actions based on the embedded inner-product distance, state equivalence, and the principle of maximum likelihood. (3) After learning the FA, if the DN continues to learn and run, it "thinks" optimally in the sense of maximum likelihood based on its past experience.

4:20PM *Mental Saccades in Control of Cognitive Process [no. 126]*
Janusz Starzyk, Ohio University, United States

This paper proposes a cognitive architecture that uses mental saccades to perform cognitive search in support of motivated behavior and learning. It is intended to control the behavior of robots in real environments and avatars that learn how to operate in virtual worlds. A mental saccade is a parallel concept to the visual saccade and yields a sequential cognitive search for the most likely solution to a problem. This model uses an attention switching mechanism that combines the effect of observations, internal motivations and abstract cognitive planning. Thus, a system that uses this model, will not only follow its internal motivations but will also take advantage of opportunities that present themselves in the environment. This model is intended for development of computational cognition, learning and intelligence in a machine.

4:40PM *CHARISMA: A Context Hierarchy-based Cognitive Architecture for Self-Motivated Social Agents [no. 399]*
Matthew Conforth and Yan Meng, Stevens Institute of Technology, United States

In this paper, we are developing the CIVS (Civilization-Inspired Vying Societies) system, which is a novel evolutionary learning multi-agent system loosely inspired by the history of human civilization. The main objective of the CIVS system is to develop a bottom-up artificial-life approach to produce artificial agents that are inherently social in how they think, learn, adapt, and operate, so as to be more adaptable and generally intelligent in a complex, challenging environment. To this end, the CHARISMA (Context Hierarchy-based Adaptive ReasonIng Self-Motivated Agent) cognitive architecture is proposed for the agents within the CIVS system. By using intrinsic motivations and dynamic knowledge representation, the CHARISMA cognitive architecture can provide autonomous mental development capability for the agent to develop its knowledge and skills through its own interactions within a dynamic challenging environment as well as social interactions with other agents.

5:00PM *A Neural Model of Motor Synergies [no. 622]*
Kiran Byadarhaly, Mithun Perdoor and Ali Minai, University of Cincinnati, United States

Understanding the ability of humans and animals to exhibit a large repretoire of complex movements in a continuosly changing and uncertain environment is of interest to both biologists and engineers. Even the simplest movements require complex control of internal and external variables of the body and the environment in a variety of contexts. Classical methods -- such as those used in industrial robotics -- are difficult to apply in these high degree-of-freedom situations. Studies on motor control in animals have led to the discovery that, rather than using standard feedback control based on continuous tracking of desired trajectories, animals' movements emerge from the controlled combination of pre-configured movement primitives or synergies. These synergies define coordinated patterns of activity across specific sets of muscles, and can be triggered as a whole with controlled amplitude and temporal offset. Combinations of synergies, therefore, allow emergent configuration of a wide range of complex movements. Control is both simpler and richer in this synergistic framework because it is based on selection and combination of synergies rather than myopic tracking of trajectories. Though the existence of motor synergies is now well-established, there is very little computational modeling of them at the neural level. In this paper, we describe a simple neural model for motor synergies, and show how a small set of synergies selected through a redundancy-reduction principle can generate a rich motor repertoire in a model two-jointed arm system.

Session Mo3-4: Bayesian Systems

Monday, August 1, 3:20PM-5:20PM, Room: Monterey, Chair: Thomas Caudell

3:20PM *Belief Function Model for Reliable Optimal Set Estimation of Transition Matrices in Discounted Infinite-Horizon Markov Decision Processes [no. 263]*
Baohua Li and Jennie Si, University of Arkansas, United States; Arizona State University, United States

We study finite-state, finite-action, discounted infinite-horizon Markov decision processes with uncertain correlated transition matrices in deterministic policy spaces. To efficiently implement an approximate robust policy iteration algorithm for computing a robust optimal or near-optimal policy, a reliable and tight set estimate of the parameters of the transition matrix is needed in advance. However, observation samples on state transitions may be small. Prior information on the parameter space may be incomplete or unavailable. In such cases, a commonly used maximum a posterior (MAP) model may not provide a reliable optimal set estimate of the parameters. In this paper, using the advantages of Dempster-Shafer theory of evidence over Bayesian theory, a belief function model is proposed based on minimizing the cardinality of a set estimate. This new model can give a more reliable optimal solution to cover the true parameters than the MAP model. It degenerates to the MAP model when prior information on the parameter space is complete or prior

information is unavailable but observation samples on state transitions are large enough. Moreover, we create a concept of principle components to characterize large observation samples so that both models result in the same reliable and tight results. The computation complexity of the new model is also discussed.

3:40PM *Topic Model with Constrainted Word Burstiness Intensities [no. 40]*
Shaoze Lei, Jianwen Zhang, Shifeng Weng and Changshui Zhang, Tsinghua University, China; Zhejiang Wanli University, China

Word burstiness phenomenon, which means that if a word occurs once in a document it is likely to occur repeatedly, has interested the text analysis field recently. Dirichlet Compound Multinomial Latent Dirichlet Allocation(DCMLDA) introduces this word burstiness mechanism into Latent Dirichlet Allocation(LDA). However, in DCMLDA, there is no restriction on the word burstiness intensity of each topic. Consequently, as shown in this paper, the burstiness intensities of words in major topics will become extremely low and the topics' ability to represent different semantic meanings will be impaired. In order to get topics that represent semantic meanings of documents well, we introduce constraints on topics' word burstiness intensities. Experiments demonstrate that DCMLDA with constrained word burstiness intensities achieves better performance than the original one without constraints. Besides, these additional constraints help to reveal the relationship between two key properties inherited from DCM and LDA respectively. These two properties have a great influence on the combined model's performance and their relationship revealed by this paper is an important guidance for further study of topic models.

4:00PM *Phase diagrams of a variational Bayesian approach with ARD prior in NIRS-DOT [no. 271]*
Atsushi Miyamoto, Kazuho Watanabe, Kazushi Ikeda and Masa-aki Sato, Nara Institute of Science and Technology, Japan; ATR Neural Information Analysis Laboratories, Japan

Diffuse optical tomography is a method used to reconstruct tomographic images from brain activities observed by near-infrared spectroscopy. This is useful for brain-machine interface and is formulated as an ill-posed inverse problem. We apply a hierarchical Bayesian approach, automatic relevance determination (ARD) prior and the variational Bayes method, that can introduce localization into the estimation of the problem. Although ARD enables sparse estimation, it is still open how hyperparameters affect the sparseness and accuracy of the estimation. Through numerical experiments, we present a schematic phase diagram of sparseness with respect to the hyperparameters in the method, which indicates the region of the hyperparameters where sparse estimation is achievable.

4:20PM *Triply Fuzzy Function Approximation for Bayesian Inference [no. 655]*
Bart Kosko, Osonde Osoba and Sanya Mitaim, University of Southern California, United States; Thammasat University, Thailand

We prove that independent fuzzy systems can uniformly approximate Bayesian posterior probability density functions by approximating prior and likelihood probability densities as well as hyperprior probability densities that underly priors. This triply fuzzy function approximation extends the recent theorem for uniformly approximating the posterior density by approximating just the prior and likelihood densities. This allows users to state priors and hyper-priors in words or rules as well as to adapt them from sample data. A fuzzy system with just two rules can exactly represent common closed-form probability densities so long as they are bounded. The function approximators can also be neural networks or any other type of uniform function approximator.

4:40PM *Simultaneous Learning of Several Bayesian and Mahalanobis Discriminant Functions by a Neural Network with Additional Nodes [no. 168]*
Yoshifusa Ito, Hiroyuki Izumi and Cidambi Srinivasan, Aichi Medical University, Japan; Aichi-Gakuin University, Japan; University of Kentucky, United States

We construct a neural network which can simultaneously approximate several Bayesian and Mahalanobis discriminant functions. The main part of the network is an ordinary one-hidden-layer neural network with a nonlinear output unit, but it has several additional nodes. Since the network has a task to approximate Mahalanobis discriminat functions, the state-conditional probability distributions are supposed to be normal distributions. The method is useful when the Bayesian discriminant functions can be decomposed into sums of a common main part and individual linear additional parts. The main part of the network approximates the quadratic part of the discriminant functions.

5:00PM *Turning Bayesian Model Averaging Into Bayesian Model Combination [no. 545]*
Kristine Monteith, James Carroll, Kevin Seppi and Tony Martinez, Brigham Young University, United States; Los Alamos National Laboratory, United States

Bayesian methods are theoretically optimal in many situations. Bayesian model averaging is generally considered the standard model for creating ensembles of learners using Bayesian methods, but this technique is often outperformed by more ad hoc methods in empirical studies. The reason for this failure has important theoretical implications for our understanding of why ensembles work. It has been proposed that Bayesian model averaging struggles in practice because it accounts for uncertainty about which model is correct but still operates under the assumption that only one of them is. In order to more effectively access the benefits inherent in ensembles, Bayesian strategies should therefore be directed more towards model combination rather than the model selection implicit in Bayesian model averaging. This work provides empirical verification for this hypothesis using several different Bayesian model combination approaches tested on a wide variety of classification problems. We show that even the most simplistic of Bayesian model combination strategies outperforms the traditional ad hoc techniques of bagging and boosting, as well as outperforming BMA over a wide variety of cases. This suggests that the power of ensembles does not come from their ability to account for model uncertainty, but instead comes from the changes in representational and preferential bias inherent in the process of combining several different models.

Session Mo3-5: Visualization

Monday, August 1, 3:20PM-5:20PM, Room: Carmel, Chair: Ke Chen

3:20PM *Quest for Efficient Option Pricing Prediction model using Machine Learning Techniques [no. 154]*

B.V. Phani, Chandra Bala and Vijay Raghav, Associate Professor , IME Department,IIT Kanpur, India; Professor, Department of Maths, IIt Delhi, India; Student,IME Department,IIT Kanpur, Iceland

Prediction of option prices has always been a challenging task. Various models have been used in the past but there has been no effort to point out which model is suited best for predicting option prices. Time is also an important factor to consider since these time series are usually large and it takes enormous amount of time if traditional statistical models are used to identify a model first and then use it for prediction. A good fitting model may not always be good for prediction due to high fluctuation in the market. Various non parametric models like Multilayer perceptron (MLP), Radial Basis function (RBF) Neural Network and Support Vector regression (SVR) have also been employed in the past. MLP and RBF networks take enormous amount of time since the network is learned after many iterations. In the literature, the General Regression Neural Networks (GRNN) which is a one pass neural network has not been tried so far for the prediction of option prices. Prediction of American stock option prices (both call and put options) for companies belonging to various sectors and also prediction of European option prices of Nifty index futures has been attempted using GRNN, Support Vector Regression (SVR), MLP and Black Scholes Model has been attempted in this paper. It has been shown how the GRNN is effective in predicting option prices and that its performance is superior to the well known Black Sholes model and other non parametric models like MLP and RBF both in terms of accuracy and time and it performs at par with SVR.

3:40PM *3D Modeling of Virtualized Reality Objects Using Neural Computing [no. 453]*

Andres F. Serna-Morales, Flavio Prieto, Eduardo Bayro-Corrochano and Edgar N. Sanchez, Universidad Nacional de Colombia at Manizales, Colombia; Universidad Nacional de Colombia at Bogota, Colombia; CINVESTAV, Unidad Guadalajara, Mexico

A methodology for 3D modeling of virtualized reality objects using neural computing is presented. In this paper the objects are represented in virtualized reality and their 3D data are acquired by one of three acquisition systems: endoneurosonographic equipment (ENS), stereo vision system and non-contact 3D digitizer. These objects are modeled by one of three neural architectures: Multilayer Feed-Forward Neural Network (MLFFNN), Self-Organizing Maps (SOM) and Neural Gas Network (NGN). The 3D virtualized representations correspond to several objects as phantom brain tumors, faces, archaeological items, fruits, among others. We carry out comparisons in terms of computational cost, architectural complexity, training method, training epochs and performance. Finally, we present the modeling results and conclude that SOM and NGN models achieve the best performances and the lowest displaying times, while MLFFNN models have the lowest memory requirements and acceptable training times.

4:00PM *CAVE-SOM: Immersive Visual Data Mining Using 3D Self-Organizing Maps [no. 509]*

Dumidu Wijayasekara, Ondrej Linda and Milos Manic, University of Idaho, United States

Data mining techniques are becoming indispensable as the amount and complexity of available data is rapidly growing. Visual data mining techniques attempt to include a human observer in the loop and leverage human perception for knowledge extraction. This is commonly allowed by performing a dimensionality reduction into a visually easy-to-perceive 2D space, which might result in significant loss of important spatial and topological information. To address this issue, this paper presents the design and implementation of a unique 3D visual data mining framework - CAVE-SOM. The CAVE-SOM system couples the Self-Organizing Map (SOM) algorithm with the immersive Cave Automated Virtual Environment (CAVE). The main advantages of the CAVE-SOM system are: i) utilizing a 3D SOM to perform dimensionality reduction of large multi-dimensional datasets, ii) immersive visualization of the trained 3D SOM, iii) ability to explore and interact with the multi-dimensional data in an intuitive and natural way. The CAVE-SOM system uses multiple visualization modes to guide the visual data mining process, for instance the data histograms, U-matrix, connections, separations, uniqueness and the input space view. The implemented CAVE-SOM framework was validated on several benchmark problems and then successfully applied to analysis of wind-power generation data. The knowledge extracted using the CAVE-SOM system can be used for further informed decision making and machine learning.

4:20PM *Visualisation of Network Forensics Traffic Data with a Self-Organising Map for Qualitative Features [no. 367]*

Esteban Jose Palomo, John North, David Elizondo, Rafael Marcos Luque and Tim Watson, University of Malaga, Spain; De Monfort University, United Kingdom

Digital crimes are a part of modern life but evidence of these crimes can be captured in network traffic data logs. Analysing these logs is a difficult process, this is especially true as the format that different attacks can take can vary tremendously and may be unknown at the time of the analysis. The main objective of the field of network forensics consists of gathering evidence of illegal acts from a networking infrastructure. Therefore, software tools, and techniques, that can help with these digital investigations are in great demand. In this paper, an approach to analysing and visualising network traffic data based upon the use of self-organising maps (SOM) is presented. The self-organising map has been widely used in clustering tasks in the literature; it can enable network clusters to be created and visualised in a manner that makes them immediately more intuitive and understandable and can be performed on high-dimensional input data, transforming this into a much lower dimensional space. In order to show the usefulness of this approach, the self-organising map has been applied to traffic data, for use as a tool in network forensics. Moreover, the proposed SOM takes into account the qualitative features that are present in the traffic data, in addition to the quantitative features. The traffic data was was clustered and visualised and the results were then analysed. The results demonstrate that this technique can be used to aid in the comprehension of digital forensics and to facilitate the search for anomalous behaviour in the network environment.

4:40PM *Coupling Clustering and Visualization for Knowledge Discovery from Data [no. 443]*
Guenael Cabanes and Younes Bennani, LIPN-CNRS, UMR 7030, France

The exponential growth of data generates terabytes of very large databases. The growing number of data dimensions and data objects presents tremendous challenges for effective data analysis and data exploration methods and tools. One solution commonly proposed is the use of a condensed description of the properties and structure of data. Thus, it becomes crucial to have visualization tools capable of representing the data structure, not from the data themselves, but from these condensed descriptions. The purpose of our work described in this paper is to develop and put a synergistic visualization of data and knowledge into the knowledge discovery process. We propose here a method of describing data from enriched and segmented prototypes using a clustering algorithm. We then introduce a visualization tool that can enhance the structure within and between groups in data. We show, using some artificial and real databases, the relevance of the proposed method.

5:00PM *Accelerated Learning of Generalized Sammon Mappings [no. 621]*
Yinjie Huang, Michael Georgiopoulos and Georgios Anagnostopoulos, University of Central Florida, United States; Florida Institute of Technology, United States

The Sammon Mapping (SM) has established itself as a valuable tool in dimensionality reduction, manifold learning, exploratory data analysis and, particularly, in data visualization. The SM is capable of projecting high- dimensional data into a low-dimensional space, so that they can be visualized and interpreted. This is accomplished by representing inter-sample dissimilarities in the original space by Euclidean inter-sample distances in the projection space. Recently, Kernel-based Sammon Mapping (KSM) has been shown to subsume the SM and a few other related extensions to SM. Both of the aforementioned models feature a set of linear weights that are estimated via Iterative Majorization (IM). While IM is significantly faster than other standard gradient-based methods, tackling data sets of larger than moderate sizes becomes a challenging learning task, as IM's convergence significantly slows down with increasing data set cardinality. In this paper we derive two improved training algorithms based on Successive Over-Relaxation (SOR) and Parallel Tangents (PARTAN) acceleration, that, while still being first-order methods, exhibit faster convergence than IM. Both algorithms are relatively easy to understand, straightforward to implement and, performance-wise, are as robust as IM. We also present comparative results that illustrate their computational advantages on a set of benchmark problems.

Session Mo3-6: Signal Processing in Biology and Engineering

Monday, August 1, 3:20PM-5:20PM, Room: Santa Clara, Chair: Yoonsuck Choe

3:20PM *Exploring Retrograde Signaling via Astrocytes as a Mechanism for Self Repair [no. 663]*
John Wade, Liam McDaid, Jim Harkin, Vincenzo Crunelli, Scott Kelso and Valeriu Beiu, Intelligent Systems Research Center, University of Ulster, United Kingdom; Neuroscience Division, University of Cardiff, United Kingdom; Center for Complex Systems and Brain Sciences, Florida Atlantic University, United States; Faculty of Information Technology, Computer Engineering, United Arab Emirates University, United Arab Emirates

Recent work has shown that astrocytes are capable of bidirectional communication with neurons which leads to modulation of synaptic activity. Moreover, indirect signaling pathways of retrograde messengers such as endocannabinoids lead to modulation of synaptic transmission probability. In this paper we hypothesize that this signaling underpins fault tolerance in the brain. In particular, faults manifest themselves in silent or near silent neurons, which is caused by low transmission probability synapses, and the enhancement of the transmission probability of a "faulty" synapse by indirect retrograde feedback is the repair mechanism. Furthermore, based on recent findings we present a model of self repair at the synaptic level, where retrograde signaling via astrocytes increases the probability of neurotransmitter release at damaged or low transmission probability synapses. Although our model is still at the embryo stage, results presented are encouraging and highlight a new research direction on brain-like self repair.

3:40PM *Evaluating dependence in spike train metric spaces [no. 542]*
Sohan Seth, Austin Brockmeier, John Choi, Mulugeta Semework, Joseph Francis and Jose Principe, University of Florida, United States; SUNY Downstate Medical Center, United States

Assessing dependence between two sets of spike trains or between a set of input stimuli and the corresponding generated spike trains is crucial in many neuroscientific applications, such as in analyzing functional connectivity among neural assemblies, and in neural coding. Dependence between two random variables is traditionally assessed in terms of mutual information. However, although well explored in the context of real or vector valued random variables, estimating mutual information still remains a challenging issue when the random variables exist in more exotic spaces such as the space of spike trains. In the statistical literature, on the other hand, the concept of dependence between two random variables has been presented in many other ways e.g. using copula, or using measures of association such as Spearman's ρ, and Kendall's τ. Although these methods are usually applied on the real line, their simplicity, both in terms of understanding and estimating, make them worth investigating in the context of spike train dependence. In this paper, we generalize the concept of association to any abstract metric spaces. This new approach is an attractive alternative to mutual information, since it can be easily estimated from realizations without binning or clustering, and it provides an intuitive understanding of what dependence implies in the context of realizations. We show that this new methodology effectively captures dependence between sets of stimuli and spike trains. Moreover, the estimator has desirable small sample characteristic, and it often outperforms an existing similar metric based approach.

4:00PM *A Texture-based Method for Classifying Cracked Concrete Surfaces from Digital Images using Neural Networks [no. 540]*
ZhiQiang Chen, Reza Derakhshani, Ceki Halmen and John Kevern, University of Missouri, Kansas City, United States

Using a dSLR camera with macro LED light, 11 samples containing light and moderately cracked concrete surfaces were imaged with perpendicular and angled illumination. Textural features from gray level co- occurrence matrix statistics were derived, from which 3-6 salient features were selected. Cross validation accuracies were as high as 94% using neural network classifiers, indicating the feasibility of rapid, automatic concrete cracking assessment using COTS digital imaging.

4:20PM *Versatile Neural Network Method for Recovering Shape from Shading by Model Inclusive Learning [no. 673]*
Yasuaki Kuroe and Hajimu Kawakami, Kyoto Institute of Technology, Japan; Ryukoku University, Japan

The problem of recovering shape from shading is important in computer vision and robotics. In this paper, we propose a versatile method of solving the problem by neural networks. We introduce a mathematical model, which we call image-formation model, expressing the process that the image is formed from an object surface. We formulate the problem as a model inclusive learning problem of neural networks and propose a method to solve it. In the proposed learning method, the image-formation model is included in the learning loop of neural networks. The proposed method is versatile in the sense that it can solve the problem in various circumstances. The effectiveness of the proposed method is shown through experiments performed in various circumstances.

4:40PM *Text to Phoneme Alignment and Mapping for Speech Technology: A Neural Networks Approach [no. 150]*
John Bullinaria, University of Birmingham, UK, United Kingdom

A common problem in speech technology is the alignment of representations of text and phonemes, and the learning of a mapping between them that generalizes well to unseen inputs. The state-of-the-art technology appears to be symbolic rule-based systems, which is surprising given the number of neural network systems for text to phoneme mapping that have been developed over the years. This paper explores why that may be the case, and demonstrates that it is possible for neural networks to simultaneously perform text to phoneme alignment and mapping with performance levels at least comparable to the best existing systems.

5:00PM *B-spline neural network based digital baseband predistorter solution using the inverse of De Boor algorithm [no. 34]*
Xia Hong, Yu Gong and Sheng Chen, University of Reading, United Kingdom; University of Southampton, United Kingdom

In this paper a new nonlinear digital baseband predistorter design is introduced based on direct learning, together with a new Wiener system modeling approach for the high power amplifiers (HPA) based on the B-spline neural network. The contribution is twofold. Firstly, by assuming that the nonlinearity in the HPA is mainly dependent on the input signal amplitude the complex valued nonlinear static function is represented by two real valued B- spline neural networks, one for the amplitude distortion and another for the phase shift. The Gauss-Newton algorithm is applied for the parameter estimation, in which the De Boor recursion is employed to calculate both the B- spline curve and the first order derivatives. Secondly, we derive the predistorter algorithm calculating the inverse of the complex valued nonlinear static function according to B-spline neural network based Wiener models. The inverse of the amplitude and phase shift distortion are then computed and compensated using the identified phase shift model. Numerical examples have been employed to demonstrate the efficacy of the proposed approaches.

Monday, August 1, 5:30PM-6:30PM

Special Session Mo4-1: Intelligent Embedded Systems

Monday, August 1, 5:30PM-6:30PM, Room: Cedar, Chair: Manuel Roveri

5:30PM *Embedded Power Quality Monitoring System based on Independent Component Analysis and SVMs [no. 462]*
Marta Ruiz-Llata, Guillermo Guarnizo and Carlos Boya, Universidad Carlos III de Madrid, Spain

On-line identification and classification of voltage and current disturbances in power systems are important tasks in the power quality monitoring and protection of power systems. Some power quality disturbances are non-stationary and transitory while other are steady-state variations that distort the voltage signal. One, two or more different power quality disturbances may appear at the same time. In this paper we propose a power quality monitoring system that employs Independent Component Analysis algorithm that is able to decouple multiple simultaneous power quality disturbances, and Support Vector Machines for identification the occurrence of a disturbance. We also show the first steps towards embedding the proposed system on an FPGA for online power quality monitoring.

5:50PM *Neural Classification of Infrasonic Signals Associated with Hazardous Volcanic Eruptions [no. 93]*
Ajay Iyer, Fredric Ham and Milton Garces, Florida Institute of Technology, United States; University of Hawaii, United States

Infrasound signals released as a result of volcanic eruptions contain information regarding the intensity of the eruptions, presence of ash emissions, and certain characteristics of the volcano itself. Knowledge of the eruption intensity can provide an estimate of the height of the ash column. This paper focuses on exploiting the infrasonic characteristics of volcanoes by extracting unique cepstral-based features from the volcano's infrasound signature. These volcano feature vectors are then used to train and test a neural-classifier that is developed to distinguish the ash-generating eruptive activity from three volcanoes, namely, Mount St. Helens-USA, Tungurahua- Ecuador, and Kasatochi-Alaska. The neural-classifier is able to correctly distinguish the eruptive activity of each of the three volcanoes with a correct classification rate (CCR) of approximately 97%.

6:10PM *A Hierarchical, Nonparametric, Sequential Change-Detection Test [no. 601]*

Cesare Alippi, Giacomo Boracchi and Manuel Roveri, Politecnico di Milano, Italy

Design of applications working in nonstationary environments requires the ability to detect and anticipate possible behavioral changes affecting the system under investigation. In this direction, the literature provides several tests aiming at assessing the stationarity of a data generating process; of particular interest are nonparametric sequential change-point detection tests that do not require any a-priori information regarding both process and change. Moreover, such tests can be made automatic through an on-line inspection of sequences of data, hence making them particularly interesting to address real applications. Following this approach, we suggest a novel two-level hierarchical change-detection test designed to detect possible occurrences of changes by observing incoming measurements. This hierarchical solution significantly reduces the number of false positives at the expenses of a negligible increase of false negatives and detection delays. Experiments show the effectiveness of the proposed approach both on synthetic dataset and measurements from real applications.

Session Mo4-2: Reinforcement Learning II

Monday, August 1, 5:30PM-6:30PM, Room: Pine, Chair: Anthony Kuh

5:30PM *Direct Heuristic Dynamic Programming with Augmented States [no. 656]*

Jian Sun, Feng Liu, Jennie Si and Shengwei Mei, Department of Electrical Engineering, Tsinghua University, China; Department of Electrical Engineering, Arizona State University, United States

This paper addresses a design issue of an approximate dynamic programming structure and its respective convergence property. Specifically, we propose to impose a PID structure to the action and critic networks in the direct heuristic dynamic programming (direct HDP) online learning controller. We demonstrate that the direct HDP with such PID augmented states improves convergence speed and that it out performs the traditional PID even though the learning controller may be initialized to be like a PID. Also for the first time, by using a Lyapnov approach we show that the action and critic network weights retain the property of uniformly ultimate boundedness (UUB) under mild conditions.

5:50PM *Reinforcement Active Learning Hierarchical Loops [no. 631]*

Goren Gordon and Ahissar Ehud, Weizmann Institute of Science, Israel; Weizamnn Institute of Science, Israel

A curious agent, be it a robot, animal or human, acts so as to learn as much as possible about itself and its environment. Such an agent can also learn without external supervision, but rather actively probe its surrounding and autonomously induce the relations between its action's effects on the environment and the resulting sensory input. We present a model of hierarchical motor-sensory loops for such an autonomous active learning agent, meaning a model that selects the appropriate action in order to optimize the agent's learning. Furthermore, learning one motor-sensory mapping enables the learning of other mappings, thus increasing the extent and diversity of knowledge and skills, usually in hierarchical manner. Each such loop attempts to optimally learn a specific correlation between the agent's available internal information, e.g. sensory signals and motor efference copies, by finding the action that optimizes that learning. We demonstrate this architecture on the well-studied vibrissae system, and show how sensory-motor loops are actively learnt from the bottom-up, starting with the forward and inverse models of whisker motion and then extending them to object localization. The model predicts transition from free-air whisking that optimally learns the self- generated motor-sensory mapping to touch-induced palpation that optimizes object localization, both observed in naturally behaving rats.

6:10PM *Connectionist Reinforcement Learning for Intelligent Unit Micro Management in StarCraft [no. 379]*

Amirhosein Shantia, Eric Begue and Marco Wiering, University of Groningen, Netherlands

Real Time Strategy Games are one of the most popular game schemes in PC markets and offer a dynamic environment that involves several interacting agents. The core strategies that need to be developed in these games are unit micro management, building order, resource management, and the game main tactic. Unfortunately, current games only use scripted and fixed behaviors for their artificial intelligence (AI), and the player can easily learn the counter measures to defeat the AI. In this paper, we describe a system based on neural networks that controls a set of units of the same type in the popular game StarCraft. Using the neural networks, the units will either choose a unit to attack or evade from the battlefield. The system uses reinforcement learning combined with neural networks using online Sarsa and neural-fitted Sarsa, both with a short term memory reward function. We also present an incremental learning method for training the units for larger scenarios involving more units using trained neural networks on smaller scenarios. Additionally, we developed a novel sensing system to feed the environment data to the neural networks using separate vision grids. The simulation results show superior performance against the human-made AI scripts in StarCraft.

Special Session Mo4-3: Autonomous Learning of Object Representation and Control

Monday, August 1, 5:30PM-6:30PM, Room: Oak, Chair: Rolf Wurtz and Janusz Starzyk

5:30PM *An insect brain inspired neural model for object representation and expectation [no. 400]*

Paolo Arena, Luca Patane' and Pietro Savio Termini, DIEEI- University of Catania, Italy

In spite of their small brain, insects show a complex behavior repertoire and are becoming a reference point in neuroscience and robotics. In particular, it is very interesting to analyze how biological reaction-diffusion systems are able to codify sensorial information with the addition of learning capabilities. In this paper we propose a new model of the olfactory system of the fruit fly Drosophila melanogaster. The architecture is a multi-layer spiking neural network, inspired by the structures of the insect brain mainly involved in the olfactory conditioning, namely the Mushroom Bodies, the Lateral Horns and the Antennal Lobes. The Antennal Lobes model is based on a competitive topology that transduces the sensorial information into a pattern, projecting such information to the Mushroom Bodies model. This model is based on a first and second order reaction- diffusion paradigm that leads to a spontaneous emerging of clusters. The Lateral Horns have been modeled as an input-triggered resetting system. The structure, besides showing the already known capabilities of associative learning, via a bottom-up processing, is also able to realize a top-down modulation at the input level, in order to implement an expectation-based filtering of the sensorial inputs.

5:50PM *Autonomous learning of a human body model [no. 97]*

Thomas Walther and Rolf P. Wurtz, Ruhr-University, Germany

The problem of learning a generalizable model of the visual appearance of humans from video data is of major importance for computing systems interacting naturally with their users and other humans populating their environment. We propose a step towards automatic behavior understanding by integrating principles of Organic Computing into the posture estimation cycle, thereby relegating the need for human intervention while simultaneously raising the level of system autonomy. The system extracts coherent motion from moving upper bodies and autonomously decides about limbs and their possible spatial relationships. The models from many videos are integrated into meta-models, which show good generalization to different individuals, backgrounds, and attire. These models even allow robust interpretation of single video frames, where all temporal continuity is missing.

6:10PM *Motivated Learning In Autonomous Systems [no. 145]*

Pawel Raif and Janusz Starzyk, Silesian University of Technology, Poland; Ohio University, United States

Motivated learning (ML) is a new biologically inspired machine learning method. It is the combination of a reinforcement learning (RL) algorithm and a system that creates hierarchy of goals. The goal creation system is concerned with creating new internal goals, building a hierarchy of them, and controlling the agent's behavior according to this constituted hierarchy of goals. As in case of reinforcement learning method, a motivated learning agent is learning through interaction with the environment. The comparisons of both methods in special type test environment show that the motivated learning method is more efficient in learning complex relations between available resources (concepts). ML has better performance than RL, especially in dynamically changing environments. In the presented experiments we have shown that ML based agent, which has the ability to set its internal goals autonomously, is able to fulfill the designer's goals more effectively than RL based agent. In addition, because the observed concepts are not predefined but emerge during the learning process, this method also addresses problem of merging connectionist and symbolic approaches for intelligent autonomous systems.

Panel Session Mo4-5: Undergraduate Education in Cognitive Science and NN

Monday, August 1, 5:30PM-6:30PM, Room: Carmel, Chairs: Peter Erdi and Simona Doboli

Panelists: Simona Doboli Péter Érdi, Daniel Levine, Irwin King, Aluizio F. R. Araujo and Robert Kozma

Session Mo4-4: Cognitive Systems

Monday, August 1, 5:30PM-6:30PM, Room: Monterey, Chair: Lokendra Shastri

5:30PM *Recognition Model of Cerebral Cortex based on Approximate Belief Revision Algorithm [no. 102]*

Yuuji Ichisugi, National Institute of Advanced Industrial Science and Technology(AIST), Japan

We propose a computational model of recognition of the cerebral cortex, based on an approximate belief revision algorithm. The algorithm calculates the MPE (most probable explanation) of Bayesian networks with a linear-sum CPT (conditional probability table) model. Although the proposed algorithm is simple enough to be implemented by a fixed circuit, results of the performance evaluation show that this algorithm does not have bad approximation accuracy. The mean convergence time is not sensitive to the number of nodes if the depth the network is constant. The computation amount is linear to the number of nodes if the number of edges per node is constant. The proposed algorithm can be used as a part of a learning algorithm for a kind of sparse-coding, which reproduces orientation selectivity of the primary visual area. The circuit that executes the algorithm shows better correspondence to the anatomical structure of the cerebral cortex, namely its six-layer and columnar features, than the approximate belief propagation algorithm that has been proposed before. These results suggest that the proposed algorithm is a promising starting point for the model of the recognition mechanism of the cerebral cortex.

5:50PM *How the Core Theory of CLARION Captures Human Decision-Making [no. 59]*

Sebastien Helie and Ron Sun, University of California, Santa Barbara, United States; Rensselaer Polytechnic Institute, United States

Some mainstream psychologists have criticized computational cognitive architectures on the issue of model complexity and parameter tweaking (i.e., the likelihood that cognitive architectures can explain any results and their opposites). This paper tries to address these criticisms by tackling the issue of model complexity in cognitive architectures. Here, we start with a well-established cognitive architecture, CLARION, and extract its core theory to explain a wide range of data. The resulting minimal model was used to provide parameter-free principled explanations for several psychological "laws" of uncertain reasoning and decision-making. This paper is concluded by a discussion of the implication of parameter-free modeling in cognitive science and psychology.

6:10PM *Interacting Maps for Fast Visual Interpretation [no. 174]*

Matthew Cook, Luca Gugelmann, Florian Jug, Christoph Krautz and Angelika Steger, Institute of Neuroinformatics of Zurich, Switzerland; ETH Zurich, Switzerland

Biological systems process visual input using a distributed representation, with different areas encoding different aspects of the visual interpretation. While current engineering habits tempt us to think of this processing in terms of a pipelined sequence of filters and other feed-forward processing stages, cortical anatomy suggests quite a different architecture, using strong recurrent connectivity between visual areas. Here we design a network to interpret input from a neuromorphic sensor by means of recurrently interconnected areas, each of which encodes a different aspect of the visual interpretation, such as light intensity or optic flow. As each area of the network tries to be consistent with the information in neighboring areas, the visual interpretation converges towards global mutual consistency. Rather than applying input in a traditional feed-forward manner, the sensory input is only used to weakly influence the information flowing both ways through the middle of the network. Even with this seemingly weak use of input, this network of interacting maps is able to maintain its interpretation of the visual scene in real time, proving the viability of this interacting map approach to computation.

Session Mo4-6: Neuromorphic Engineering

Monday, August 1, 5:30PM-6:30PM, Room: Santa Clara, Chair: Eros Pasero

5:30PM *Implementation of Signal Processing Tasks on Neuromorphic Hardware [no. 248]*

Olivier Temam and Rodolphe Heliot, INRIA Saclay, France; CEA-LETI, France

Because of power and reliability issues, computer architects are forced to explore new types of architectures, such as heterogeneous systems embedding hardware accelerators. Neuromorphic systems are good candidate accelerators that can perform efficient and robust computing for certain classes of applications. We propose a spiking neurons based accelerator, with its hardware and software, that can be easily programmed to execute a wide range of signal processing applications. A library of operators is built to facilitate implementation of various types of applications. Automated placement and routing software tools are used to map these applications onto the hardware. Altogether, this system aims at providing to the user a simple way to implement signal processing tasks on neuromorphic hardware.

5:50PM *Pulse-Type Hardware Inhibitory Neural Networks for MEMS Micro Robot Using CMOS Technology [no. 337]*

Ken Saito, Kazuto Okazaki, Kentaro Sakata, Tatsuya Ogiwara, Yoshifumi Sekine and Fumio Uchikoba, Nihon University, Japan

This paper presents the locomotion generator of MEMS (Micro Electro Mechanical Systems) micro robot. The locomotion generator demonstrates the locomotion of the micro robot, controlled by the P-HINN (Pulse-Type Hardware Inhibitory Neural Networks). P-HINN generates oscillatory patterns of electrical activity such as living organisms. Basic components are the cell body models and inhibitory synaptic models. P-HINN has the same basic features of biological neurons such as threshold, refractory period, spatio-temporal summation characteristics and enables the generation of continuous action potentials. P- HINN was constructed by MOSFETs, can be integrated by CMOS technology. Same as the living organisms P-HINN realized the robot control without using any software programs, or A/D converters. The size of the micro robot fabricated by the MEMS technology was 4*4*3.5 mm. The frame of the robot was made of silicon wafer, equipped with the rotary type actuators, the link mechanisms and 6 legs. The MEMS micro robot emulated the locomotion method and the neural networks of the insect by the rotary type actuators, link mechanisms and P-HINN. As a result, we show that P-HINN can control the forward and backward locomotion of fabricated MEMS micro robot, and also switched the direction by inputting the external trigger pulse. The locomotion speed was 19.5 mm/min and the step width was 1.3 mm.

6:10PM *Memristor synaptic dynamics influence on synchronous behavior of two Hindmarsh-Rose neurons [no. 495]*

Fernando Corinto, Alon Ascoli, Valentina Lanza and Marco Gilli, Politecnico di Torino, Italy

Besides being at the basis of next-generation ultradense non-volatile memories, a nanoscale memristor also has the potential to reproduce the behavior of a biological synapse. As in a living creature the weight of a synapse is adapted by the ionic flow through it, so the conductance of a memristor is adjusted by the flux across or the charge through it depending on its controlling source. In this manuscript we consider two Hindmarsh-Rose neurons, coupled via a memristive device mimicking a biological synapse. We investigate how the dynamics of the memristive element may influence the syncronization properties of the network.

Monday, August 1, 7:30PM-9:30PM

Poster Session Mo-PA: Poster Session A

Monday, August 1, 7:30PM-9:30PM, Room: Bayshore Ballroom, Chair: Michael Georgiopoulos

P101 *Evaluating the Training Dynamics of a CMOS based Synapse [no. 256]*
Arfan Ghani, Liam McDaid, Ammar Belatreche, Peter Kelly, Steve Hall, Tom Dowrick, Shou Huang, John Marsland and Andy Smith, University of Ulster, United Kingdom; University of Liverpool, United Kingdom

Recent work by the authors proposed compact low power synapses in hardware, based on the charge-coupling principle, that can be configured to yield a static or dynamic response. The focus of this work is to investigate the training dynamics of these synapses. Empirical models of the Post Synaptic Response (PSP), derived from hardware simulations, were developed and subsequently embedded into the MATLAB environment. A network of these synapses was then used to solve a benchmark problem using a well-established training algorithm where the performance metrics are convergence time, accuracy and weight range; the Spike Response Model (SRM) was used to implement point neurons. Results are presented and compared with standard synaptic responses

P102 *Stability analysis of neural plasticity rules for implementation on memristive neuromorphic hardware [no. 524]*
Zlatko Vasilkoski, Heather Ames, Ben Chandler, Anatoli Gorchetchnikov, Jasmin Leveille, Gennady Livitz, Ennio Mingolla and Massimiliano Versace, Boston University, United States

In the foreseeable future, synergistic advances in high-density memristive memory, scalable and massively parallel hardware, and neural network research will enable modelers to design large-scale, adaptive neural systems to support complex behaviors in virtual and robotic agents. A large variety of learning rules have been proposed in the literature to explain how neural activity shapes synaptic connections to support adaptive behavior. A generalized parametrizable form for many of these rules is proposed in a satellite paper in this volume [1}. Implementation of these rules in hardware raises a concern about the stability of memories created by these rules when the learning proceeds continuously and affects the performance in a network controlling freely-behaving agents. This paper can serve as a reference document as it summarizes in a concise way using a uniform notation the stability properties of the rules that are covered by the general form in [1].

P103 *A Digital Implementation of the Nucleus Laminaris [no. 314]*
Enrico Heinrich, Ralf Joost and Ralf Salomon, University of Rostock, Germany

The nucleus laminaris of the barn owl auditory system is quite impressive, since its underlying time estimation is much better than the processing speed of the involved neurons. Since precise localization is also very important in many technical applications, this paper explores to what extent the main principles of the nucleus laminaris can be implemented in digital hardware. The first prototypical implementation yields a time resolution of about 20 ps, even though the chosen standard, lowcost device is clocked at only 85 MHz, which leads to an internal duty cycle of approximately 12 ns.

P104 *Development of large-scale neural network hardware for practical applications [no. 680]*
Iman Mohtashemi, Babak Azimi, Dimitri Kitariev and Charles Dickinson, NeuroMachines LLC, United States

Introduction: Complex problems require sophisticated processing techniques. Artificial neural networks are based on the communication of neurons in living brains. Like the millions of neurons in your brain, these models often require a parallel processing approach to be computed at practical speeds. Artificial neural networks are being used in a growing number of research fields, and the development of algorithms and software for ease of use will lead to advancements in dozens of areas. One such area is climatology and weather prediction, and research is proposed which will establish a system for using neural networks in climate simulations. Others findings have led to new research problems such as protein structure prediction, multiple alignment, or phylogenetic inference. For all these problems, machine learning offers one promising approach to achieve efficient and reliable heuristic solutions. As the size of acquired data for many of these problems increase exponentially, software-only solutions become limited in compute power. Proposal of work: Our proposal is to solve massive artificial neural network processing by providing a small scale hardware platform with supporting software, such that many of current complex problems could be solved with minimal training cycles. Preliminary data: A net with 0.3e9 connections runs at speed of 10 iteration per second on 2 cards. Our initial estimates indicated that a 1e10 net will run 1 iteration per second on 1 box (6 cards).The results show that our solution will run 1e10 net at speed of 10/30*6/2=1 iteration per second. The implementation supports batch propagation. We have observed that performance increases nearly linearly with the batch number as expected. Application test: The 2010 Netflix prize was awarded to groups that improved the accuracy of predictions relative to Netflix's own algorithm. RMSE was one criteria to gauge performance. We used a network with 0.6e6 connection. We used a subset of the whole database with 0.25e5 entries (the entire data base is 1e8 entries i.e. 4000 times larger) The RMSE on this smallish database is 1.2. The best result is 0.85 (e.g the winner). Other improvements are also possible and underway. We have a proven solution for Netflix which does converges in reasonable time and gets us not the best but a reasonable error. Conclusions: We only expanded about on man - week on Netflix work. So we have not even attempted to find an optimal solution but simply used brut force approach. This basically confirms our proposition that our approach can deliver good enough solution in minimal amount of time. Further improvements are being made. The hardware design coupled to a well-constructed NN algorithm has limitless possibilities and applications.

P105 *A Digital Bit Serial Dynamical System Implementation of a Silicon Neuron [no. 687]*
Sharayu Kulkarni, Eric Basham and David W. Parent, San Jose State Univerisity, United States

A completely digital, bit serial dynamical system implementation of a silicon (hardware) neuron in 0.25um 2.5V CMOS technology is presented. In general, digital circuit implementations have several advantages over analog circuit implementations. These include tolerance to process variability, ease of testing,

scalability and the ability to prototype using field programmable digital hardware. As an alternative to biophysically based models that require a complex set of tuning parameters we used the dynamical system approach to neuromorphic engineering outlined in [1, 2]. However, it is challenging to implement nonlinear dynamical systems in digital circuits. Using bit serial logic we describe a signal processing approach that results in a topology that displays a rich set of neural behavior including true spiking behavior, variable frequency spiking, excitability and bistability through bifurcation. This is accomplished with a small bit number, eight bits and a sign bit, for a nine bit working total. A comparison study of hardware neurons implemented using serial processing, partial parallel processing and fully parallel processing showed that serial implementation occupies nearly one third of the area of that occupied by fully parallel processing [3]. Further area reduction is achieved by implementing the design using domino logic. The use of serial architecture can impact the computational speed of digital circuits, thus a four phase clocking scheme is employed. This results in robust operation at a 400Mhz clock speed. [1] J. V. Arthur and K. Boahen, "Silicon-Neuron Design: A Dynamical Systems Approach," Circuits and Systems I: Regular Papers, IEEE Transactions on, pp. 1-1. [2] E. M. Izhikevich, Dynamical systems in neuroscience : the geometry of excitability and bursting. Cambridge, Mass.: MIT Press, 2007. [3] S. Al-Kazzaz and R. Khalil, "FPGA Implementation of artificial neurons: comparison study," 2008, pp. 1-6.

P106 *Memristor based brain-like computing system [no. 697]*

Marius-Tudor Benea, Pierre and Marie Curie University, Paris, France, France

A strong belief exists, that the computational systems of the future will use combinations of both standard CPU's and self-adapting neural networks, each having its own advantages and each completing the other one's minuses. The traditional CPU's are already in a state of advanced development and they are also quickly becoming more and more powerful. On the other side, a neural network hardware implementation comprising mechanisms for coding the computations and the memory in a manner similar to the brain, while having the ability to learn, is still only one important desire of the humanity. Fortunately, the recent discovery of one way to implement the memristor by the team of researchers from HP Labs Palo Alto coordinated by Stanley Williams, having as one of its applications the possibility to translate the natural synapses in electronic circuits, is considered to be a huge step towards a solution to this problem and offers us a huge opportunity. This work proposes and analyzes a physical neural network model based on memristors. The approach used is an adaption for memristors of the physical neural network model proposed by Alex Nugent. This work also compares Nugent's approach with the memristor based one.

P107 *Object recognition and localization in a virtual animat: large-scale implementation in dense memristive memory devices [no. 458]*

Jasmin Leveille, Heather Ames, Anatoli Gorchetchnikov, Ben Chandler and Massimiliano Versace, Department of Cognitive and Neural Systems and Center of Excellence for Learning in Education, Science, and Technology, Boston University, Canada; Department of Cognitive and Neural Systems and Center of Excellence for Learning in Education, Science, and Technology, Boston University, United States; Department of Cognitive and Neural Systems and Center of Excellence for Learning in Education, Science, and Technology, Boston University, Russia; Department of Cognitive and Neural Systems and Center of Excellence for Learning in Education, Science, and Technology, Boston University, Italy

We propose a model for the perceptual system of a virtual agent, the Modular Neural Exploring Traveling Agent (MoNETA) [1], performing a visually-based navigation task. While the idea of using a virtual environment for studying animal vision is not new [2, 3], this approach has mostly been applied to rather simplistic neural visual systems, due in part to the lack of adequate computing resources. Our work illustrates how a recently developed software platform for large-scale heterogeneous clusters, Cog Ex Machina [4], helps overcome such limitations. Cog Ex Machina is especially suitable for memristor-based parallel and distributed neural models that make use of local learning laws. Drawing inspiration from the multi-target tracking literature [5], our neural model is formulated as having multiple coordinated attentional windows, each of which probes a different part of the visual scene at a given time. The location of each window is governed in large part by the distribution of bottom-up saliency, and also by top-down attentional feedback that refines location estimates. Whereas location estimation is accomplished in the brain's where pathway, object recognition is carried out in the what pathway by a feature pyramid that projects to a simple classifier. The feature pyramid incorporates the biologically plausible HMAX operator and utilizes color, edges, or learned features from the virtual environment. The model is posed as an essentially feedforward architecture without slow temporal dynamics so as to minimize the duration of a perceptual cycle. Although each component of the model is based on a separate, already published model, several adaptations were made to the various pieces to make them compatible with Cog Ex Machina's parallel distributed framework, and to embed it in our MoNETA animat. We conclude on an analysis of the performance of our system and, based on experiments in the virtual environment, propose various modifications towards an improved system. 1. Versace, M., and Chandler, B. (2010). MoNETA: A Mind Made from Memristors. IEEE Spectrum, December 2011. 2. D. Terzopoulos, and T. Rabie, (1995) Animat vision: Active vision with artificial animats, in Proc. ICCV95, Cambridge, pp.801-808. 3. L.S. Yaeger (1994) Computational Genetics, Physiology, Metabolism, Neural Systems, Learning, Vision, and Behavior or Polyworld: Life in a new context, in Proc. Artificial Life III, Reading, pp. 263-298. 4. G. Snider, R. Amerson, D. Carter, H. Abdalla, S. Qureshi, J. Leveille, M. Versace, H. Ames, S. Patrick, B. Chandler, A. Gorchetchnikov, and E. Mingolla (2011) Adaptive Computation with Memristive Memory, Computer, vol. 44, no. 2, pp. 21-28. 5. P. Cavanagh, and G.A. Alvarez (2005) Tracking multiple targets with multifocal attention, Trends in Cognitive Sciences, vol. 9, pp. 349-354. Supported in part by DARPA contract HR0011-09-3-0001 and CELEST, an NSF Science of Learning Center (SBE-0354378 and OMA-0835976).

P108 *Percolation in Memristive Networks [no. 567]*

Giovanni E. Pazienza, Robert Kozma and Jordi Albo-Canals, University of Memphis, United States; University Ramon Llull, Barcelona, Spain

Numerous scientists claim that the memristor may be a real breakthrough in the fields of electronic and circuit design. For this reason, it is important to study what dynamics arise in memristive networks and speculate about how they could be used for meaningful tasks. In this paper, we focus on the phenomenon of percolation in memristive networks, studying the theoretical aspects and performing SW simulations.

P109 *The Visually-Guided Adaptive Robot (ViGuAR) [no. 620]*

Gennady Livitz, Heather Ames, Ben Chandler, Anatoli Gorchetchnikov and Jasmin Leveille, Boston University, Neuromorphics Lab, United States; Boston University, Neuromorphics Lab, Russia; Boston University, Neuromorphics Lab, Canada

A neural modeling platform known as Cog ex Machina1 (Cog) developed in the context of the DARPA SyNAPSE2 program offers a computational environment

that promises, in a foreseeable future, the creation of adaptive whole-brain systems subserving complex behavioral functions in virtual and robotic agents. Cog is designed to operate on low-powered, extremely storage-dense memristive hardware3 that would support massively-parallel, scalable computations. We report an adaptive robotic agent, ViGuAR4, that we developed as a neural model implemented on the Cog platform. The neuromorphic architecture of the ViGuAR brain is designed to support visually-guided navigation and learning, which in combination with the path-planning, memory-driven navigation agent - MoNETA5 - also developed at the Neuromorphics Lab at Boston University, should effectively account for a wide range of key features in rodents' navigational behavior.

P110 *Distributed Configuration of Massively-Parallel Simulation on SpiNNaker Neuromorphic Hardware [no. 243]*

Thomas Sharp, Cameron Patterson and Steve Furber, The University of Manchester, United Kingdom

SpiNNaker is a massively-parallel neuromorphic computing architecture designed to model very large, biologically plausible spiking neural networks in real-time. A SpiNNaker machine consists of up to 2^16 homogeneous eighteen-core multiprocessor chips, each with an on-board router which forms links with neighbouring chips for packet-switched inter-processor communications. The architecture is designed for dynamic reconfiguration and optimised for transmission of neural activity data, which presents a challenge for machine configuration, program loading and simulation monitoring given a lack of globally-shared memory resources, intrinsic addressing mode or sideband configuration channel. We propose distributed software mechanisms to address these problems and present experiments which demonstrate the necessity of this approach in contrast to centralised mechanisms.

P111 *Neuroevolution of Hierarchical Nonlinearities in a Production Environment [no. 529]*

Anya Getman, Side Zhao, Chenyao Chen, Chuck Rathke, Alex Morin and Clayton Wilson, NMHG, United States; Oregon State University, United States

Hardware in the Loop, Software in the Loop, and Model Based Autocode Generation have become necessary autocalibration production realities[1]. Interrelationships between similar yet different technologies, by different suppliers, and across multiple platforms, must be modeled to adapt in a timely manner to ever changing performance and regulatory targets [2]. Neuroevolution similar to [3] is proposed for this next level of Auto-Development. Depending on timing and supplier availability, some entire subsystem options are swapped, while individual variables and components within other subsystems are varied via a DOE sensitivity analysis, with a combined target of maximized performance, minimized fuel consumption and emissions, robustness to manufacturing variability, and seamless support for a plethora of configurations, user preferences, and optional features. Forklift hydraulic systems are an ideal example of multiple levels of nonlinear complexity to optimize simultaneously. Valves stick, levels oscillate, and interacting components suffer from suboptimal hysteresis, resonance, and hammering. At the component level, one can explore an optimal mix of transducers, variations in orifice size, land area metering, spool design, and pressure adjustment springs, keeping in mind that the optimum part must be discretized to that which is readily available from suppliers. At the subsystem level, the full range of functions must be simulated for hydraulic loops, electronic circuitry, and diagnostics of real world events, as verified, shifted, scaled, and phased via test data. At the top system level, one seeks to more effectively track resonances, either to reduce them, or move them quickly through zones where they amplify. Once properly designed, system models can improve a supervisory control system, autocalibrating gains to maintain tolerances over 150,000 miles or 8000 hours [4]. Hydraulics modeling in HIL has fallen behind that of other subsystems, as the "exact" motion equations are difficult to reduce adequately, requiring a customized approximation that must quickly evolve for the next challenge [5]. Adaptive nonlinear approaches are necessary to indirectly capture behavior that is normally unobservable, occurs under extreme operating conditions, is intermittent over long periods of time, and experiences work cycles that are highly variable, high speed, and with instantaneous changes in direction. Challenges for this "family of forklift organisms" are not limited to system design optimization and control. As production waits for component testing to complete, intelligent prognostics can determine a reasonable number of cycles to assure that an o-ring of a new design, a different size, and in new operating conditions, will stay below its torsion threshold and not roll up in actual field use. [1] http://www.patentbuddy.com/patentdetails/2023657. [2] http://ewh.ieee.org/conf/ssci/index.php?q=node/61 , 3:36pm. [3] http://eplex.cs.ucf.edu/hyperNEATpage/HyperNEAT.html [4] http://gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/C005457/1 [5] http://etd.gatech.edu/theses/available/etd-05192005- 175356/unrestricted/driscoll_scott_c_200508_mast.pdf

P112 *Short-Term Load Forecasting for Electrical Regional of a Distribution Utility Considering Temperature [no. 419]*

Ronaldo Aquino, Aida Ferreira, Milde Lira, Otoni Nobrega Neto, Priscila Amorim, Carlos Diniz and Tatiana Silveira, UFPE, Brazil; IFPE, Brazil; CELPE, Brazil

This work deals with the application of Artificial Neural Networks (ANN) and Adaptive Neuro-Fuzzy Inference System (ANFIS) to provide the decentralized daily load short-term forecasting which is based on the average daily temperature. It is not an easy task to forecast the load demand of an electrical regional mainly because of the system reconfiguration either temporary (operational maneuvers) or permanent (creation of new regional). In this regard, ANN and ANFIS were chosen because they have robustness in their responses. Both models carry out the load forecasting for each electrical regional of CELPE distribution system in the period of 7 and 14 days ahead. The results were compared between each other and also with the PREVER software, demonstrating a considerable improvement in performance of the new models.

P113 *Hospital Foundation Actions: Neural Network Model Variable Importance [no. 451]*

Mary Malliaris and Maria Pappas, Loyola University Chicago, United States; Thorek Hospital Foundation, United States

Though all foundations have the goal to increase funds available to causes they support, some attempt this by using volunteers and others choose to compensate those who work for the foundation. There are also many different ways that foundations can choose to raise money, and different ways they can choose to spend money. This paper looks at IRS 990 data from a variety of non-profit foundations supporting hospitals throughout the US and asks how they can spend their time and money in the most profitable fashion. Foundations are faced with decisions, often made by volunteer boards, about whether to fund a gala or an athletic event, whether to buy the hospital a new x-ray machine or fund free community vaccinations. This study uses a neural network to rank the 990 form input variables in order to understand how revenue amounts are generated by non- profit hospital foundations. Inputs including, among others, compensation, type of support given to the hospital, type of foundation expenditures, and hospital size were used to develop a model of hospital foundation revenue. The variable importance generated

by the model indicates what variables contribute most to a foundation's yearly income. These results have implications for foundations in structuring their choices about how their foundation is run.

P114 *Toward Constructive Methods for Sigmoidal Neural Networks - Function Approximation in Engineering Mechanics Applications [no. 517]*
Jin-Song Pei, Joseph Wright, Sami Masri, Eric Mai and Andrew Smyth, the University of Oklahoma, United States; Weidlinger Associates Inc., United States; the University of Southern California, United States; Berkeley Transportation Systems, United States; Columbia University, United States

This paper reports a continuous development of the work by the authors presented at IJCNN 2005 and 2007. A series of parsimonious universal approximator architectures with pre-defined values for weights and biases called neural network prototypes are proposed and used in a repetitive and systematic manner for the initialization of sigmoidal neural networks in function approximation. This paper provides a more in-depth literature review, presents one training example using laboratory data indicating quick convergence and trained sigmoidal neural networks with stable generalization capability, and discusses the complexity measure in Barron 1993 and 1994. This study centers on approximating a subset of static nonlinear target functions - mechanical restoring force considered as a function of system states (displacement and velocity) for single-degree-of-freedom systems. We strive for efficient and rigorous constructive methods for sigmoidal neural networks to solve function approximation problems in this engineering mechanics application and beyond. Future work is identified.

P115 *A Novel Multilayer Neural Network Model for Heat Treatment of Electroless Ni-P Coatings [no. 640]*
Sayed Yousef Monir Vaghefi and Sayed Mahmoud Monir Vaghefi, RMIT University, Australia; Isfahan University of Technology, Iran

A novel multilayer neural network was designed and implemented for prediction of the hardness of electroless Ni-P coatings. Heat treatment, a process for adjusting the hardness of electroless Ni-P coatings, was modeled. Three neural network models, a multilayer preceptron, a radial basis functions network, and a novel model, called the decomposer-composer model, were implemented and applied to the problem. The input parameters were the phosphorus content of the coatings, and the temperature and duration of the heat treatment process. The models output was the hardness of electroless Ni-P coatings. The training and test data were extracted from a number of experimental projects. The decomposer- composer model achieved better result and performance compared to the other models.

P116 *Selecting Syntactic Attributes for Authorship Attribution [no. 58]*
Paulo Varela, Edson Justino and Luiz Oliveira, PUCPR, Brazil; UFPR, Brazil

In this work we present a methodology to select syntactic attributes for authorship attribution. The approach takes into account a multi-objective genetic algorithm and a Support Vector Machine classifier and it operates in a wrapper mode. Through a series of comprehensive experiments on a database composed of 3000 short articles written in Portuguese we show that the proposed methodology is able to provide a concise subset of attributes, which increases the recognition rate in about 15 percentage points.

P117 *Melody Retrieval by Self-Organizing Map with Refractoriness which has Robustness for Fluctuation of Key Input [no. 285]*
Akira Cho and Yuko Osana, Tokyo University of Technology, Japan

In this research, we propose a melody retrieval system by self-organizing map with refractoriness which has robustness for fluctuation of key input. In the self-organizing map with refractoriness, the plural neurons in the Map Layer corresponding to the input can fire sequentially because of the refractoriness. The proposed melody retrieval system using the self-organizing map with refractoriness makes use of this property in order to retrieve plural similar melodies. In this melody retrieval system, as the melody features, rhythm, tone and keyword (genre of music) are employed. We carried out a series of computer experiments and confirmed that the effectiveness of the proposed system even when the key input includes fluctuation.

P118 *Chord Recognition Using Neural Networks Based on Particle Swarm Optimization [no. 182]*
Cheng-Jian Lin, Chin-Ling Lee and Chun-Cheng Peng, National Chin-Yi University of Technology, Taiwan; National Taichung Institute of Technology, Taiwan

A sequence of musical chords can facilitate musicians in music arrangement and accompaniment. To implement an intelligent system for chord recognition, in this paper we propose a novel approach using Artificial Neural Networks (ANN) trained by the Particle Swarm Optimization (PSO) technique and Backpropagation (BP) learning algorithm. All the training and testing data are generated from Musical Instrument Digital Interface (MIDI) symbolic data. Furthermore, in order to improve the recognition efficiency an additional feature of cadences is also included. In other words, cadence is not only the structural punctuation of a melodic phrase but also considered as the important feature for chord recognition. Experimental results of our proposed approach show that adding cadence feature significantly improves recognition rate, and the ANN-PSO method outperforms ANN-BP in chord recognition. In addition, since preliminary experimental recognition rates are generally not stable enough, we further choose the optimal ANNs to propose a two-phase ANN model to ensemble the recognition results.

P119 *Stochastic Analysis of Smart Home User Activities [no. 25]*
M. R. Alam, M. B. I. Reaz, M. A. M. Ali and F. H. Hashim, Universiti Kebangsaan Malaysia, Malaysia

This paper attempts to formulate the behavioral pattern of smart homes user activities. Smart homes depend on effective representation of residents' activities into ubiquitous computing elements. User activities inside a home follow specific temporal patterns, which are predictable utilizing statistical analysis. This paper intended to develop a temporal learning algorithm to find out the time difference between residents' activities in smart homes. A temporal algorithm is proposed to incrementally construct a temporal database, which is used to predict the time of next activity of the residents employing central limit theory of statistical probability. The algorithm exhibits 88.3% to 95.3% prediction accuracies for different ranges of mean and standard deviations when verified by practical smart home data. Further stochastic analyses prove that the time difference between the residents' activities follows normal distribution, which was merely an assumption previously.

P120 *Agent Teams and Evolutionary Computation: Optimizing Semi-Parametric Spatial Autoregressive Models [no. 77]*
Tamas Krisztin and Matthias Koch, Vienna University of Business and Economics, Austria

Classical spatial autoregressive models share the same weakness as the classical linear regression models, namely it is not possible to estimate non-linear relationships between the dependent and independent variables. In the case of classical linear regression a semi-parametric approach can be used to address this issue. Therefore an advanced semi-parametric modelling approach for spatial autoregressive models is introduced. Advanced semi-parametric modelling requires determining the best configuration of independent variable vectors, number of spline-knots and their positions. To solve this combinatorial optimization problem an asynchronous multi-agent system based on genetic-algorithms is utilized. Three teams of agents work each on a subset of the problem and cooperate through sharing their most optimal solutions. Through this system more complex relationships between the dependent and independent variables can be derived. These could be better suited for the possibly non-linear real-world problems faced by applied spatial econometricians.

P121 *Modeling the Young Modulus of Nanocomposites: A Neural Network Approach [no. 335]*
Leandro Cupertino, Omar VilelaNeto, Marco Aurelio Pacheco, Marley Vellasco and Jose Roberto dAlmeida, PUC-Rio, Brazil; UFMG, Brazil

Composite materials have changed the way of using polymers, as the strength was favored by the incorpora- tion of fibers and particles. This new class of materials allowed a larger number of applications. The insertion of nanometric sized particles has enhanced the variation of properties with a smaller load of fillers. In this paper, we attempt to a better understanding of nanocomposites by using an artificial intelligence's technique, known as artificial neural networks. This technique allowed the modeling of Young's modulus of nanocomposites. A good approximation was obtained, as the correlation between the data and the response of the network was high, and the error percentage was low.

P122 *Modeling a System for Monitoring an Object Using Artificial Neural Networks and Reinforcement Learning [no. 482]*
Helton Peixoto, Anthony Diniz, Nathalee Almeida, Jorge Melo, Ana Guerreiro and Adriao Doria Neto, Federal University of Rio Grande do Norte, Brazil

This paper presents a modeling of a system designed to monitor a moving object from images captured by a camera. The research was focused on defining the steps necessary to the functioning of systems, they are: capture and image processing, pattern recognition with artificial neural networks and seek the best path for moving the camera, using reinforcement learning. The results show the viability of the proposed system, being a relevant alternative to monitoring and security environments.

P123 *Pattern Classifiers with Adaptive Distances [no. 321]*
Telmo Silva Filho and Renata Souza, Universidade Federal de Pernambuco, Brazil

This paper presents learning vector quantization classifiers with adaptive distances. The classifiers furnish discriminant class regions from the input data set that are represented by prototypes. In order to compare prototypes and patterns, the classifiers use adaptive distances that change at each iteration and are different from one class to another or from one prototype to another. Experiments with real and synthetic data sets demonstrate the usefulness of these classifiers.

P124 *A Fast Exact k-Nearest Neighbors Algorithm for High Dimensional Search Using k-Means Clustering and Triangle Inequality [no. 284]*
Xueyi Wang, Northwest Nazarene University, United States

The k-nearest neighbors (k-NN) algorithm is a widely used machine learning method that finds nearest neighbors of a test object in a feature space. We present a new exact k-NN algorithm called kMkNN (k-Means for k-Nearest Neighbors) that uses the k-means clustering and the triangle inequality to accelerate the searching for nearest neighbors in a high dimensional space. The kMkNN algorithm has two stages. In the buildup stage, instead of using complex tree structures such as metric trees, kd-trees, or ball-tree, kMkNN uses a simple k-means clustering method to preprocess the training dataset. In the searching stage, given a query object, kMkNN finds nearest training objects starting from the nearest cluster to the query object and uses the triangle inequality to reduce the distance calculations. Experiments show that the performance of kMkNN is surprisingly good compared to the traditional k-NN algorithm and tree-based k-NN algorithms such as kd-trees and ball-trees. On a collection of 20 datasets with up to 106 records and 104 dimensions, kMkNN shows a 2- to 80-fold reduction of distance calculations and a 2- to 60-fold speedup over the traditional k-NN algorithm for 16 datasets. Furthermore, kMkNN performs significant better than a kd-tree based k-NN algorithm for all datasets and performs better than a ball-tree based k-NN algorithm for most datasets. The results show that kMkNN is effective for searching nearest neighbors in high dimensional spaces.

P125 *A GPU based Parallel Hierarchical Fuzzy ART Clustering [no. 572]*
Sejun Kim and Donald Wunsch II, Missouri University of Science and Technology, United States

Hierarchical clustering is an important and powerful but computationally extensive operation. Its complexity motivates the exploration of highly parallel approaches such as Adaptive Resonance Theory (ART). Although ART has been implemented on GPU processors, this paper presents the first hierarchical ART GPU implementation we are aware of. Each ART layer is distributed in the GPU's multiprocessors and is trained simultaneously. The experimental results show that for deep trees, the GPU's performance advantage is significant.

P126 *Online Parts-Based Feature Discovery using Competitive Activation Neural Networks [no. 315]*
Lester Solbakken and Steffen Junge, Norwegian University of Science and Technology, Norway

The family of competitive activation models has recently attracted some interest. These models are a variation upon competitive neural networks where a local feedback process drives the competitive interaction rather than some form of lateral inhibition. However, this process can be viewed in terms of a generative model that reduces the generalized Kullback-Leibler divergence between the input distribution and the reconstruction distribution. From this insight we construct an online training method based on a stochastic gradient descent that reduces this measure while retaining the constraint of non-negativity inherent in the competitive neural network. We compare our results to non-negative matrix factorization (NMF), and show how the method results in a highly orthogonal, localized and parts-based representation of the data set, even when NMF does not, without the use of any

explicit orthogonality or localization regularizers. Additionally, we show how the method leads to a basis better suited for discriminative tasks.

P127 *A New Algorithm for Graph Mining [no. 215]*
Chandra Bala and Shalini Bhaskar, Professor, Indian Institute of Technology, Delhi, India; PhD Student,Indian Institute of Technology, Delhi, India

Mining frequent substructures has gained importance in the recent past. Number of algorithms has been presented for mining undirected graphs. Focus of this paper is on mining frequent substructures in directed labeled graphs since it has variety of applications in the area of biology, web mining etc. A novel approach of using equivalence class principle has been proposed for reducing the size of the graph database to be processed for finding frequent substructures. For generating candidate substructures a combination of L-R join operation, serial and mixed extensions have been carried out. This avoids missing of any candidate substructures and at the same time candidate substructures that have high probability of becoming frequent are generated.

P128 *Stochastic Artificial Neural Networks and Random Walks [no. 250]*
Richard Windecker, Retired, United States

We showed in previous work how complex stochastic automata can be constructed from simple stochastic parts networked together. Here, we apply this modeling paradigm to create model automata that can mimic some aspects of the random walks animals make as they search for food or prey. We focus on step lengths and create and study two models leading to two different distributions of step lengths. The first is an exponential (Brownian) distribution and the second is a truncated Levy distribution. Both distributions are observed in animal data. Our models are not unique (within the modeling paradigm) in their ability to mimic the observed distributions. Also, in order to keep the models simple and focused, we ignore some of the factors that may also influence random walk behavior. Therefore, we do not assert that our models have a direct correspondence with any real animal nervous systems. However, these models do suggest explanations for some of the characteristics of experimentally observed random walks. In particular, the model that gives the exponential distribution is extremely simple. This suggests that one reason exponential distributions are common is that the neural mechanisms needed to produce them are extremely simple. The more complicated model that produces a truncated Levy distribution requires that the animal keep track of how far it has already come during any given step. This suggests that one reason a Levy distribution is often observed to be truncated is that the animal has a limited amount of this kind of memory.

P129 *Semantic Knowledge Inference from Online News Media using an LDA-NLP Approach [no. 646]*
Sarjoun Doumit and Ali Minai, University of Cincinnati, United States

The amount of news delivered by the different media in the current environment can be overwhelming. Although the events being reported are factually the same, the ways with which the news is delivered vary with the media sources involved. In many cases, it is difficult to reliably uncover the latent information hidden within the news reports due to the great diversity of topics and the sheer volume of news. Analysis of the news media has always been of interest to news analysts, politicians and policy makers in order to aggregate and make sense of the information generated every day. News sources try to achieve relevance to their audiences by providing them with news that the audience wants or finds interesting, but often also have implicit motives such as shaping the perceptions of their audience. Although these agendas or target audiences are not explicitly identified, we consider ways in which this information can be inferred by applying the tools of natural language processing and semantic analysis to the news streams from these sources.

P130 *Noise Benefits in the Expectation-Maximization Algorithm: NEM Theorems and Models [no. 671]*
Bart Kosko, Osonde Osoba and Sanya Mitaim, University of Southern California, United States; Thammasat University, Thailand

We prove a general sufficient condition for a noise benefit in the expectation-maximization (EM) algorithm. Additive noise speeds the average convergence of the EM algorithm to a maximum-likelihood estimate when the condition holds. The sufficient condition states when additive noise makes the signal more probable on average. The performance measure is Kullback relative entropy. A Gaussian-mixture problem demonstrates the EM noise benefit. Corollary results give other special cases when noise improves performance in the EM algorithm.

P131 *Hidden Markov model estimation based on alpha-EM algorithm: Discrete and continuous alpha-HMMs [no. 180]*
Yasuo Matsuyama, Waseda University, Japan

Fast estimation algorithms for Hidden Markov models (HMMs) for given data are presented. These algorithms start from the alpha-EM algorithm which includes the traditional log-EM as its proper subset. Since existing or traditional HMMs are the outcome of the log-EM, it had been expected that the alpha-HMM would exist. In this paper, it is shown that this foresight is true by using methods of the iteration index shift and likelihood ratio expansion. In each iteration, new update equations utilize one-step past terms which are computed and stored during the previous maximization step. Therefore, iteration speedup directly appears as that of CPU time. Since the new method is theoretically based on the alpha-EM, all of its properties are inherited. There are eight types of alpha- HMMs derived. They are discrete, continuous, semi-continuous and discrete- continuous alpha-HMMs, and both for single and multiple sequences. Using the properties of the alpha-EM algorithm, the speedup property is theoretically analyzed. Experimental results including real world data are given.

P132 *Beyond Probabilistic Record Linkage: Using Neural Networks and Complex Features to Improve Genealogical Record Linkage [no. 23]*
D. Randall Wilson, FamilySearch, United States

Probabilistic record linkage has been used for many years in a variety of industries, including medical, government, private sector and research groups. The formulas used for probabilistic record linkage have been recognized by some as being equivalent to the naive Bayes classifier. While this method can produce useful results, it is not difficult to improve accuracy by using one of a host of other machine learning or neural network algorithms. Even a simple single-layer perceptron tends to outperform the naive Bayes classifier--and thus traditional probabilistic record linkage methods--by a substantial margin. Furthermore, many record linkage system use simple field comparisons rather than more complex features, partially due to the limits of the probabilistic formulas they use. This paper presents an overview of probabilistic record linkage, shows how to cast it in machine learning terms, and then shows that it is equivalent to a naive Bayes classifier. It then discusses how to use more complex features than simple field comparisons, and shows how probabilistic record linkage formulas can be modified to handle this.

Finally, it demonstrates a huge improvement in accuracy through the use of neural networks and higher- level matching features, compared to traditional probabilistic record linkage on a large (80,000 pair) set of labeled pairs of genealogical records used by FamilySearch.org.

P133 *A Novel Multilayer Neural Network Model for TOA-Based Localization in Wireless Sensor Networks [no. 648]*

Sayed Yousef Monir Vaghefi and Reza Monir Vaghefi, RMIT University, Australia; Chalmers University of Technology, Sweden

A novel multilayer neural network model, called artificial synaptic network, was designed and implemented for single sensor localization with time-of- arrival (TOA) measurements. In the TOA localization problem, the location of a source sensor is estimated based on its distance from a number of anchor sensors. The measured distance values are noisy and the estimator should be able to handle different amounts of noise. Three neural network models: the proposed artificial synaptic network, a multi-layer perceptron network, and a generalized radial basis functions network were applied to the TOA localization problem. The performance of the models was compared with one another. The efficiency of the models was calculated based on the memory cost. The study result shows that the proposed artificial synaptic network has the lowest RMS error and highest efficiency. The robustness of the artificial synaptic network was compared with that of the least square (LS) method and the weighted least square (WLS) method. The Cramer-Rao lower bound (CRLB) of TOA localization was used as a benchmark. The model's robustness in high noise is better than the WLS method and remarkably close to the CRLB.

P134 *A Stochastic Model based on Neural Networks [no. 317]*

Luciana Campos, Marley Vellasco and Juan Lazo, PUC-Rio, Brazil

This paper presents the proposal of a generic model of stochastic process based on neural networks, called Neural Stochastic Process (NSP). The proposed model can be applied to problems involving phenomena of stochastic behavior and / or periodic features. Through the NSP's neural networks it is possible to capture the historical series' behavior of these phenomena without requiring any a priori information about the series, as well as to generate synthetic time series with the same probabilities as the historical series. The NSP model was applied to the treatment of monthly inflows series and the results indicate that the generated synthetic series exhibit statistical characteristics similar to historical series.

P135 *A Fast Learning Algorithm with Promising Convergence Capability [no. 205]*

Chi Chung Cheung, Sin-Chun Ng, Andrew K Lui and Sean Shensheng Xu, The Hong Kong Polytechnic University, Hong Kong; The Open University of Hong Kong, Hong Kong

Backpropagation (BP) learning algorithm is the most widely supervised learning technique which is extensively applied in the training of multi-layer feed- forward neural networks. Many modifications of BP have been proposed to speed up the learning of the original BP. However, these modifications sometimes cannot converge properly due to the local minimum problem. This paper proposes a new algorithm, which provides a systematic approach to make use of the characteristics of different fast learning algorithms so that the convergence of a learning process is promising with a fast learning rate. Our performance investigation shows that the proposed algorithm always converges with a fast learning rate in two popular complicated applications whereas other popular fast learning algorithms give very poor global convergence capabilities in these two applications.

P136 *Optimal Output Gain Algorithm for Feed-Forward Network Training [no. 533]*

Babu Hemanth Kumar Aswathappa, Michael T. Manry and Rohit Rawat, Intel Corporation, United States; University of Texas at Arlington, United States

A batch training algorithm for feed-forward networks is proposed which uses Newton's method to estimate a vector of optimal scaling factors for output errors in the network. Using this vector, backpropagation is used to modify weights feeding into the hidden units. Linear equations are then solved for the network's output weights. Elements of the new method's Gauss-Newton Hessian matrix are shown to be weighted sums of elements from the total network's Hessian. The effect of output transformation on training a feed-forward network is reviewed and explained, using the concept of equivalent networks. In several examples, the new method performs better than backpropagation and conjugate gradient, with similar numbers of required multiplies. The method performs almost as well as Levenberg-Marquardt, with several orders of magnitude fewer multiplies due to the small size of its Hessian.

P137 *Random Sampler M-Estimator Algorithm for Robust Function Approximation via Feed-Forward Neural Networks [no. 660]*

Moumen El-Melegy, Assiut University, Egypt

This paper addresses the problem of fitting a functional model to data corrupted with outliers using a multilayered feed-forward neural network. The importance of this problem stems from the vast, diverse, practical applications of neural networks as data-driven function approximator or model estimator. Yet, the challenges raised by the presence of outliers in the data have not received the same careful attention from the neural network research community. The paper proposes an enhanced algorithm to train neural networks for robust function approximation in a random sample consensus (RANSAC) framework. The new algorithm follows the same strategy of the original RANSAC algorithm, but employs an M-estimator cost function to decide the best estimated model. The proposed algorithm is evaluated on synthetic data, contaminated with varying degrees of outliers, and compared to existing neural network training algorithms.

P138 *Analysis and Improvement of Multiple Optimal Learning Factors for Feed-Forward Networks [no. 530]*

Praveen Jesudhas, Michael T. Manry and Rohit Rawat, University of Texas at Arlington, United States

The effects of transforming the net function vector in the Multilayer Perceptron (MLP) are analyzed. The use of optimal diagonal transformation matrices on the net function vector is proved to be equivalent to training the MLP using multiple optimal learning factors (MOLF). A method for linearly compressing large ill-conditioned MOLF Hessian matrices into smaller well-conditioned ones is developed. This compression approach is shown to be equivalent to using several hidden units per learning factor. The technique is extended to large networks. In simulations, the proposed algorithm performs almost as well as the Levenberg Marquardt (LM) algorithm with the computational complexity of a first order training algorithm.

P139 *Proving the Efficacy of Complementary Inputs for Multilayer Neural Networks [no. 428]*
Timothy Andersen, Boise State University, United States

This paper proposes and discusses a backpropagation-based training approach for multilayer networks that counteracts the tendency that typical backpropagation-based training algorithms have to "favor" examples that have large input feature values. This problem can occur in any real valued input space, and can create a surprising degree of skew in the learned decision surface even with relatively simple training sets. The proposed method involves modifying the original input feature vectors in the training set by appending complementary inputs, which essentially doubles the number of inputs to the network. This paper proves that this modification does not increase the network complexity, by showing that it is possible to map the network with complimentary inputs back into the original feature space.

P140 *A New Sensitivity-Based Pruning Technique for Feed-Forward Neural Networks That Improves Generalization [no. 445]*
Iveta Mrazova and Zuzana Reitermanova, Charles University, Czech Republic

Multi-layer neural networks of the backpropagation type (MLP-networks) became a well-established tool used in various application areas. Reliable solutions require, however, also sufficient generalization capabilities of the formed networks and an easy interpretation of their function. These characteristics are strongly related to less sensitive networks with an optimized network structure. In this paper, we will introduce a new pruning technique called SCGSIR that is inspired by the fast method of scaled conjugate gradients (SCG) and sensitivity analysis. Network sensitivity inhibited during training impacts efficient optimization of network structure. Experiments performed so far yield promising results outperforming the reference techniques when considering both their ability to find networks with optimum architecture and improved generalization.

P141 *Boundedness and Convergence of MPN for Cyclic and Almost Cyclic Learning with Penalty [no. 50]*
Jian Wang, Wei Wu and Jacek Zurada, Dalian University of Technology, China; University of Louisville, United States

Weight-decay method as one of classical complexity regularizations is simple and appears to work well in some applications for multi-layer perceptron network (MPN). This paper shows results for the weak and strong convergence for cyclic and almost cyclic learning MPN with penalty term (weight-decay). The convergence is guaranteed under some relaxed conditions such as the activation functions, learning rate and the assumption for the stationary set of error function. Furthermore, the boundedness of the weights in the training procedure is obtained in a simple and clear way.

P142 *PCA and Gaussian Noise in MLP Neural Network Training Improve Generalization in Problems with Small and Unbalanced Data Sets [no. 546]*
Icamaan Silva and Paulo Adeodato, Federal University of Pernambuco (UFPE), Brazil

Machine learning approaches have been successfully applied for automatic decision support in several domains. The quality of these systems, however, degrades severely in classification problems with small and unbalanced data sets for knowledge acquisition. Inherent to several real-world problems, data sets with these characteristics are the reality to be tackled by learning algorithms, but the small amount of data affects the classifiers' generalization power while the imbalance in class distribution makes the classifiers biased towards the larger classes. Previous work had addressed these data constraints with the addition of Gaussian noise to the input patterns' variables during the iterative training process of a MultiLayer perceptron (MLP) neural network (NN). This paper improves the quality of such classifier by decorrelating the input variables via a Principal Component Analysis (PCA) transformation of the original input space before applying additive Gaussian noise to each transformed variable for each input pattern. PCA transformation prevents the conflicting effect of adding decorrelated noise to correlated variables, an effect which increases with the noise level. Three public data sets from a well-known benchmark (Proben1) were used to validate the proposed approach. Experimental results indicate that the proposed methodology improves the performance of the previous approach being statistically better than the traditional training method (95% confidence) in further experimental set-ups.

P143 *Parameterized Online quasi-Newton Training for High-Nonlinearity Function Approximation using Multilayer Neural Networks [no. 571]*
Hiroshi Ninomiya, Shonan Institute of Technology, Japan

Recently, the improved online (stochastic) quasi-Newton method was developed for neural network training improving the gradient of error function. The gradient was calculated by a training sample in the online method, but the gradient of improved online one was calculated by variable training samples which were automatically increased from one to all samples as quasi-Newton iteration progressed. That is, the improved algorithm gradually changed from online to batch methods during iteration. The algorithm was efficient, and provided high quality training solutions regardless of initial values compared with online and batch methods. This paper proposes a novel robust training algorithm based on quasi-Newton in which online and batch error functions are associated by a weighting coefficient parameter. This means that the transition from the online method to the batch one is parameterized in quasi-Newton iteration in the same concept as the above improved algorithm. Furthermore, an analogy between the proposed algorithm and Langevin one is considered. Langevin algorithm is a gradient-based continuous optimization method using Simulated Annealing concept. The proposed algorithm is employed for robust neural network training purpose. Neural network training for some benchmark problems with high-nonlinearity is presented to demonstrate the validity of proposed algorithm. The new training algorithm achieves more accurate and robust training results than the other quasi-Newton based training algorithms.

P144 *Towards a generalization of decompositional approach of rules extraction from Network [no. 328]*
Norbert Tsopze, Engelbert Mephu Nguifo and Gilbert Tindo, University of Yaounde I, Cameroon; Universite Blaise Pascal, France

The current development of knowledge discovery domain has pointed out a high number of applications where the need of explanation is at the heart of the process. Using neural networks for those applications requires to be able to provide a set of rules extracted from the trained neural networks, that can help the user to comprehend the learning process. The current literature reports two kinds of rules: 'if condition then conclusion' (called if-then) and 'if m of conditions then conclusion' (also called MofN). We propose a new method able to extract one intermediate structure (called generators list) from which it is possible to extract both forms of rules. The extracted structure is a generic representation that gives the possibility to the user to visualize each form of rules.

P145 *Experimental Studies with a Hybrid Model of Unsupervised Neural Networks [no. 353]*

Sato Kazuhito, Madokoro Hirokazu, Otani Toshimitsu and Kadowaki Sakura, Akita Prefectural University, Japan; Smart Design Corp., Japan

This paper presents an unsupervised clustering method to classify the optimal number of clusters from a given dataset based solely on the image characteristics. The proposed method contains a feature based on the hybridization of two unsupervised neural networks, Self-Organizing Maps (SOMs) and Fuzzy Adaptive Resonance Theory (ART), which has a seamless mapping procedure comprising the following two steps. First, based on the similarity of the spatial topological structure of images, we will form a local neighborhood region holding the order of topological changes. Then the region is mapped to one-dimensional space equivalent to more than the optimal number of clusters. Furthermore, by additional learning in accordance with the order of the one-dimensional maps formed in the neighborhood region, we must generate suitable labels that match the optimal number of clusters. We use it as a target problem for which the number of categories or clusters is unknown. We emphasize the effectiveness of the proposed method for resolving the target problem for which the number of categories and clusters is unknown, and we anticipate its use for the categorization of facial expression patterns for timeseries datasets and for the segmentation of brain tissues shown in Magnetic Resonance (MR) images.

P146 *A SOM combined with KNN for Classification Task [no. 488]*

Leandro A. Silva and Emilio Del-Moral-Hernandez, School of Computing and Informatics of Mackenzie Presbyterian University, Brazil; Polytechnic School of the University of Sao Paulo, Brazil

Classification is a common task that humans perform when making a decision. Techniques of Artificial Neural Networks (ANN) or statistics are used to help in an automatic classification. This work addresses a method based in Self- Organizing Maps ANN (SOM) and K-Nearest Neighbor (KNN) statistical classifier, called SOM-KNN, applied to digits recognition in car plates. While being much faster than more traditional methods, the proposed SOM-KNN keeps competitive classification rates with respect to them. The experiments here presented contrast SOM-KNN with individual classifiers, SOM and KNN, and the results are classification rates of 89.48+-5.6, 84.23+-5.9 and 91.03+-5.1 percent, respectively. The equivalency between SOM-KNN and KNN recognition results are confirmed with ANOVA test, which shows a p-value of 0.27.

P147 *A Hybrid PCA-LDA Model for Dimesion Reduction [no. 452]*

Zhao Nan, Mio Washington and Liu Xiuwen, the Department of Computer Science, Florida State University, United States; the Department of Mathematics, Florida State University, United States

Several variants of Linear Discriminant Analysis (LDA) have been investigated to address the vanishing of the within-class scatter under projection to a low-dimensional subspace in LDA. However, some of these proposals are ad hoc and some others do not address the problem of generalization to new data. Meanwhile, even though LDA is prefered in many application of dimension reduction, it does not always outperform Principal Component Analysis (PCA). In order to optimize discrimination performance in a more generative way, a hybrid dimension reduction model combining PCA and LDA is proposed in this paper. We also present a dimension reduction algorithm correspondingly and illustrate the method with several experiments. Our results have shown that the hybrid model outperform PCA, LDA and the combination of them in two seperate stages.

P148 *Hybrid Neural-Evolutionary Model for Electricity Price Forecasting [no. 666]*

Dipti Srinivasan, Guofan Zhang, Abbas Khosravi, Saeid Nahavandi and Doug Creighton, National University of Singapore, Singapore; Centre for Intelligent Systems Research (CISR), Deakin University, Australia

Evolving artificial neural networks has attracted much attention among researchers recently, especially in the fields where plenty of data exist but explanatory theories and models are lacking or based upon too many simplifying assumptions. Financial time series forecasting is one of them. A hybrid model is used to forecast the hourly electricity price from the California Power Exchange. A collaborative approach is adopted to combine ANN and evolutionary algorithm. The main contributions of this thesis include: Investigated the effect of changing values of several important parameters on the performance of the model, and selected the best combination of these parameters; good forecasting results have been obtained with the implemented hybrid model when the best combination of parameters is used. The lowest MAPE through a single run is 5. 28134%.And the lowest averaged MAPE over 10 runs is 6.088%, over 30 runs is 6.786%; through the investigation of the parameter period, it is found that by including "future values" of the homogenous moments of the instant being forecasted into the input vector, forecasting accuracy is greatly enhanced. A comparison of results with other works reported in the literature shows that the proposed model gives superior performance on the same data set.

P149 *Evolving Clonal Adaptive Resonance Theory based on ECOS Theory [no. 425]*

Jose Alexandrino, Cleber Zanchettin and Edson Carvalho Filho, Federal University of Pernambuco, Brazil

The present work describes an evolution of the hybrid immune approach called Clonart (Clonal Adaptive Resonance Theory) using ECOS (Evolving Connectionist Systems) architectures. Some improvements were developed to allow the control of the growth of the clusters. Clonart's architecture is an Evolutionary Algorithm biologically inspired on the use of the Clonal Selection Principle. Therefore, a technique inspired on ART 1 network was combined to store the best antibodies. However, these strategies may create a lot of clusters due to the ART behavior. For that reason, techniques of insertion, aggregation and pruning inspired on ECOS operation were used to control the amount of clusters in Clonart. In this way, old and unnecessary clusters may confuse the Clonart and increase the learning error rate. This behavior was especially important, because many problems need constant retraining. The effectiveness of this approach was evaluated using ten databases from UCI Machine Learning Repository.

P150 *A Distributed, Bio-Inspired Coordination Strategy for Multiple Agent Systems Applied to Surveillance Tasks in Unknown Environments [no. 713]*

Rodrigo Calvo, Janderson Oliveira, Mauricio Figueiredo and Roseli Romero, University of Sao Paulo, Brazil; Federal University of Sao Carlos, Brazil

Multiple agent systems are applied to exploration and surveillance tasks. A new distributed coordination strategy, designed according to a modified version of the artificial ant system, is described. The strategy is able to adapt the current system dynamics if the number of robots or the environment structure or both change. Experiment simulations are executed to evaluate two versions of the strategy considering different multiple robot systems and environment structures. Results confirm that exploration and surveillance general behaviors emerge from the

individual agent behavior. Different compiled data sets are considered to assess the strategies, namely: needed time to conclude the task; and time between two consecutive sensory on a specific region. The results show that the strategy is effective and relatively efficient to execute the exploration and surveillance tasks.

P151 *Hybrid Learning Based on Multiple Self-organizing Maps and Genetic Algorithm [no. 480]*

Qiao Cai, Haibo He and Hong Man, Stevens Institute of Technology, United States; University of Rhode Island, United States

Multiple Self-Organizing Maps (MSOMs) based classification methods are able to combine the advantages of both unsupervised and supervised learning mechanisms. Specifically, unsupervised SOM can search for similar properties from input data space and generate data clusters within each class, while supervised SOM can be trained from the data via label matching in the global SOM lattice space. In this work, we propose a novel classification method that integrates MSOMs with Genetic Algorithm (GA) to avoid the influence of local minima. Davies-Bouldin Index (DBI) and Mean Square Error (MSE) are adopted as the objective functions for searching the optimal solution space. Experimental results demonstrate the effectiveness and robustness of our proposed approach based on several benchmark data sets from UCI Machine Learning Repository.

P152 *Forecasting Time Series with a Logarithmic Model for the Polynomial Artificial Neural Networks [no. 560]*

Carlos Luna, Eduardo Gomez-Ramirez, Kaddour Najim and Enso Ikonen, La Salle University, Mexico; ENSIACET, France; University of Oulu, Finland

The adaptation made for the Polynomial Artificial Neural Networks (PANN) using not only integer exponentials but also fractional exponentials, have shown evidence of its better performance, especially, when it works with non-linear and chaotic time series. In this paper we show the comparison of the PANN improved model of fractional exponentials with a new logarithmic model. We show that this new model have even better performance than the last PANN improved model.

P153 *Ensemble of Perceptrons with Confidence Measure for Piecewise Linear Decomposition [no. 153]*

Pitoyo Hartono, Chukyo University, Japan

In this study an ensemble of several perceptrons with a simple competitive learning mechanism is proposed. The objective of this ensemble is to decompose a non-linear classification problem into several more manageable linear problems, thus realizing a piecewise-linear classifier. During the competitive learning process, each member of the ensemble competes to learn from one linear subproblem in a reinforcement learning-like mechanism. The linearity of the ensemble members' will simplify the task for interpreting the rule captured by the ensemble. Although the final goal of this study is to generate a "Whitebox" non-linear classifier, this paper focuses on the explanation of the properties of the proposed model, while leaving the rule extraction part to the existing methods.

P154 *A Method For Dynamic Ensemble Selection Based on a Filter and an Adaptive Distance to Improve the Quality of the Regions of Competence [no. 249]*

Rafael Cruz, George Cavalcanti and Tsang Ren, Federal University of Pernambuco, Brazil

Dynamic classifier selection systems aim to select a group of classifiers that is most adequate for a specific query pattern. This is done by defining a region around the query pattern and analyzing the competence of the base classifiers in this region. However, the regions are often surrounded by noise which can difficult the classifier selection. This fact makes the performance of most dynamic selection systems no better than static selections. In this paper we demonstrate that the performance of dynamic selection systems end up limited by the quality of the regions extracted. After, we propose a new dynamic classifier selection system that improves the regions of competence in order to achieve higher recognition rates. Results obtained from several classification databases show the proposed method not only significantly increase the recognition performance, but can also reduce the computational cost in most cases.

P155 *Ensemble Classifier Composition: Impact on Feature Based Offline Cursive Character Recognition [no. 179]*

Ashfaqur Rahman and Brijesh Verma, CINS, CQUni, Australia

In this paper we propose different ensemble classifier compositions and investigate their influence on offline cursive character recognition. Cursive characters are difficult to recognize due to different handwriting styles of different writers. The recognition accuracy can be improved by training an ensemble of classifiers on multiple feature sets focussing on different aspects of character images. Given the feature sets and base classifiers, we have developed multiple ensemble classifier compositions using three architectures. Type-1 architecture is based on homogeneous base classifiers and Type-2 architecture is composed of heterogeneous base classifiers. Type-3 architecture is based on hierarchical fusion of decisions. The experimental results demonstrate that the presented method with best composition of classifiers and feature sets performs better than existing methods for offline cursive character recognition.

P156 *Probabilistic Self-Organizing Maps for Multivariate Sequences [no. 186]*

Rakia Jaziri, Mustapha Lebbah, Nicoleta Rogovschi and Younes Bennani, LIPN, Paris 13 university, France; LIPADE, Paris-Descartes University, France; LIPN, Paris 13 university, France

This paper describes a new algorithm to learn a new probabilistic Self-Organizing Map for not independent and not identically distributed data set. This new paradigm probabilistic self-organizing map uses HMM (Hidden Markov Models) formalism and introduces relationships between the states of the map. The map structure is integrated in the parameter estimation of Markov model using a neighborhood function to learn a topographic clustering. We have applied this novel model to cluster and to reconstruct the data captured using a WACOM tablet.

P157 *Combining Different Ways to Generate Diversity in Bagging Models: An Evolutionary Approach [no. 463]*

Diego Silveira Costa Nascimento, Anne Magaly de Paula Canuto, Ligia Maria Moura e Silva and Andre Luis Vasconcelos Coelho, Federal University of Rio Grande do Norte - UFRN, Brazil; University of Fortaleza - UNIFOR, Brazil

Bagging algorithm has been proven to be efficient on different classification problems. However, the success of Bagging depends strongly on the diversity level reached by the individual classifiers of the ensemble systems. Diversity in ensemble systems can be obtained when the individual classifiers are built using different circumstances, such as parameter settings, training datasets and learning algorithms. This paper presents a new approach which combines these three different ways to obtain high diversity in Bagging models, aiming, as a consequence, to obtain high levels of accuracy for the ensemble systems. In the proposed approach, in order to obtain the optimal configurations for features selection and ensemble models, we have applied genetic algorithm (evolutionary approach). In order to validate the proposed approach, experiments involving 10 classification algorithms have been conducted, applying the resulting bagging structures in 5 pattern classification datasets taken from the UCI repository. In addition, we will analyze the performance of the resulting bagging structures in terms of two recently proposed diversity measures, good and bad.

P158 *Information Coding with Neural Ensembles for a Mobile Robot [no. 183]*

Daniel Calderon, Tatiana Baidyk and Ernst Kussul, Center of Applied Sciences and Technological Development UNAM, Mexico

For robot navigation (obstacle avoidance) we propose to use special neural network, because of its large information capacity for non correlated data. We prove this feature in contrast for correlated data in the robot task. This information is generated by a simulator and coded into neural ensembles. The coding method allows different parameters with their numeric values to be stored; it also provides similarity for close values and eliminates it in other case. The developed system combines the quality of the neural network as associative memory and the coding method to permit learning from some specific situations. So we prove the system introducing only the situation information and retrieving the appropriate maneuver for it.

P159 *Comparison of Neural Networks-based ANARX and NARX Models by application of correlation tests [no. 439]*

Sven Nomm and Ulle Kotta, Institute of Cybernetics at Tallinn University of Technology, Estonia

A correlation-test-based validation procedure is applied in this study to compare neural networks based non- linear autoregressive exogenous model class to its subclass of additive nonlinear autoregressive exogenous models.

P160 *An Online Actor-Critic Learning Approach with Levenberg-Marquardt Algorithm [no. 483]*

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This paper focuses on the efficiency improvement of online actor-critic design base on the Levenberg-Marquardt (LM) algorithm rather than traditional chain rule. Over the decades, several generations of adaptive/approximate dynamic programming (ADP) structures have been proposed in the community and demonstrated many successfully applications. Neural network with backpropagation has been one of the most important approaches to tune the parameters in such ADP designs. In this paper, we aim to study the integration of Levenberg-Marquardt method into the regular actor-critic design to improve weights updating and learning for a quadratic convergence under certain condition. Specifically, for the critic network design, we adopt the LM method targeting improved learning performance, while for the action network, we use the neural network with backpropagation to provide an appropriate control action. A detailed learning algorithm is presented, followed by benchmark tests of pendulum swing up and balance and cart-pole balance tasks. Various simulation results and comparative study demonstrated the effectiveness of this approach.

P161 *Development of a Mix-Design Based Rapid Chloride Permeability Assessment Model Using Neuronets [no. 566]*

Hakan Yasarer and Yacoub Najjar, Doctoral Student, United States; Professor, United States

Corrosion of reinforcing steel due to chloride penetration is one of the most common causes of deterioration in concrete pavement structures. On an annual basis, millions of dollars are spent on corrosion-related repairs. High incidence rates and repair costs have stimulated widespread research interests in order to properly assess the durability problem of concrete pavements. Chloride penetration of concrete pavement structures is determined through the Rapid Chloride Permeability test (RCPT). In a composite material, such as concrete, the parameters of the mixture design and interaction between them determine the behavior of the material. Previous studies have shown that Artificial Neural Network (ANN) based material modeling approach has been successfully used to capture complex interactions among input and output variables. In this study, back-propagation ANN, and Regression-based permeability response prediction models were developed to assess the permeability potential of various concrete mixes using data obtained from actual RCPTs. The back-propagation ANN learning technique proved to be an efficient method to produce relatively accurate permeability response prediction models. Comparison of the prediction accuracy of the developed ANN models and the regression model proved that the developed ANN model outperformed the regression-based model. The developed ANN models have high predictive capability to properly assess the chloride permeability of concrete mixes based on various mix-design parameters. These models can reliably be used for permeability prediction tasks in order to reduce or eliminate the duration of the testing as well as the sample preparation periods required for proper RCP testing.

P162 *Hierarchical Discriminative Sparse Coding via Bidirectional Connections [no. 586]*

Zhengping Ji, Wentao Huang, Garrett Kenyon and Luis Bettencourt, Los Alamos National Laboratory, United States; John Hopkins University, United States

Conventional sparse coding learns optimal dictionaries of feature bases to approximate input signals; however, it is not favorable to classify the inputs. Recent research has focused on building discriminative sparse coding models to facilitate the classification tasks. In this paper, we develop a new discriminative sparse coding model via bidirectional flows. Sensory inputs (from bottom-up) and discriminative signals (supervised from top-down) are propagated through a hierarchical network to form sparse representations at each level. The l0-constrained sparse coding model

allows highly efficient online learning and does not require iterative steps to reach a fixed point of the sparse representation. The introduction of discriminative top-down information flows helps to group reconstructive features belonging to the same class and thus to benefit the classification tasks. Experiments are conducted on multiple data sets including natural images, hand-written digits and 3-D objects with favorable results. Compared with unsupervised sparse coding via only bottom-up directions, the two-way discriminative approach improves the recognition performance significantly.

P163 *Lag Selection for Time Series Forecasting using Particle Swarm Optmization [no. 501]*

Gustavo Ribeiro, Paulo Neto, George Cavalcanti and Ing Ren Tsang, Center of Informatics, Federal University of Pernambuco, Brazil

The time series forecasting is an useful application for many areas of knowledge such as biology, economics, climatology, biology, among others. A very important step for time series prediction is the correct selection of the past observations (lags). This paper uses a new algorithm based in swarm of particles to feature selection on time series, the algorithm used was Frankenstein's Particle Swarm Optimization (FPSO). Many forms of filters and wrappers were proposed to feature selection, but these approaches have their limitations in relation to properties of the data set, such as size and whether they are linear or not. Optimization algorithms, such as FPSO, make no assumption about the data and converge faster. Hence, the FPSO may to find a good set of lags for time series forecasting and produce most accurate forecastings. Two prediction models were used: Multilayer Perceptron neural network (MLP) and Support Vector Regression (SVR). The results show that the approach improved previous results and that the forecasting using SVR produced best results, moreover its showed that the feature selection with FPSO was better than the features selection with original Particle Swarm Optimization.

P164 *Metamodeling for Large-Scale Optimization Tasks Based on Object Networks [no. 605]*

Ludmilla Werbos, Robert Kozma, Rodrigo Silva-Lugo, Giovanni E. Pazienza and Paul Werbos, University of Memphis and IntControl LLC, United States; University of Memphis, United States; University of Memphis and NSF, United States

Optimization in large-scale networks - such as large logistical networks and electric power grids involving many thousands of variables - is a very challenging task. In this paper, we present the theoretical basis and the related experiments involving the development and use of visualization tools and improvements in existing best practices in managing optimization software, as preparation for the use of "metamodeling" - the insertion of complex neural networks or other universal nonlinear function approximators into key parts of these complicated and expensive computations; this novel approach has been developed by the new Center for Large-Scale Integrated Optimization and Networks (CLION) at University of Memphis, TN.

P165 *A weighted image reconstruction based on PCA for pedestrian detection [no. 420]*

Guilherme Carvalho, Lailson Moraes, George Cavalcanti and Ing Ren Tsang, Federal University of Pernambuco, Brazil

Pedestrian detection is a task usually associated with security and surveillance systems. The development of a pedestrian detection system poses a hard challenge, because of its inherently complex nature. In this work, we present an analysis of an existing pedestrian detection model based on PCA reconstruction errors. We investigate how the method works and where changes can be made to improve its original performance. The proposed improvements enhance the system's accuracy by using weights, that are found in an automated way using a genetic algorithm. We also found that some reconstruction errors used by the original method are not strictly necessary and therefore they can be eliminated to reduce the classifying time by half.

P166 *Partitioning Methods used in DBS Treatments Analysis Results - paper upload [no. 378]*

Oana Geman and Cornel Turcu, University Stefan cel Mare Suceava, Romania

Parkinson's disease is a neurodegenerative disorder and is associated with motor symptoms including tremor. The DBS - Deep Brain Stimulation involves implanting an electrode into subcortical structures for long-term stimulation at frequencies greater than 100Hz. First, we made a linear and nonlinear analysis of the tremor signals to determine a set of parameters and rules for recognizing the behavior of the investigated patient and to characterize the typical responses for several forms of DBS. Second, we found representatives for homogeneous group in order to data reduction. We used Data Mining and Knowledge discovery techniques to reduce the number of data. Then, we found "clusters" used the most well-known and commonly used partitioning methods: K-Means and K-Medoids. To make such predictions, we make a model of the tremor, to perform tests to determine of the DBS will reduce the tremor or induce tolerance and lesion if the stimulation is chronic.

P167 *A Tool to Implement Probabilistic Automata in RAM-based Neural Networks [no. 232]*

Marcilio de Souto, Universidade Federal de Pernambuco, Brazil

In previous works, it was proved that General Single-layer Sequential Weightless Neural Networks (GSSWNNs) are equivalent to probabilistic automata. The class of GSSWNNs is an important representative of the research on temporal pattern processing in Weightless Neural Networks or RAM-based neural networks. Some of the proofs provide an algorithm to map any probabilistic automaton into a GSSWNN. They not only allows the construction of any probabilistic automaton, but also increases the class of functions that can be computed by the GSSWNNs. For instance, these networks are not restricted to finite-state languages and can now deal with some context-free languages. In this paper, based on such algorithms, we employ the probability interval method and Java to develop a tool to transform any PA into a GSSWNNs (including the probabilistic recognition algorithm). The probability interval method minimizes the round-off errors that occur while computing the probabilities.

P168 *Global Stability Analysis Using the Method of Reduction of Dissipativity Domain [no. 522]*

Reza Jafari and Martin Hagan, Oklahoma State University, United States

This paper describes a modification to the method of Reduction Of Dissipativity Domain with Linear Boundaries (RODD-LB1) which was introduced by Barabanov and Prokharov. The RODD method is a computational technique for the global stability analysis of nonlinear dynamic systems. In this paper we introduce an extension to the original RODD method that is designed to speed up convergence. The efficiency of the extended algorithm is demonstrated through numerical examples.

P169 *Decentralized Neural Block Control for an Industrial PA10-7CE Robot Arm [no. 575]*

Ramon Garcia, Edgar Sanchez, Victor Santibanez and Jose Antonio Ruz, Universidad Autonoma del Carmen, Mexico; Centro de Investigacion y de Estudios Avanzados del IPN, Mexico; Instituto Tecnologico de la Laguna, Mexico

This paper presents a solution of the trajectory tracking problem for robotic manipulators using a recurrent high order neural network (RHONN) structure to identify the robot arm dynamics, and based on this model a discrete-time control law is derived, which combines block control and the sliding mode techniques. The block control approach is used to design a nonlinear sliding surface such that the resulting sliding mode dynamics is described by a desired linear system. The neural network learning is performed online by Kalman filtering. The local controller for each joint uses only local angular position and velocity measurements. The applicability of the proposed control scheme is illustrated via simulations.

P170 *Object Permanence: Growing Humanoid Robot through the Human Cognitive Development Stages [no. 117]*

Jun-Cheol Park, Seungkyu Nam and Dae-Shik Kim, Dept. of Electrical Engineering, KAIST, Korea (South)

Introduction Object permanence is a prominent procedure of infant developments. Our goal is to bring up a robot by emulating human cognitive development stages. We initially assumed that we can design development stages to make a robot take those stages and develop its own intelligence. In attempt to observe the outcome of the emulation, we conducted experiments with NAO, the humanoid robot developed by Aldebaran Robotics. Method Our method of emulating object permanence is to track the positions of a single moving object. First of all, we located NAO in front of a touch screen that shows the movement of a colored circle. The robot follows the circle's movement on the screen with its right arm. The trajectories of the right arm are recorded for later analysis. The robot would keep tracking the movement even when another object covers the circle on the screen to make the robot impossible to detect it. NAO has actuators with total of 26 degrees of freedom, and each arm has 5 degrees of freedom. In the experiment NAO uses only one arm and a computer controls the robot through LAN or Wi-Fi. Since NAO is provided with the platform which enables the direct connection between the robot and the computer, we do not need additional hardware to control the robot. In order to detect the circle's movement on the screen, a vision system such as a camera is required. Since the small frame rate of the camera equipped on NAO's head makes it difficult to handle the moving object due to the slow speed of wireless network control, we installed another higher-resolution web-cam on the head. In our vision system, the positions of the circle and the right arm are tracked when the robot detects them through image processing technique. The coordinates of each object are then obtained. Our cortex model consists of two Self-Organizing Feature Maps (SOMs) and two additional layers. These two SOMs represent Motor Cortex and Visual Cortex, respectively, and are organized by collected data with the positions of the actuators. Under the conditions of Hebbian Learning Rule and time delayed activity, the trajectories of the circle are used to organize the two types of connectivity strength between two Cortexes and the adjacent layer. After several trials, one of the layers would predict the next position of the moving circle, and the other would use the prediction to determine whether the object actually exists or not. Results As a result, there were some miss-predictions when the movements of the object were random. On the contrary, when the movement was predictable, the number of miss-predictions decreased. In human life, objects do not move randomly. For example, a ball thrown by someone moves predictably in one direction. Therefore, we can safely conclude that our model could be applied to determine the probability of existence of a moving object in practice.

P171 *Image Segmentation Based on Local Spectral Histograms and Linear Regression [no. 124]*

Jiangye Yuan, DeLiang Wang and Rongxing Li, The Ohio State University, United States

We present a novel method for segmenting images with texture and nontexture regions. Local spectral histograms are feature vectors consisting of histograms of chosen filter responses, which capture both texture and nontexture information. Based on the observation that the local spectral histogram of a pixel location can be approximated through a linear combination of the representative features weighted by the area coverage of each feature, we formulate the segmentation problem as a multivariate linear regression, where the solution is obtained by least squares estimation. Moreover, we propose an algorithm to automatically identify representative features corresponding to different homogeneous regions, and show that the number of representative features can be determined by examining the effective rank of a feature matrix. We present segmentation results on different types of images, and our comparison with another spectral histogram based method shows that the proposed method gives more accurate results.

P172 *Power Wind Mill Fault Detection via one-class nu-SVM Vibration Signal Analysis [no. 130]*

David Martinez-Rego, Oscar Fontenla-Romero and Amparo Alonso-Betanzos, University of A Corunna, Spain

Vibration analysis is one of the most used techniques for predictive maintenance in high-speed rotating machinery. Using the information contained in the vibration signals, a system for alarm detection and diagnosis of failures in mechanical components of power wind mills is devised. As previous failure data collection is unfeasible in real life scenarios, the method to be employed should be capable of discerning between failure and normal data, being only trained with the latter type. Other interesting capability of such a method is the possibility of measuring the evolution of the failure. Taking into account these restrictions, a method that uses the one-class nu-SVM paradigm is employed. In order to test its adequacy, three different scenarios are tested: (a) a simulated scenario, (b) a controlled experimental scenario with real vibrational data, and (c) a real scenario using vibrational data captured from a windmill power machine installed in a wind farm in North West Spain. The results showed not only the capabilities of the method for detecting the failure in advance to the breakpoint of the component in all three scenarios, but also its capacity to present a qualitative indication on the evolution of the defect. Finally, the results of the SVM paradigm are compared to one of the most used novelty detection methods, obtaining more accurate results under noisy circumstances.

P173 *Improved Image Super-Resolution by Support Vector Regression [no. 161]*

Le An and Bir Bhanu, University of California, Riverside, United States

With the wide spread application of video cameras, surveillance systems and hand-held devices that are equipped with moderate image sensors, it is desirable to obtain images or video streams with high quality while not increasing the cost of the hardware. However the outputs of those image sensors are often with low-resolution since the imaging process undergoes blurring and downscaling steps with

noise added during those processes. The purpose of super-resolution is to reverse this imaging process and generate high-resolution image from the low-resolution observations. In this paper, the super-resolution is regarded as a regression problem. Our approach is based on Support Vector Regression, the regression version of the Support Vector Machine that can construct a set of hyper-planes in a high or infinite dimensional space to separate the data. We select both local weighted pixel intensity values and the gradient information to construct the feature vectors. During the training, the model from the original low-resolution images to their high-resolution version is learned. In the prediction step, the learned model is applied to the input low-resolution image to get the super-resolved output. We use different types of images for training and testing. The size of the training set is limited which makes the training relatively fast while still achieving good results. The results show that the gradient information added in the feature vectors helps to reconstruct the edges and fine details. Both subjective and objective evaluations suggest that our method is able to produce better super-resolved images than some of the state-of-the-art approaches.

P174 *A Statistical Parametric Method for the Extraction of Stimulus Dependent Activity from Intrinsic Optical Signals [no. 204]*
Gang Wang, Katsutoshi Miyahara and Masaru Kuroiwa, Kagoshima University, Japan; Canon Inc., Japan; Tokyo Electron Limited, Japan

The anterior part of inferotemporal cortex (IT) is thought to be critical for the object recognition and discrimination. To understand the mechanism on how objects are presented by the activation of neurons, and then how the information on the objects is processed in this brain area, the optical imaging technique based on intrinsic signals was applied to directly visualize the responsive neurons when viewing various object images. Instead of using just the ratio of the optical intensities, here we proposed a novel method based on a statistical parametric map for the extraction of the stimulus-dependent signals from the response images. Statistical parameter, t was introduced to evaluate the difference of means between the response and control images obtained with and without visual stimulation. t value for each pixel was computed by comparing the means of optical intensities at the particular pixel in response images and control images, and used to evaluate the significance of the response. The performance of this method was evaluated by the number of spiking neurons. In the region extracted with the proposed method, in as high as 81.8% of penetrations, neurons were responsive, this was significantly higher than 45.5% if in the region extracted by using the ratio of the optical intensities. The results demonstrate that the method proposed here is effective for the signal extraction in the optical imaging experiments.

P175 *Realizing Video Time Decoding Machines with Recurrent Neural Networks [no. 223]*
Aurel A. Lazar and Yiyin Zhou, Columbia University, United States

Video Time Decoding Machines faithfully reconstruct bandlimited stimuli encoded with Video Time Encoding Machines. The key step in recovery calls for the pseudo-inversion of a typically poorly conditioned large scale matrix. We investigate the realization of time decoders employing only neural components. We show that Video Time Decoding Machines can be realized with recurrent neural networks, describe their architecture and evaluate their performance. We provide the first demonstration of recovery of natural and synthetic video scenes encoded in the spike domain with decoders realized with only neural components. The performance in recovery using the latter decoder is not distinguishable from the one based on the pseudo-inversion matrix method.

P176 *Blind Signal Separation in Distributed Space-Time Coding Systems Using the FastICA Algorithm [no. 614]*
Xianxue Fan, Jorge Igual, Raul Llinares, Addisson Salazar and Gang Wu, 28th Research Institute of China Electronics Technology Group Corporation, China; Universitat Politecnica Valencia, Spain; University of Electronic Science and Technology of China, China

One of the main advantages of cooperative communication systems is the use of information at the surrounding nodes in order to create spatial diversity and so far obtaining higher throughput and reliability. We propose in this paper a blind detector that involves the formulation of the system as a Blind Source Separation BSS problem. In the BSS framework, we do not have to estimate the channel using training data, removing the necessity of pilot symbols and the prior estimation of the channel. We analyze two kinds of distributed space-time codes for the single relay system, showing that they can be stated in terms of BSS as a linear instantaneous mixture of complex-valued sources. The BSS method applied is the complex version of the FastICA algorithm since it is very flexible, robust and the convergence is very fast so we can estimate the symbols accurately with a low-complexity algorithm that can adapt to changes in the channel with relative simplicity.

P177 *The Role of Orientation Diversity in Binocular Vergence Control [no. 471]*
Chao Qu and Bertram Shi, The Hong Kong university of science and technology, Hong Kong

Neurons tuned to binocular disparity in area V1 are hypothesized to be responsible for short latency binocular vergence movements, which align the two eyes on the same object as it moves in depth. Disparity selective neurons in V1 are not only selective to disparity, but also to other visual stimulus dimensions, in particular orientation. In this work, we explore the role of neurons tuned to different orientations in binocular vergence control, by training an artificial binocular vision system to execute corrective vergence movements based on the outputs of model disparity tuned neurons that are selective to different orientations. As might be expected, we find that neurons tuned to vertical orientations have the strongest effect on the vergence eye movements, and that the effect of neurons tuned to other orientations decreases as the tuned orientation approaches horizontal. Although adding neurons tuned to non-vertical orientations does not appear to improve vergence tracking accuracy, we find that neurons tuned to non-vertical orientations still play critical roles in binocular vergence control. First, they decrease the time required to learn the vergence control strategy. Second, they also increase the effective range of vergence control.

P178 *PAC learnability versus VC dimension: a footnote to a basic result of statistical learning [no. 251]*
Vladimir Pestov, University of Ottawa, Canada

A fundamental result of statistical learnig theory states that a concept class is PAC learnable if and only if it is a uniform Glivenko-Cantelli class if and only if the VC dimension of the class is finite. However, the theorem is only valid under special assumptions of measurability of the class, in which case the PAC learnability even becomes consistent. Otherwise, there is a classical example, constructed under the Continuum Hypothesis by Dudley and Durst and further adapted by Blumer, Ehrenfeucht, Haussler, and Warmuth, of a concept class of VC dimension one which is neither uniform Glivenko-Cantelli nor consistently PAC learnable. We show that, rather surprisingly, under an additional set-theoretic hypothesis which is

much milder than the Continuum Hypothesis (Martin's Axiom), PAC learnability is equivalent to finite VC dimension for every concept class.

P179 *Instance Selection Algorithm based on a Ranking Procedure [no. 496]*
Cristiano Pereira and George Cavalcanti, Federal Institute of Pernambuco, Brazil; Federal University of Pernambuco, Brazil

This paper presents an innovative instance selection method, called Instance Selection Algorithm based on a Ranking Procedure (ISAR), which is based on a ranking criterion. The ranking procedure aims to order the instances in the data set; better the instance higher the score associate to it. With the purpose of eliminating irrelevant instances, ISAR also uses a coverage strategy. Each instance delimits a hypersphere centered in it. The radius of each hypersphere is used as a normalization factor in the classification rule; bigger the radius smaller the distance. After a comparative study using real-world databases, the ISAR algorithm reached promising generalization performance and impressive reduction rates when compared with state of the art methods.

P180 *Learning to Rank Relational Objects Based on the Listwise Approach [no. 384]*
Yuxin Ding, Di Zhou, Min Xiao and Li Dong, Harbin Institute of Technology Shenzhen Graduate School, China

In recent years machine learning technologies have been applied to ranking, and a new research branch named "learning to rank" has emerged. Three types of learning-to-rank methods - pointwise, pairwise and listwise approaches - have been proposed. This paper is concerned with listwise approach. Currently structural support vector machine(SVM) and linear neural network have been utilized in listwise approach, but these methods only consider the content relevance of an object with respect to queries, they all ignore the relationships between objects. In this paper we study how to use relationships between objects to improve the performance of a ranking model. A novel ranking function is proposed, which combines the content relevance of documents with respect to queries and relation information between documents. Two types of loss functions are constructed as the targets for optimization. Then we utilize neural network and gradient descent algorithm as model and training algorithm to build ranking model. In the experiments, we compare the proposed methods with two conventional listwise approaches. Experimental results on OHSUMED dataset show that the proposed methods outperform the conventional methods.

P181 *Fast AdaBoost Training using Weighted Novelty Selection [no. 273]*
Mojtaba Seyedhosseini, Antonio Paiva and Tolga Tasdizen, University of Utah, United States; ExxonMobil Upstream Research Company, United States

In this paper, a new AdaBoost learning framework, called WNS-AdaBoost, is proposed for training discriminative models. The proposed approach significantly speeds up the learning process of adaptive boosting (AdaBoost) by reducing the number of data points. For this purpose, we introduce the weighted novelty selection (WNS) sampling strategy and combine it with AdaBoost to obtain an efficient and fast learning algorithm. WNS selects a representative subset of data thereby reducing the number of data points onto which AdaBoost is applied. In addition, WNS associates a weight with each selected data point such that the weighted subset approximates the distribution of all the training data. This ensures that AdaBoost can trained efficiently and with minimal loss of accuracy. The performance of WNS-AdaBoost is first demonstrated in a classification task. Then, WNS is employed in a probabilistic boosting-tree (PBT) structure for image segmentation. Results in these two applications show that the training time using WNS-AdaBoost is greatly reduced at the cost of only a few percent in accuracy.

P182 *Multiple Distribution Data Description Learning Method for Novelty Detection [no. 481]*
Trung Le, Dat Tran, Phuoc Nguyen, Wanli Ma and Dharmendra Sharma, University of Canberra, Australia

Current data description learning methods for novelty detection such as support vector data description and small sphere with large margin construct a spherically shaped boundary around a normal data set to separate this set from abnormal data. The volume of this sphere is minimized to reduce the chance of accepting abnormal data. However those learning methods do not guarantee that the single spherically shaped boundary can best describe the normal data set if there exist some distinctive data distributions in this set. We propose in this paper a new data description learning method that constructs a set of spherically shaped boundaries to provide a better data description to the normal data set. An optimisation problem is proposed and solving this problem results in an iterative learning algorithm to determine the set of spherically shaped boundaries. We prove that the classification error will be reduced after each iteration in our learning method. Experimental results on 23 well-known data sets show that the proposed method provides lower classification error rates.

P183 *Weight of evidence as a tool for attribute transformation in the preprocessing stage of supervised learning algorithms [no. 60]*
Eftim Zdravevski, Petre Lameski and Andrea Kulakov, Ni Tekna - Intelligent Technologies, Macedonia; Faculty of Computer Sciences and Engineering, UKIM, Skopje, Macedonia

A common task in the data preprocessing stage of data mining and classification problems is the transformation of features. Many classification algorithms have preference of continual attributes over nominal attributes, and sometimes the distance between different data points cannot be estimated if the values of the attributes are not continual and normalized. The Weight of Evidence has some very desirable properties that make it very useful tool for transformation of attributes, but unfortunately there are some preconditions that need to be met in order to calculate it. In this paper we propose modified calculation of the Weight of Evidence that overcomes these preconditions, and additionally makes it usable for test examples that were not present in the training set. The proposed transformation can be used for all supervised learning problems. At the end, we present the results from the proposed transformation, and discussion of the benefits of the transformed nominal and continual attributes from the PAKDD 2009 dataset.

P184 *On Improving Trust-Region Variable Projection Algorithms for Separable Nonlinear Least Squares Learning [no. 107]*
Eiji Mizutani and James Demmel, National Taiwan University of Science and Technology, Taiwan; University of California at Berkeley, United States

In numerical linear algebra, the variable projection (VP) algorithm has been a standard approach to separable ``mixed'' linear and nonlinear least squares problems since early 1970s. Such a separable case often arises in diverse contexts of machine learning (e.g., with generalized linear discriminant functions); yet VP is not fully investigated in the literature. We thus describe in detail its implementation

issues, highlighting an economical trust-region implementation of VP in the framework of a so-called block-arrow least squares (BA) algorithm for a general multiple-response nonlinear model. We then present numerical results using an exponential-mixture benchmark, seven-bit parity, and color reproduction problems; in some situations, VP enjoys quick convergence and attains high classification rates, while in some others VP works poorly. This observation motivates us to investigate original VP's strengths and weaknesses compared with other (full-functional) approaches. To overcome the limitation of VP, we suggests how VP can be modified to be a Hessian matrix-based approach that exploits negative curvature when it arises. For this purpose, our economical BA algorithm is very useful in implementing such a modified VP especially when a given model is expressed in a multi-layer (neural) network for efficient Hessian evaluation by the so-called second-order stagewise backpropagation.

P185 *ITR-Score Algorithm: a New Efficient Trace Ratio Criterion based Algorithm for Supervised Dimensionality Reduction [no. 53]*
MIngbo Zhao, Zhao Zhang and Tommy W.S. Chow, EE Department, City University of Hong Kong, Hong Kong

Dimensionality reduction has been a fundamental tool when dealing with high-dimensional dataset. And trace ration optimization has been widely used in dimensionality reduction because Trace ratio can directly reflect the similarity (Euclidean distance) of data points. Conventionally, there is no close-form solution to the original trace ratio problem. Prior works have indicated that trace ratio problem can be solved by an iterative way. In this paper, we propose an efficient algorithm to find the optimal solutions. The proposed algorithm can be easily extended to its corresponding kernel version for handling the nonlinear problems. Finally, we evaluate our proposed algorithm based on extensive simulations of real world datasets. The results show our proposed method is able to deliver marked improvements over other supervised and unsupervised algorithms.

P186 *Supervised Link Prediction in Weighted Networks [no. 473]*
Hially Sa and Ricardo Prudencio, Federal University of Pernambuco, Brazil

Link prediction is an important task in Social Network Analysis. This problem refers to predicting the emergence of future relationships between nodes in a social network. Our work focuses on a supervised machine learning approach for link prediction. Here, the target attribute is a class label indicating the existence or absence of a link between a node pair. The predictor attributes are metrics computed from the network structure, describing the given pair. The majority of works for supervised prediction only considers unweighted networks. In this light, our aim is to investigate the relevance of using weights to improve supervised link prediction. Link weights express the strength of relationships and could bring useful information for prediction. However, the relevance of weights for unsupervised approaches of link prediction was not always verified (in some cases, the performance was even harmed). Our preliminary results on supervised prediction on a coauthorship network revealed satisfactory results when weights were considered, which encourage us for further analysis.

P187 *Variations to incremental growing neural gas algorithm based on label maximization [no. 209]*
Jean-Charles Lamirel, Raghvendra Mall, Pascal Cuxac and Ghada Safi, INRIA-TALARIS Project, France; IIIT Hyderabad, India; INIST-CNRS, France; Aleppo University, Syria

Neural clustering algorithms show high performance in the general context of the analysis of homogeneous textual dataset. This is especially true for the recent adaptive versions of these algorithms, like the incremental growing neural gas algorithm (IGNG) and the label maximization based incremental growing neural gas algorithm (IGNG-F). In this paper we highlight that there is a drastic decrease of performance of these algorithms, as well as the one of more classical algorithms, when a heterogeneous textual dataset is considered as an input. Specific quality measures and cluster labeling techniques that are independent of the clustering method are used for the precise performance evaluation. We provide variations to incremental growing neural gas algorithm exploiting in an incremental way knowledge from clusters about their current labeling along with cluster distance measure data. This solution leads to significant gain in performance for all types of datasets, especially for the clustering of complex heterogeneous textual data.

P188 *Robust Locally Linear Embedding using Penalty Functions [no. 477]*
Manda Winlaw, Leila Samimi Dehkordy and Ali Ghodsi, University of Waterloo, Canada; University of Tehran, Iran

We introduce a modified version of locally linear embedding (LLE) which is more robust to noise. This is accomplished by adding a regularization term to the reconstruction weight cost function. We propose two alternative regularization terms, the L2-norm and the elastic-net function; a weighted average of the L2- and L1-norm. Adding the L2-norm to the cost function produces more uniform weights. With noise in the data, a more uniform weight structure provides a better representation of the linear patch surrounding each data point. In the case of the elastic-net function, the addition of the L1-norm produces sparse weights; eliminating possible outliers from the reconstruction. We use several examples to show that these methods are able to outperform LLE and are comparable to other dimensionality reduction algorithms.

P189 *On the Clustering of Large-scale Data: A Matrix-based Approach [no. 52]*
Lijun Wang and Ming Dong, Wayne State University, United States

Nowadays, the analysis of large amounts of digital documents become a hot research topic since the libraries and database are converted electronically, such as PUBMED and IEEE publications. The ubiquitous phenomenon of massive data and sparse information imposes considerable challenges in data mining research. In this paper, we propose a theoretical framework, Exemplar-based Low-rank sparse Matrix Decomposition (ELMD), to cluster large-scale datasets. Specifically, given a data matrix, ELMD first computes a representative data subspace and a near-optimal low-rank approximation. Then, the cluster centroids and indicators are obtained through matrix decomposition, in which we require that the cluster centroids lie within the representative data subspace. From a theoretical perspective, we show the correctness and convergence of the ELMD algorithm, and provide detailed analysis on its efficiency. Through extensive experiments performed on both synthetic and real datasets, we demonstrate the superior performance of ELMD for clustering large-scale data.

P190 *A Fast Optimized Semi-Supervised Non-Negative Matrix Factorization Algorithm [no. 514]*
Noel Lopes and Bernardete Ribeiro, Polytechnic Institute of Guarda, Portugal; University of Coimbra, Portugal

Non-negative Matrix Factorization (NMF) is an unsupervised technique that projects data into lower dimensional spaces, effectively reducing the number of features of a dataset while retaining the basis information necessary to reconstruct the original data. In this paper we present a semi-supervised NMF approach that reduces the

computational cost while improving the accuracy of NMF- based models. The advantages inherent to the proposed method are supported by the results obtained in two well-known face recognition benchmarks.

P191 *Density and Neighbor Adaptive Information Theoretic Clustering [no. 72]*
Baoyuan Wu and Baogang Hu, NLPR/LIAMA, Institute of Automation, Chinese Academy of Sciences, China

This work presents a novel clustering algorithm, named Adaptive Information Theoretic Clustering (AITC). Specific adaptations concerned in AITC are densities and neighbors. Based on the utilization of the within/between information potential, the proposed algorithm is easily computable and carries an intuitive interpretation. We also propose two ways in implementations, the direct and indirect ones, which can not only provide a lower degree of complexity compared with conventional hierarchical clusterings, but also facilitate the adjustment of parameters. Experiments to evaluate the performance of AITC are presented on both synthetic and real datasets with different types of distributions. Better results are gained by the proposed algorithm in comparison with other widely used clustering algorithms.

P192 *Entropy Penalized Learning for Gaussian Mixture Models [no. 429]*
Boyu Wang, Feng Wan, Peng Un Mak, Pui In Mak and Mang I Vai, University of Macau, Macau

In this paper, we propose an entropy penalized approach to address the problem of learning the parameters of Gaussian mixture models (GMMs) with components of small weights. In addition, since the method is based on minimum message length (MML) criterion, it can also determine the number of components of the mixture model. The simulation results demonstrate that our method outperform several other state-of-art model selection algorithms especially for the mixtures with components of very different weights.

P193 *Model-based clustering with Hidden Markov Model regression for time series with regime changes [no. 579]*
Chamroukhi Faicel, Same Allou, Aknin Patrice and Govaert Gerard, Computer science lab of Paris Nord University, France; Research Unit UPE, IFSTTAR, GRETTIA, France; Heudiasyc Lab, UMR CNRS 6599, France

This paper introduces a novel model-based clustering approach for clustering time series which present changes in regime. It consists of a mixture of polynomial regressions governed by hidden Markov chains. The underlying hidden process for each cluster activates successively several polynomial regimes during time. The parameter estimation is performed by the maximum likelihood method through a dedicated Expectation-Maximization (EM) algorithm. The proposed approach is evaluated using simulated time series and real-world time series issued from a railway diagnosis application. Comparisons with existing approaches for time series clustering, including the stand EM for Gaussian mixtures, K-means clustering, the standard mixture of regression models and mixture of Hidden Markov Models, demonstrate the effectiveness of the proposed approach.

P194 *Tangent Space Guided Intelligent Neighbor Finding [no. 535]*
Michael Gashler and Tony Martinez, Brigham Young University, United States

We present an intelligent neighbor-finding algorithm called SAFFRON that chooses neighboring points while avoiding making connections between points on geodesically distant regions of a manifold. SAFFRON identifies the suitability of points to be neighbors by using a relaxation technique that alternately estimates the tangent space at each point, and measures how well the estimated tangent spaces align with each other. This technique enables SAFFRON to form high-quality local neighborhoods, even on manifolds that pass very close to themselves. SAFFRON is even able to find neighborhoods that correctly follow the manifold topology of certain self-intersecting manifolds.

P195 *Controlled Consensus Time for Community Detection in Complex Networks [no. 85]*
Jean Huertas and Liang Zhao, University of Sao Paulo, Brazil

Networks are powerful representations for many complex systems, where nodes represent elements of the system and edges represent connections between them. Consensus problems in coupled agents have already been studied in complex networks. This paper explores the use of the consensus time in the presence of a leader as distance measure on complex networks. In this case, the distance between two nodes in the network is characterized by the time that one of them takes to reach a stationary state with the other node being pinned. A new technique for community detection of complex networks has been developed based on the proposed distance measure. The method has been tested with various networks and promising results have been obtained.

P196 *New Approaches for Solving Permutation Indeterminacy and Scaling Ambiguity in Frequency Domain Separation of Convolved Mixtures [no. 201]*
Zhitang Chen and Laiwan Chan, Department of Computer Science and Engineering, The Chinese University of Hong Kong, Hong Kong

Permutation indeterminacy and scaling ambiguity occur in ICA and they are particularly problematic in time-frequency domain separation of convolutive mixtures. The quality of separation is severely degraded if these two problems are not well addressed. In this paper, we propose new approaches to solve the permutation indeterminacy and scaling ambiguity in the separation of convolutive mixture in frequency domain. We first apply Short Time Fourier Transform to the observed signals in order to transform the convolutive mixing in time domain to instantaneous mixing in time-frequency domain. A fixed-point algorithm with test of saddle point is adopted to derive the separated components in each frequency bin. To solve the permutation problem, we propose a new matching algorithm for this purpose. First we use discrete Haar Wavelet Transform to extract the feature vectors from the magnitude waveforms of the separated components and use Singular Value Decomposition to achieve dimension reduction. The permutation problem is solved by clustering the feature vectors using the new matching algorithm which is a combination of basic K-means and Hungarian algorithm. To solve the scaling ambiguity problem, we treat it as an overcomplete problem and realize it by maximizing the posterior of the scaling factor. Finally, experiments are conducted using benchmark data to present the effectiveness and performance of our proposed algorithms.

P197 *On the Structure of Algorithm Spaces [no. 155]*
Adam Peterson, Tony Martinez and George Rudolph, Adobe Systems, United States; Brigham Young University, United States; The Citadel, United States

Many learning algorithms have been developed to solve various problems. Machine learning practitioners must use their knowledge of the merits of the algorithms they know to decide which to use for each task. This process often raises questions such as: (1) If performance is poor after trying certain algorithms, which should be tried next? (2) Are some learning algorithms the same in terms of actual task classification? (3) Which algorithms are most different from each other? (4) How different? (5) Which algorithms should be tried for a particular problem? This research uses the COD (Classifier Output Difference) distance metric for measuring how similar or different learning algorithms are. The COD quantifies the difference in output behavior between pairs of learning algorithms. We construct a distance matrix from the individual COD values, and use the matrix to show the spectrum of differences among families of learning algorithms. Results show that individual algorithms tend to cluster along family and functional lines. Our focus, however, is on the structure of relationships among algorithm families in the space of algorithms, rather than on individual algorithms. A number of visualizations illustrate these results. The uniform numerical representation of COD data lends itself to human visualization techniques.

P198 *Feature selection of pathway markers for microarray-based disease classification using negatively correlated feature sets [no. 725]*
Jonathan Chan, Pitak Sootanan and Ponlavit Larpeampaisarl, King Mongkut's University of Technology Thonburi, Thailand

Microarray-based classification of disease states is based on gene expression profiles of subjects. Various methods have been proposed to identify diagnostic markers that can accurately discriminate between two classes such as case and control. Many of the methods that used only a subset of ranked genes in the pathway may not be able to fully represent the classification boundaries for the two disease classes. The use of negatively correlated feature sets (NCFS) for identifying phenotype-correlated genes (PCOGs) and inferring pathway activities is used here. The NCFS-based pathway activity inference schemes significantly improved the power of pathway markers to discriminate between normal and cancer, as well as relapse and non-relapse, classes in microarray expression datasets of breast cancer. Furthermore, the use of ranker feature selection methods with top 3 pathway markers has been shown to be suitable for both logistic and NB classifiers. In addition, the proposed single pathway classification (SPC) ranker provided similar performance to the traditional SVM and Relief-F feature selection methods. The identification of PCOGs within each pathway, especially with the use of NCFS based on correlation with ideal markers (NCFS-i), helps to minimize the effect of potentially noisy experimental data, leading to accurate and robust classification results.

Tuesday, August 2, 8:00AM-9:00AM

Plenary Talk Tu-Plen1: Plenary Session: From Brains to Machines A

Tuesday, August 2, 8:00AM-9:00AM, Room: Oak, Chair: Peter Erdi

8:00AM *Brains, Machines and Buildings*

Michael Arbib, University of Southern California, United States

The talk will introduce Neuromorphic Architecture, exploring ways to incorporate "brains" into buildings, developing the view that future buildings are to be constructed as perceiving, acting and adapting entities. The discussion is grounded in an exposition of Ada - the intelligent space, a pavilion visited by over 550,000 guests at the Swiss National Exhibition of 2002. She had a "brain" based (in part) on neural networks, had "emotions" and "wanted" to play with her visitors. Dramatic new developments will emerge as we explore the lessons from neuroscience on how the brain supports an animal's interactions with its physical and social world to develop brain operating principles that lead to new algorithms for a neuromorphic architecture which supports the "social interaction" of rooms with people and other rooms to constantly adapt buildings to the needs of their inhabitants and enhance interactions between the people who use them and their environment.

Tuesday, August 2, 9:30AM-11:30AM

Special Session Tu1-1: Computational Intelligence in Patient Care

Tuesday, August 2, 9:30AM-11:30AM, Room: Cedar, Chair: Jim DeLeo and Adam Gaweda

9:30AM *Spectral decomposition methods for the analysis of MRS information from human brain tumors [no. 722]*

Sandra Ortega-Martorell, Alfredo Vellido, Paulo J.G. Lisboa, Margarida Julia-Sape and Carles Arus, Departament de Bioquimica i Biologia Molecular, Universitat Autonoma de Barcelona (UAB), Spain; Department of Computer Languages and Systems, Universitat Politecnica de Catalunya (UPC), Spain; Department of Mathematics and Statistics, Liverpool John Moores University (LJMU), United Kingdom; Centro de Investigacion Biomedica en Red en Bioingenieria, Biomateriales y Nanomedicina (CIBER-BBN), Spain

The clinical assessment of human brain tumors requires the use of non-invasive information measurement technologies, usually from the modalities of imaging or spectroscopy. The latter may provide insight into the tumor metabolism. The Magnetic Resonance Spectroscopy (MRS) signal is the result of the combination of heterogeneous signal sources. In this study, we investigate the use of two spectral decomposition techniques for the identification of such sources in MRS from brain tumors collected in an international database, and for a number of different diagnostic problems.

9:50AM *PLANN-CR-ARD model predictions and Non-parametric estimates with Confidence Intervals [no. 327]*

Arsene Corneliu and Lisboa Paulo, Research Fellow of National University Research Council of Romania at IPA SA, Bucharest , Romania, Romania; School of Computing and Mathematical Sciences, Liverpool John Moores University, Liverpool, United Kingdom, United Kingdom

This paper investigates the performance of the PLANN-CR-ARD network predictions through a comparison with the confidence intervals and the non-parametric estimates obtained from the survival analysis of a Primary Billiary Cirrhosis (PBC) dataset. The predictions of the PLANN-CR-ARD model are marginalized using two methods: approximation of the integral of marginalization and the Monte Carlo method. The numerical results show that the PLANN-CR-ARD predicts very well, the results being situated within the confidence intervals of the non- parametric estimates. The Model Selection is also performed on the same dataset. The PLANN-CR-ARD can be used to explore the non-linear inter- dependencies between the predicted outputs and the input data which in survival analysis describes the characteristics of the patients.

10:10AM *Magnetic Resonance Estimation of Longitudinal Relaxation Time (T1) in Spoiled Gradient Echo Using an Adaptive Neural Network [no. 523]*

Hassan Bagher-Ebadian, Rajan Jain, Ramesh Paudyal, Siamak Nejad-Davarani, Jayant Narang, Quan Jiang, Tom Mikkelsen and James Ewing, Henry Ford Hospital, United States

Recently, the acquisition of high-resolution T1 maps in a clinically feasible time frame has been demonstrated with Driven Equilibrium Single Pulse Observation of T1 (DESPOT1). DESPOT1 derives the longitudinal relaxation time, T1, from two or more spoiled gradient recalled echo (SPGR) images acquired with a constant TR and different flip angles. In general, T1 can be estimated from two or more SPGR images. Estimation of MR parameters (T1, M0, etc.) from these sequences is challenging and susceptible to the level of noise in signal acquisition. Methods such as Simplex Optimization, Weighted Non-Linear Least Squares (WNLS), Linear Least Square (LLS or Gupta's LLS), and Intensity based Linear Least Square (ILLS) method have been employed to estimate T1. In both linear and non-linear methods, the estimated T1 values are highly dependent on defining the weighting factors; errors in these weighting factors can result in a biased estimate of T1. In this study, an adaptive neural network (ANN) is introduced, trained and evaluated. The ANN was trained using an analytical model of the SPGR signal in the presence of different levels of signal to noise ratio (2 to 30). Receiver Operator Characteristic (ROC) analysis and the K-fold crossvalidation (KFCV) method were employed to train, test, and optimize the network. The result (Az=0.81) shows that, compared to the other techniques, ANNs can provide a faster and unbiased estimate of T1 from SPGR signals.

10:30AM *Optimizing Drug Therapy with Reinforcement Learning: The Case of Anemia Management [no. 433]*
Jordan Malof and Adam Gaweda, Duke University, United States; University of Louisville, United States

Optimal management of anemia due to End-Stage Renal Disease (ESRD) is a challenging task to physicians due to large inter-subject variability in response to Erythropoiesis Stimulating Agents (ESA). We demonstrate that an optimal dosing strategy for ESA can be derived using Reinforcement Learning (RL) techniques. In this study, we show some preliminary results of using a batch RL method, called Fitted Q-Iteration, to derive optimal ESA dosing strategies from retrospective treatment data. Presented results show that such dosing strategies are superior to a standard ESA protocol employed by our dialysis facilities.

10:50AM *Alzheimer's Disease Detection Using A Self-adaptive Resource Allocation Network Classifier [no. 404]*
Mahanand B. S., Suresh S., Sundararajan N. and Aswatha Kumar M., Sri Jayachamarajendra College of Engineering, Mysore, India; Nanyang Technological University, Singapore; M S Ramaiah Institute of Technology, Bangalore, India

This paper presents a new approach using Voxel-Based Morphometry (VBM) detected features with a Self-adaptive Resource Allocation Network (SRAN) classifier for the detection of Alzheimer's Disease (AD) from Magnetic Resonance Imaging (MRI) scans. For feature reduction, Principal Component Analysis (PCA) has been performed on the morphometric features obtained from the VBM analysis and these reduced features are then used as input to the SRAN classifier. In our study, the MRI volumes of 30 'mild AD to moderate AD' patients and 30 normal persons from the well-known Open Access Series of Imaging Studies (OASIS) data set have been used. The results indicate that the SRAN classifier produces a mean testing efficiency of 91.18% with only 20 PCA reduced features whereas, the Support Vector Machine (SVM) produces a mean testing efficiency of 90.57% using 45 PCA reduced features. Also, the results show that the SRAN classifier avoids over-training by minimizing the number of samples used for training and provides a better generalization performance compared to the SVM classifier. The study clearly indicates that our proposed approach of PCA-SRAN classifier performs accurate classification of AD subjects using reduced morphometric features.

11:10AM *Neural Model of Blood Glucose Level for Type 1 Diabetes Mellitus Patients [no. 422]*
Alma Y. Alanis, Edgar N. Sanchez, Eduardo Ruiz-Velazquez and Blanca S. Leon, CUCEI, Universidad de Guadalajara, Mexico; CINVESTAV, Unidad Guadalajara, Mexico

This paper presents on-line blood glucose level modeling for Type 1 Diabetes Mellitus (T1DM) patients. The model is developed using a recurrent neural network trained with an extended Kalman filter based algorithm in order to develop an affine model, which captures the nonlinear behavior of the blood glucose metabolism. The goal is to derive an on-line dynamical mathematical model of the T1DM for the response of a patient to meal and subcutaneous insulin infusion. Simulation results are utilized for identification and for testing the applicability of the proposed scheme.

Session Tu1-2: Self Organization

Tuesday, August 2, 9:30AM-11:30AM, Room: Pine, Chair: Emilio Del Moral Hernandez

9:30AM *BSOM network for pupil segmentation [no. 555]*
Gabriel Vasconcelos, Carlos Bastos, Ing Ren Tsang and George Cavalcanti, Center of Informatics, Federal University of Pernambuco, Brazil

Segmentation is a preliminary step in many computer vision systems. In most of pupil segmentation algorithms it is assumed that the pupil has a predefined shape, usually circular. This parametrization might lead to errors when the eye image is distorted or deformed and when the pupil is partially occluded by eyelids or eyelashes. In this work, we propose a new method for pupil segmentation based on a batch-SOM (BSOM) neural network composed by three steps: (1) definition of the initial neurons position; (2) use BSOM to extract the contour; and (3) perform a contour adjustment. The method is capable of finding the pupil contour in a flexible manner, independently of a predefined shape. We modified the BSOM algorithm in three points: (1) in the update process, introducing the neighborhood constraint; (2) removal of the neurons, and (3) in the convergence criteria. Experiments were performed using Casia-IrisV3 Interval, Casia-IrisV4 Syn, and MMU1 iris image databases.

9:50AM *A Self-Organizing Neural Scheme for Road Detection in Varied Environments [no. 643]*
Usman Ali Malik, Syed Usman Ahmed and Faraz Kunwar, Department of Mechatronics Engineering, CEME, National University of Sciences and Technology (NUST), Pakistan

Detection of a drivable space is a key step in the autonomous control of a vehicle. In this paper we propose an adaptive vision based algorithm for road detection in diverse outdoor conditions. Our novel approach employs feature based classification and uses the Kohonen Self-Organizing Map (SOM) for the purpose of road detection. The robustness of the algorithm lies in the unique ability of SOM to organize information while learning diverse inputs. Features used for the training and testing of SOM are identified. The proposed method is capable of working with structured as well as unstructured roads and noisy environments that may be encountered by an intelligent vehicle. The proposed technique is extensively compared with the k-Nearest Neighbor (KNN) algorithm. Results show that SOM outperforms KNN in classification consistency and is independent to the lighting conditions while taking comparable classification time which shows that the network can also be used as an online learning architecture.

10:10AM *A Batch Self-Organizing Maps Algorithm Based on Adaptive Distances [no. 475]*
Luciano D. S. Pacifico and Francisco de A. T. De Carvalho, Universidade Federal de Pernambuco, Brazil

Clustering methods aims to organize a set of items into clusters such that items within a given cluster have a high degree of similarity, while items belonging to different clusters have a high degree of dissimilarity. The self-organizing map (SOM) introduced by Kohonen is an unsupervised competitive learning neural network method which has both clustering and visualization properties, using a neighborhood lateral interaction function to discover the topological structure hidden in the data set. In this paper, we introduce a batch self-organizing map algorithm based on adaptive distances. Experimental results obtained in real benchmark datasets show the effectiveness of our approach in comparison with traditional batch self-organizing map algorithms.

10:30AM *Magnification in divergence based neural maps [no. 113]*
Thomas Villmann and Sven Haase, University of Applied Sciences Mittweida, Germany

In this paper, we consider the magnification behavior of neural maps using several (parametrized) divergences as dissimilarity measure instead of the Euclidean distance. We show experimentally for self-organizing maps that optimal magnification, i.e. information optimum data coding by the prototypes, can be achieved for properly chosen divergence parameters. Thereby, the divergences considered here represent all main classes of divergences. Hence, we can conclude that information optimal vector quantization can be processed independently from the divergence class by appropriate parameter setting.

10:50AM *Cooperation Control and Enhanced Class structure in Self-Organizing Maps [no. 160]*
Ryotaro Kamimura, Tokai University, Japan

In this paper, we propose a new type of information-theoretic method called "information-theoretic cooperative learning." In this method, two networks, namely, cooperative and uncooperative networks are prepared. The roles of these networks are controlled by the cooperation parameter α. As the parameter is increased, the role of cooperative networks becomes more important in learning. We applied the method to the automobile data from the machine learning database. Experimental results showed that cooperation control could be used to increase mutual information on input patterns and to produce clearer class structure in SOM.

11:10AM *Fast Online Incremental Transfer Learning for Unseen Object Classification Using Self-Organizing Incremental Neural Networks [no. 170]*
Aram Kawewong, Sirinart Tangruamsub, Pichai Kankuekul and Osamu Hasegawa, Tokyo Institute of Technology, Japan

Classifying new unseen object classes has become a popular topic of research in the computer-vision and robotics community. Coping with this problem requires determining the attributes shared among objects and transferring them for use in classifying unseen object classes. Nevertheless, most current state-of-the-art methods require a fully offline training process and take a very long time for the batch training process, which renders them inapplicable for use in online applications such as robotics. This study proposes a novel online and incremental approach for learning and transferring the learned attributes in order to classify another disjoint set of image classes. Among three methods proposed in this paper, a method combining those favorable features of a self- organizing incremental neural network (SOINN) and a support vector machine (SVM) achieves the best performance. This method, called the Alt-SOINN-SVM, can run online incrementally, similar to an SOINN, and perform accurate classification, similar to an SVM. An evaluation was performed with 50 classes of an animal with an attributes dataset (>30,000 images). The results shows that despite the great reduction in both learning time (92.25% reduction) and classification time (99.87% reduction), and possessing the ability for incremental learning on gradually obtained samples, the proposed method offers reasonably good accuracy for classification. Furthermore, the proposed methods are applicable to use with the increasing number of attribute which improves the accuracy gradually and incrementally.

Special Track Tu1-3: From Brains to Machines I

Tuesday, August 2, 9:30AM-11:30AM, Room: Oak, Chair: Steven Bressler

9:30AM *Neural networks underlying top-down enhancement and suppression of visual processing*
Adam Gazzaley, University of Califonia San Francisco, United States

Top-down modulation is a bi-directional process that underlies our ability to focus our attention on task-relevant stimuli and ignore irrelevant distractions by differentially enhancing or suppressing neural activity in sensory cortical regions. It is believed that this modulation is not an intrinsic property of visual cortices, but is achieved via functional connectivity between sensory brain regions and a distributed network of frontal and parietal regions. I will present new data from our lab that reveals differential entrainment of stimulus-selective, visual association cortical areas with regions of the "frontal-parietal attention network" or the "default network" depending on the participant's goals. Additionally, there is sparse evidence in humans that a direct causal connection exists between prefrontal control regions and visual cortical activity modulation. Using a multi-modal approach that couples fMRI, rTMS and EEG, I will present evidence for a direct role of the inferior frontal junction (IJF) in top-down modulation of feature processing and its influence on subsequent working memory.

10:10AM *The effects of aging on functional connectivity during cognitive tasks and at rest*
Cheryl Grady, Rotman Research Institute, Baycrest Centre, Canada

In the past several decades we have learned much about how growing older affects cognition and the brain. Some of the most exciting findings emerging from the functional neuroimaging work indicate that aspects of brain aging may have the potential to influence a broad array of cognitive functions and may be of fundamental importance to our understanding of aging. These include age differences in large-scale functional connectivity of brain networks and variability of brain activity. In this talk I will review our work on how the functional connectivity of brain networks,

such as the default network, are influenced by aging and how these changes might affect cognition across multiple domains (e.g., perception, attention, memory).

10:50AM *New insights into the cortical neural substrate for goal-directed cognitive control*
Jennie Si, Arizona State University, United States

New Insights into the Cortical Neural Substrate for Goal-Directed Cognitive Control Unveiling the fundamental neural mechanism associated with intelligent, goal-directed behaviors remains elusive. However, this has not prevented scientists from conducting many studies designed to address a piece of the puzzle. Neuroscientists have worked diligently and successfully on the anatomy of the brain circuit, on the function of each and every part of the brain, and recently, on stimulating and emulating the brain. Stable multi-channel single unit recordings have provided unprecedented opportunities for researchers to tackle the ultimate question of relating the fundamental computing units in the brain, neurons, to behaviors. With this in mind, I will introduce some of my lab results contributing to a possible understanding of cognitive control in relation to cortical neural representation. Our results center on a behavioral apparatus used by rats while multichannel chronic recordings were obtained from the rat's motor and premotor areas. The experiment involves a self-paced, freely moving rat learning by trial and error to switch a directional light cue to a center location from one of five locations. The movement of the light can be controlled by the rat with a press of either a left or a right lever. The experiment involves a complete cycle from perception to action. Significant amount of behavioral and neuronal data have been collected while rats learn to perform the described control task from a naive stage. Our extensive data analyses show that 1) motor control may employ a hierarchical mechanism with different roles for premotor and motor cortices, and neural modulation related to motor planning happens earlier and primarily in PM compared with MI and that the acquisition of a new cognitive control strategy could be associated with neural adaptation in the premotor area; 2) in addition to commonly believed neuronal plasticity and roles for motor cortical areas, they may also be useful in storing and representing sequential movement information; 3) as the rat improves his behavioral trial success rate, his neural firing activities become more organized in a way that they result in more clear and accurate predictions of his control decisions and motor control behaviors. Several useful techniques, from neural firing rate to spike timing synchrony, statistical inference and functional models based on a neuronal ensemble were used for obtaining the results herein.

Special Session Tu1-5: Consciousness-Driven Vision: Toward a Breakthrough in Bio-Inspired Computer Vision

Tuesday, August 2, 9:30AM-11:30AM, Room: Carmel, Chair: Chao-Hui Huang and Daniel Racoceanu

9:30AM *Consciousness-driven Model for Visual Attention [no. 233]*
Pierre Cagnac, Noel Di Noia, Chao-Hui Huang, Daniel Racoceanu and Laurent Chaudron, French Air Force Academy, France; Bioinformatics Institute (BII), Agency for Science, Technology, and Research (A-STAR), Singapore; Image and Pervasive Access Lab (IPAL), Centre National de la Recherche Scientifique (CNRS), France; French Aerospace Lab (ONERA), France

A consciousness-driven visual attention model is presented in this paper. It is based on a bio-inspired computer fovea model and a hierarchical analysis for the given visual receptive field. Indeed, the bio-inspired computer fovea model is used to simulate the neural activity on the human visual system, and the hierarchical analysis provides a function to explore the information on the given visual scene. The proposed model can evaluate the contents on the scene and automatically highlights visually important regions. This model can be used in various applications, such as surveillance, visual navigation and target acquisition, etc.

9:50AM *A Neurophysiologically Inspired Hippocampus Based Associative-ART Artificial Neural Network Architecture [no. 437]*
Craig Vineyard, Stephen Verzi, Michael Bernard, Shawn Taylor and Wendy Shaneyfelt, Sandia National Laboratories, United States

Hippocampus within medial temporal lobe of the brain is essentially involved in episodic memory formation. Rather than simply being a mechanism of storing information, episodic memory associates information such as the spatial and temporal context of an event. Using hippocampus neurophysiology and functionality as an inspiration, we have developed an artificial neural network architecture called Associative-ART to associate k-tuples of inputs. In this paper we present an overview of hippocampus neurophysiology, explain the design of our neural network architecture, and present experimental results from an implementation of our architecture.

10:10AM *Where-What Network 5: Dealing with Scales for Objects in Complex Backgrounds [no. 576]*
Xiaoying Song, Wenqiang Zhang and Juyang Weng, School of Computer Science, Fudan University, Shanghai, China; Department of Computer Science and Engineering, Michigan State University, East Lansing, Michigan, United States

The biologically-inspired developmental Where-What Networks (WWN) are general purpose visuomotor networks for detecting and recognizing objects from complex backgrounds, modeling the dorsal and ventral streams of the biological visual cortex. The networks are designed for the attention and recognition problem. The architecture in previous versions were meant for a single scale of foreground. This paper focuses on Where-What Network-5 (WWN-5), the extension for multiple scales. WWN-5 can learn three concepts of an object: type, location and scale.

10:30AM *A Hybrid System with What-Where-Memory for Multi-Object Recognition [no. 396]*
Yuhua Zheng and Yan Meng, Stevens Institute of Technology, United States

To improve the efficiency of multi-object recognition in complex scenes, a hybrid system is proposed to learn the concurrencies and spatial relationships among different objects, and to apply such relationships for better recognitions. The hybrid system includes a bottom-up saliency map to generate regions of interest (ROIs), an independent classifiers to recognize these ROIs based on object appearances,

and a what-where-memory (WWM) to cast the top-down knowledge of object relationships to help the recognitions provided by independent classifiers. The WWM learns not only the concurrencies but also the spatial layouts of different classes, which can filter out the classes that unlikely appear, and distinguish the correct class from ambiguous classes provided by independent classifiers. Experiments of multi-object recognition on two well-known image datasets demonstrate the efficiency of the proposed system.

10:50AM *ECoG Patterns in short-term (STM) vs. long-term (LTM) Memory Formation [no. 61]*
Walter J Freeman, University of California, United States

Two sequential steps in cognition are sensation - "the activity of a sense organ and closely connected nerve structures" - and perception - "the meaningful impression of objects obtained by use of the senses" (Webster). Brains sense by using microscopic local networks in cortex to extract and process sensory information. The sensory and motor cortices contain numerous, highly specialized, local networks. They are tuned by local, rapid, short-term synaptic changes that select features in the input and bind them into sustained discharges of microscopic Hebbian cell assemblies. The operations are modeled with cellular neural networks (CNN) by modifying connections during reinforcement learning. Brains perceive by macroscopic processes that categorize sensory input and construct its meaning by combining it with memories. The learning mechanisms in perception require the global connectivity of random graph theory, not only the nearest-neighbor connectivity of CNN. The localized assemblies in Layers II-IV are embedded in brain-wide, macroscopic neuropil in Layers I, V and VI, which sustain beta-gamma patterns that resemble cinematographic frames. The required synaptic changes occur in longer times during consolidation than during association. The aim of this report is to describe the two forms of change in spatial patterns of ECoGs (electrocorticograms) and EEG (electroencephalograms). Method/Models ECoGs were recorded from 8x8 grids of 64 electrodes at 0.5-1.25 mm spacing in cats, rabbits and humans [2]. The EEGs were recorded from the scalp [4]. Signals recorded simultaneously from all channels were band pass filtered in the beta or gamma range. The analytic phase and power were calculated with the Hilbert transform. Spatial patterns of amplitude modulation (AM) were expressed as feature vectors in time segments with invariant analytic phase [4]. The 64x1 vectors formed clusters of points in 64-space that were correlated with conditioned stimuli (CS) the subjects had learned to discriminate [3]. Classification was by Euclidean distance of each point from centers of gravity of the clusters in 64-space [2]. Results AM pattern changes under reinforcement learning were observed by comparing contour plots of the root mean square amplitudes made during the conditioning process. Verification of the AM pattern differences was by multivariate analysis of variance off-line of the sets of 10 feature vectors for each category to be classified (the vertical differences). Changes with consolidation were revealed by comparisons across trial sets (horizontal). Conclusion/Discussions Categorization of AM patterns was found in all sensory cortices. The lack of invariance with respect to invariant CS demonstrated that the AM patterns were perceptual, not sensory. The similarities of findings fin the ECoG and scalp EEG from conventional 10-20 arrays of 64 channels im plied that the dynamics of AM pattern formation in both association and consolidation was scale-free. The temporal localization of the classifiable AM patterns in theta-gamma coupling [3] showed that perception is by cinematic frames and not by a continuous 'stream of consciousness' in time. References [1] WJ Freeman "How Brains Make Up Their Minds", New York: Columbia, 2001. [2] WJ Freeman, Clin. Neurophysiol. 116 (5): 1118-1129, 2005. [3] WJ Freeman, Cognitive Neurodynamics 3(1): 105-116, 2009. [4] Y Ruiz, S Pockett, WJ Freeman, E Gonzales, G Li, J Neurosci. Methods, 191, 110-118, 2010.

11:10AM *The temporality of consciousness: computational principles of a single Information Integration-Propagation Process (I2P2) [no. 369]*
Jean-Christophe Sarrazin, Vanessa Gonzalez, Bruno Berberian and Arnaud Tonnelier, Office National Etudes et de Recherches Aerospatiales, France; Institut National de Recherche en Informatique et Automatique, France

Time plays a central role in consciousness. A crucial question is the following: Why Consciousness takes time? We suggest the contents of consciousness could emerge as the result of global competition biased by top-down (intentional) modulation, which implements global constraint satisfaction. In our simplified conceptual framework, the information integration and the consciousness are not implemented by separate processes but are unified through the idea that a network arrives at an interpretation of the input by converging towards a dynamical state, i.e. a recurring pattern related to the existence of a stable travelling wave. The synfire propagation can be recasted in this framework as a particular instance of conscious computation where (i) the network has a specialized topology (a chain of connected pools) and (ii) the sequence of spikes converge towards a synchronous spike volley. The framework we suggest has interesting connections with the neural processing proposed by Hopfield (1982) where the computation is achieved through the convergence of the dynamical system describing the neural network towards a fixed point. Here the attractors are correlated activities (or spatiotemporal periodic travelling waves) and the idea of associative memory can be generalized in this context.

Session Tu1-4: Kernel Methods and SVM I

Tuesday, August 2, 9:30AM-11:30AM, Room: Monterey, Chair: David Casasent

9:30AM *Out-of-Sample Eigenvectors in Kernel Spectral Clustering [no. 485]*
Carlos Alzate and Johan A.K. Suykens, ESAT-SCD, K.U.Leuven, Belgium

A method to estimate eigenvectors for out-of-sample data in the context of kernel spectral clustering is presented. The proposed method is within a constrained optimization framework with primal and dual model representations. This formulation allows the clustering model to be extended naturally to out-of- sample points together with the possibility to perform model selection in a learning setting. A model selection methodology based on the Fisher criterion is also presented. The proposed criterion can be used to select clustering parameters such that the out-of-sample eigenvector space show a desirable structure. This special structure appears when the clusters are well-formed and the clustering parameters have been chosen properly. Simulation results with toy examples and images show the applicability of the proposed method and model selection criterion.

9:50AM *Multi-task Beta Process Sparse Kernel Machines [no. 54]*
Junbin Gao, Charles Sturt University, Australia

In this paper we propose a nonparametric extension to the sparse kernel machine using a beta process prior. The extended Beta Process Sparse Kernel Machine (BPSKM) allows for a sparse model to be constructed from a set of training data. The recent research on beta process reveals elegant property of Bayesian conjugate prior which is utilized to derive a variational Bayes inference algorithm. The performance of the proposed algorithm has been investigated on both synthetic and real-life data sets.

10:10AM *In-sample Model Selection for Support Vector Machines [no. 255]*
Davide Anguita, Alessandro Ghio, Luca Oneto and Sandro Ridella, University of Genoa, Italy

In-sample model selection for Support Vector Machines is a promising approach that allows using the training set both for learning the classifier and tuning its hyperparameters. This is a welcome improvement respect to out-of-sample methods, like cross-validation, which require to remove some samples from the training set and use them only for model selection purposes. Unfortunately, in-sample methods require a precise control of the classifier function space, which can be achieved only through an unconventional SVM formulation, based on Ivanov regularization. We prove in this work that, even in this case, it is possible to exploit well- known Quadratic Programming solvers like, for example, Sequential Minimal Optimization, so improving the applicability of the in-sample approach.

10:30AM *Kernel Principal Subspace Mahalanobis Distances for Outlier Detection [no. 519]*
Cong Li, Michael Georgiopoulos and Georgios Anagnostopoulos, University of Central Florida, United States; Florida Institute of Technology, United States

Over the last few years, Kernel Principal Component Analysis (KPCA) has found several applications in outlier detection. A relatively recent method uses KPCA to compute the reconstruction error (RE) of previously unseen samples and, via thresholding, to identify atypical samples. In this paper we propose an alternative method, which performs the same task, but considers Mahalanobis distances in the orthogonal complement of the subspace that is utilized to compute the reconstruction error. In order to illustrate its merits, we provide qualitative and quantitative results on both artificial and real datasets and we show that it is competitive, if not superior, for several outlier detection tasks, when compared to the original RE-based variant and the One-Class SVM detection approach.

10:50AM *Kernel Adaptive Filtering with Maximum Correntropy Criterion [no. 421]*
Songlin Zhao, Badong Chen and Jose Principe, University of Florida, United States

At present, kernel adaptive filters have drawn increasing attention due to their advantages such as universal nonlinear approximation, linearity and convexity in Reproducing Kernel Hilbert Space (RKHS). Among them, the kernel least mean square (KLMS) algorithm deserves particular attention because of its simplicity and sequential learning approach. Similar to most conventional adaptive filtering algorithms, the KLMS adopts the mean square error (MSE) as the adaptation cost. However, the mere second-order statistics is often not suitable for nonlinear and non-Gaussian situations. Therefore, various non-MSE criteria, which involve higher-order statistics, have received an increasing interest. Recently, the correntropy, as an alternative of MSE, has been successfully used in nonlinear and non-Gaussian signal processing and machine learning domains. This fact motivates us in this paper to develop a new kernel adaptive algorithm, called the kernel maximum correntropy (KMC), which combines the advantages of the KLMS and maximum correntropy criterion (MCC). We also study its convergence and self- regularization properties by using the energy conservation relation. The superior performance of the new algorithm has been demonstrated by simulation experiments in the noisy frequency doubling problem.

11:10AM *Parallel Semiparametric Support Vector Machines [no. 123]*
Roberto Diaz-Morales, Harold Y. Molina-Bulla and Angel Navia-Vazquez, Department of Signal Theory and Communications, University Carlos III de Madrid, Spain

In recent years the number of cores in computers has increased considerably, opening new lines of research to adapt classical techniques of machine learning to a parallel scenario. In this paper, we have developed and implemented with the multi-platform application programing interface OpenMP a method to train Semiparametric Support Vector Machines relying on Sparse Greedy Matrix Approximation (SGMA) and Iterated Re-Weighted Least Squares algorithm (IRWLS).

Session Tu1-6: Feed-Forward Networks

Tuesday, August 2, 9:30AM-11:30AM, Room: Santa Clara, Chair: Seiichi Ozawa

9:30AM *RANSAC Algorithm with Sequential Probability Ratio Test for Robust Training of Feed-Forward Neural Networks [no. 714]*
Moumen El-Melegy, Assiut University, Egypt

This paper addresses the problem of fitting a functional model to data corrupted with outliers using a multilayered feed-forward neural network (MFNN). Almost all previous efforts to solve this problem has focused on using a training algorithm that minimizes an M-estimator based error criterion. However the robustness gained from M-estimators is still low. Using a training algorithm based on the RANdom SAmple Consensus (RANSAC) framework improves significantly the robustness of the algorithm. However the algorithm typically requires prolonged period of time before a final solution is reached. In this paper, we propose a new strategy to improve the time performance of the RANSAC algorithm for training MFNNs. A statistical pre-test based on Wald's sequential probability ratio test (SPRT) is performed on each randomly generated sample to decide whether it deserves to be used for model estimation. The proposed algorithm is evaluated on synthetic data, contaminated with varying degrees of outliers, and have demonstrated faster performance compared to the original RANSAC algorithm with no significant sacrifice of the robustness.

9:50AM *Advances on Criteria for Biological Plausibility in Artificial Neural Networks: Think of Learning Processes [no. 303]*

Alberione Silva and Joao Luis Rosa, University of Sao Paulo, Brazil

Artificial neural network (ANN) community is engaged in biological plausibility issues these days. Different views about this subject can lead to disagreements of classification criteria among ANN researchers. In order to contribute to this debate, two of these views are highlighted here: one is related directly to the cerebral cortex biological structure, and the other focuses the neural features and the signaling between neurons. The model proposed in this paper considers that a biologically more plausible ANN has the purpose to create a more faithful model concerning the biological structure, properties, and functionalities, including learning processes, of the cerebral cortex, not disregarding its computational efficiency. The choice of the models upon which the proposed description is based takes into account two main criteria: the fact they are considered biologically more realistic and the fact they deal with intra and inter-neuron signaling in electrical and chemical synapses. Also, the duration of action potentials is taken into account. In addition to the characteristics for encoding information regarding biological plausibility present in current spiking neuron models, a distinguishable feature is emphasized here: a combination of Hebbian learning and error-driven learning.

10:10AM *Efficient Levenberg-Marquardt Minimization of the Cross-Entropy Error Function [no. 21]*

Amar Saric (Sarich) and Jing Xiao, UNC Charlotte, United States

The Levenberg-Marquardt algorithm is one of the most common choices for training medium-size artificial neural networks. Since it was designed to solve nonlinear least-squares problems, its applications to the training of neural networks have so far typically amounted to using simple regression even for classification tasks. However, in this case the cross-entropy function, which corresponds to the maximum likelihood estimate of the network weights when the sigmoid or softmax activation function is used in the output layer, is the natural choice of the error function and a convex function of the weights in the output layer. It is an important property which leads to a more robust convergence of any descent-based training method. By constructing and implementing a modified version of the Levenberg-Marquardt algorithm suitable for minimizing the cross-entropy function, we aim to close a gap in the existing literature on neural networks. Additionally, as using the cross-entropy error measure results in one single error value per training pattern, our approach results in lower memory requirements for multi- valued classification problems when compared to the direct application of the algorithm.

10:30AM *Learning Algorithms for a Specific Configuration of the Quantron [no. 140]*

Simon de Montigny and Richard Labib, Polytechnique Montreal, Canada

The quantron is a new artificial neuron model, able to solve nonlinear classification problems, for which an efficient learning algorithm has yet to be developed. Using surrogate potentials, constraints on some parameters and an infinite number of potentials, we obtain analytical expressions involving ceiling functions for the activation function of the quantron. We then show how to retrieve the parameters of a neuron from the images it produced.

10:50AM *Optimizing The Quality of Bootstrap-based Prediction Intervals [no. 647]*

Abbas Khosravi, Saeid Nahavandi, Doug Creighton and Dipti Srinivasan, Alfred Deakin Postdoctoral Research Fellow, Deakin University, Australia; Deakin University, Australia; National University of Singapore, Singapore

The bootstrap method is one of the most widely used methods in literature for construction of confidence and prediction intervals. This paper proposes a new method for improving the quality of bootstrap-based prediction intervals. The core of the proposed method is a prediction interval-based cost function, which is used for training neural networks. A simulated annealing method is applied for minimization of the cost function and neural network parameter adjustment. The developed neural networks are then used for estimation of the target variance. Through experiments and simulations it is shown that the proposed method can be used to construct better quality bootstrap-based prediction intervals. The optimized prediction intervals have narrower widths with a greater coverage probability compared to traditional bootstrap-based prediction intervals.

11:10AM *The impact of preprocessing on forecasting electrical load: an empirical evaluation of segmenting time series into subseries [no. 723]*

Sven F. Crone and Nikolaos Kourentzes, Lancaster University, United Kingdom

Forecasting future electricity load represents one of the most prominent areas of electrical engineering, in which artificial neural networks (NN) are routinely applied in practice . The common approach to overcome the complexity of building NNs for high-frequency load data is to segment the time series into simpler and more homogeneous subseries, e.g. seven subseries of hourly loads of only Mondays, Tuesdays etc. These are forecasted independently, using a separate NN model, and then recombined to provide a complete trace forecast for the next days ahead. Despite the empirical importance of load forecasting, and the high operational cost associated with forecast errors, the potential benefits of segmenting time series into subseries have not been evaluated in an empirical comparison. This paper assesses the accuracy of segmenting continuous time series into daily subseries, versus forecasting the original, continuous time series with NNs. Accuracy on hourly UK load data is provided in a valid experimental design, using multiple rolling time origins and robust error metrics in comparison to statistical benchmark algorithms. Results indicate the superior performance of NN on continuous, non-segmented time series, in contrast to best practices in research, practice and software implementations.

Tuesday, August 2, 11:40AM-12:40PM

Special Session Tu2-1: Automated Supervised and Unsupervised Learning

Tuesday, August 2, 11:40AM-12:40PM, Room: Cedar, Chair: Nistor Grozavu and Shogo Okada

11:40AM *Training a network of mobile neurons [no. 356]*

Bruno Apolloni, Simone Bassis and Lorenzo Valerio, Department of Computer Science, University of Milano, Italy; Department of Mathematics, University of Milano, Italy

We introduce a new paradigm of neural networks where neurons autonomously search for the best reciprocal position in a topological space so as to exchange information more profitably. The idea that elementary processors move within a network to get a proper position is borne out by biological neurons in brain morphogenesis. The basic rule we state for this dynamics is that a neuron is attracted by the mates which are most informative and repelled by ones which are most similar to it. By embedding this rule into a Newtonian dynamics, we obtain a network which autonomously organizes its layout. Thanks to this further adaptation, the network proves to be robustly trainable through an extended version of the backpropagation algorithm even in the case of deep architectures. We test this network on two classic benchmarks and thereby get many insights on how the network behaves, and when and why it succeeds.

12:00PM *Incremental 2-Directional 2-Dimensional Linear Discriminant Analysis for Multitask Pattern Recognition [no. 606]*

Chunyu Liu, Young-Min Jang, Seiichi Ozawa and Minho Lee, Kobe University, Japan; Kyungpook National University, Korea (South)

In this paper, we propose an incremental 2-directional 2-dimensional linear discriminant analysis (I-(2D)2LDA) for multitask pattern recognition (MTPR) problems in which a chunk of training data for a particular task are given sequentially and the task is switched to another related task one after another. In I-(2D)2LDA, a discriminant space of the current task spanned by 2 types of discriminant vectors is augmented with effective discriminant vectors that are selected from other tasks based on the class separability. We call the selective augmentation of discriminant vectors knowledge transfer of feature space. In the experiments, the proposed I-(2D)2LDA is evaluated for the three tasks using the ORL face data set: person identification (Task 1), gender recognition (Task 2), and young-senior discrimination (Task 3). The results show that the knowledge transfer works well for Tasks 2 and 3; that is, the test performance of gender recognition and that of young-senior discrimination are enhanced.

12:20PM *Online Incremental Clustering with Distance Metric Learning for High Dimensional Data [no. 426]*

Okada Shogo and Nishida Toyoaki, Kyoto University, Japan

In this paper, we present a novel incremental clustering algorithm which assigns of a set of observations into clusters and learns the distance metric iteratively in an incremental manner. The proposed algorithm SOINN-AML is composed based on the Self-organizing Incremental Neural Network (Shen et al 2006), which represents the distribution of unlabeled data and reports a reasonable number of clusters. SOINN adopts a competitive Hebbian rule for each input signal, and distance between nodes is measured using the Euclidean distance. Such algorithms rely on the distance metric for the input data patterns. Distance Metric Learning (DML) learns a distance metric for the high dimensional input space of data that preserves the distance relation among the training data. DML is not performed for input space of data in SOINN based approaches. SOINN-AML learns input space of data by using the Adaptive Distance Metric Learning (AML) algorithm which is one of the DML algorithms. It improves the incremental clustering performance of the SOINN algorithm by optimizing the distance metric in the case that input data space is high dimensional. In experimental results, we evaluate the performance by using two artificial datasets, seven real datasets from the UCI dataset and three real image datasets. We have found that the proposed algorithm outperforms conventional algorithms including SOINN (Shen et al 2006) and Enhanced SOINN (Shen et al 2007). The improvement of clustering accuracy (NMI) is between 0.03 and 0.13 compared to state of the art SOINN based approaches.

Session Tu2-2: Deep Learning

Tuesday, August 2, 11:40AM-12:40PM, Room: Pine, Chair: Marley Vellasco

11:40AM *Modular Deep Belief Networks that do not Forget [no. 260]*

Leo Pape, Faustino Gomez, Mark Ring and Juergen Schmidhuber, IDSIA, Switzerland

Deep belief networks (DBNs) are popular for learning compact representations of high-dimensional data. However, most approaches so far rely on having a single, complete training set. If the distribution of relevant features changes during subsequent training stages, the features learned in earlier stages are gradually forgotten. Often it is desirable for learning algorithms to retain what they have previously learned, even if the input distribution temporarily changes. This paper introduces the M-DBN, an unsupervised modular DBN that addresses the forgetting problem. M-DBNs are composed of a number of modules that are trained only on samples they best reconstruct. While modularization by itself does not prevent forgetting, the M-DBN additionally uses a learning method that adjusts each module's learning rate proportionally to the fraction of best reconstructed samples. On the MNIST handwritten digit dataset module specialization largely corresponds to the digits discerned by humans. Furthermore, in several learning tasks with changing MNIST digits, M-DBNs retain learned features even after those features are removed from the training data, while monolithic DBNs of comparable size forget feature mappings learned before.

12:00PM *Scalable Low-Power Deep Machine Learning with Analog Computation [no. 200]*

Itamar Arel and Holleman Jeremy, University of Tennessee, United States

The human brain contains roughly 100 billion neurons, or processing units. Each neuron operates at approximately 150 Hz, far slower than modern digital processors, suggesting that the brain's computational strength stems from its massively parallel architecture rather than sheer processing speed. Modern digital computers, despite having billions of transistors switching billions of times per second, have yet to approach the performance of the human brain in image processing, speech recognition, and other high-dimensional problems. As Richard Bellman observed over 50 years ago, the difficulty of such problems is fundamentally related to high dimension of the associated inputs. This curse of dimensionality is typically addressed by adding a pre-processing stage, known as feature extraction or dimensionality reduction. Since the performance of the subsequent classification system heavily depends on the extent to which salient features are extracted from the data, the dimensionality reduction step introduces a significant human engineering problem into the classification or clustering process, falling short of the goal of truly autonomous learning systems. Deep machine learning (DML) has recently emerged as a promising new framework for mimicking the information representation capabilities of the brain. Inspired by discoveries in neurobiology, hidden layers of deep learning systems encode hierarchically distributed representations of complex sensory inputs. However, the fundamental mismatch between a highly parallel learning architecture and the serial structure of conventional processors limits the scalability of software DML systems. As DML techniques are scaled up to practical problems, the computational requirements grow rapidly out of reach of conventional digital computers. By fully leveraging the computational power of individual transistors, analog neuromorphic circuits can achieve much greater density and power efficiency than is possible using digital technology. This work will present a novel framework for implementing large-scale deep learning architectures using analog VLSI technology. Attaining this framework is achieved by investigating resource-efficient DML algorithms that map well to custom analog hardware realization. The algorithms are optimized to utilize primarily local connectivity, tolerate analog error sources, and leverage the large-scale computation afforded by analog computational circuits and floating- gate memories. In particular, favorable speed and power consumption characteristics are anticipated facilitating modest form factor designs. The node computations in DML are independent and thus naturally suited to parallel execution, and indeed must be executed in parallel in order to achieve usable run times for large-scale problems. In this work we consider a single ``cortical unit" in a custom analog integrated circuit. Because sophisticated DML systems can be built from large, regular, arrays of a single cortical unit, the design of one unit will be sufficient to characterize the performance of a large DML system. References: [1] I. Arel, D. Rose, T. Karnowski, "Deep Machine Learning - A New Frontier in Artificial Intelligence Research," IEEE Computational Intelligence Magazine, Vol. 14, pp. 12-18, November, 2010. [2] J. Holleman, "Micro-power Integrated Circuits for Neural Interfaces," Ph.D. Dissertation, University of Washington, 2009.

12:20PM *Exploring Speaker-Specific Characteristics with Deep Learning [no. 47]*

Ahmad Salman and Ke Chen, School of Computer Science, The University of Manchester, United Kingdom

Speech signals convey different types of information which vary from linguistic to speaker-specific and should be used in different tasks. However, it is hard to extract a special type of information such that nearly all acoustic representations of speech present all kinds of information as a whole. The use of the same representation in different tasks creates a difficulty in achieving good performance in either speech or speaker recognition. In this paper, we present a deep neural architecture to explore speaker-specific characteristics from popular Mel-frequency cepstral coefficients. For learning, we propose an objective function consisting of contrastive cost in terms of speaker similarity and dissimilarity as well as data reconstruction cost used as regularization to normalize non-speaker related information. Learning deep architecture is done by a greedy layerwise local unsupervised training for initialization and a global supervised discriminative training for extracting a speaker-specific representation. By means of two narrow-band benchmark corpora, we demonstrate that our deep architecture generates a robust overcomplete speech representation in characterizing various speakers and the use of this new representation yields a favorite performance in speaker verification.

Special Track Tu2-3: From Brains to Machines I (cont.)

Tuesday, August 2, 11:40AM-12:40PM, Room: Oak, Chair: Steven Bressler

11:40AM *Dynamical functional organization of the human brain*

Vinod Menon, Stanford University, United States

Understanding how the human brain produces cognition must ultimately depend on knowledge of its large-scale wiring. Brain areas engaged during cognitive tasks also form coherent large-scale brain networks that can be readily identified using intrinsic functional and structural connectivity. I describe how recent research on intrinsic connectivity is beginning to provide new insights into the functional architecture of the human brain. I show that neurocognitive network models help to synthesize extant findings of brain connectivity into a unified framework for understanding human cognition. I will demonstrate the usefulness of this approach by describing a dynamic network model for saliency detection, attentional capture, and cognitive control. The human brain undergoes protracted structural and functional changes during which it constructs dedicated large-scale brain networks comprised of discrete, interconnected, brain regions. I will describe how network analysis of brain connectivity can be used to elucidate key principles underlying the ontogeny of neurocognitive networks and illustrate how this approach provides novel insights into the maturation of cognitive control in the developing brain.

12:20PM *Discussion - Part I*

Michael Arbib, Adam Gazzaley, Cheryl Grady, Vinod Menon and Jennie Si, University of Southern California, United States; University of California, San Francisco, United States; Rotman Research Institute, Canada; Stanford University, United States; Arizona State University, United States

Special Session Tu2-5: Biologically Inspired Computational Vision

Tuesday, August 2, 11:40AM-12:40PM, Room: Carmel, Chair: Khan Iftekharuddin

11:40AM *Modeling Dopamine and Serotonin Systems in a Visual Recognition Network [no. 632]*

Stephen Paslaski, Courtland VanDam and Juyang Weng, Michigan State University, United States

Many studies have been performed to train a classification network using supervised learning. In order to enable a recognition network to learn autonomously or to later improve its recognition performance through simpler confirmation or rejection, it is desirable to model networks that have an intrinsic motivation system. Although reinforcement learning has been extensively studied, much of the existing models are symbolic whose internal nodes have preset meanings from a set of handpicked symbolic set that is specific for a given task or domain. Neural networks have been used to automatically generate internal (distributed) representations. However, modeling a neuromorphic motivational system for neural networks is still a great challenge. By neuromorphic, we mean that the motivational system for a neural network must be also a neural network, using a standard type of neuronal computation and neuronal learning. This work proposes a neuromorphic motivational system, which includes two subsystems -- the serotonin system and the dopamine system. The former signals a large class of stimuli that are intrinsically aversive (e.g., stress or pain). The latter signals a large class of stimuli that are intrinsically appetitive (e.g., sweet and pleasure). We experimented with this motivational system for visual recognition settings to investigate how such a system can learn through interactions with a teacher, who does not give answers, but only punishments and rewards.

12:00PM *Image Compression based on Growing Hierarchical Self-Organizing Maps [no. 345]*

Esteban J. Palomo and Enrique Dominguez, University of Malaga, Spain

Self-Organizing Maps (SOM) have some problems related to its fixed topology and its lack of representation of hierarchical relations among input data. Growing Hierarchical SOM (GHSOM) solve these limitations by generating a hierarchical architecture that is automatically determined according to the input data and reflects the inherent hierarchical relations among them. These advantages can be utilized to perform a compression of an image, where the size of the codebook (leaf neurons in the hierarchy) is automatically established. Moreover, this hierarchy provides a different compression at each layer, where the deeper the layer, the lower the rate compression and the higher the quality of the compressed image. Thus, different trade-offs between compression rate and quality are given by the architecture. Also, the size of the codebooks and the depth of the hierarchy can be controlled by two parameters. In this paper a new approach for image compression based on the GHSOM model is proposed. Experimental results confirm the good performance of the proposed approach.

12:20PM *GPGPU Acceleration of Cellular Simultaneous Recurrent Networks Adapted for Maze Traversals [no. 558]*

Kenneth Rice, Tarek Taha, Khan Iftekharuddin, Keith Anderson and Teddy Salan, Clemson University, United States; University of Dayton, United States; University of Memphis, United States

At present, a major initiative in the research community is investigating new ways of processing data that capture the efficiency of the human brain in hardware and software. This has resulted in increased interest and development of bio-inspired computing approaches in software and hardware. One such bio- inspired approach is Cellular Simultaneous Recurrent Networks (CSRNs). CSRNs have been demonstrated to be very useful in solving state transition type problems, such as maze traversals. Although powerful in image processing capabilities, CSRNs have high computational demands with increasing input problem size. In this work, we revisit the maze traversal problem to gain an understanding of the general processing of CSRNs. We use a 2.67 GHz Intel Xeon X5550 processor coupled with an NVIDIA Tesla C2050 general purpose graphical processing unit (GPGPU) to create several novel accelerated CSRN implementations as a means of overcoming the high computational cost. Additionally, we explore the use of decoupled extended Kalman filters in the CSRN training phase and find a significant reduction in runtime with negligible change in accuracy. We find in our results that we can achieve average speedups of 21.73 and 3.55 times for the training and testing phases respectively when compared to optimized C implementations. The main bottleneck in training performance was a matrix inversion computation. Therefore, we utilize several methods to reduce the effects of the matrix inversion computation.

Session Tu2-4: Information Retrieval

Tuesday, August 2, 11:40AM-12:40PM, Room: Monterey, Chair: Irwin King

11:40AM *Unified Perception-Prediction Model for Context Aware Text Recognition on a Heterogeneous Many-Core Platform [no. 362]*

Qinru Qiu, Qing Wu and Richard Linderman, Binghamton University, United States; US Air Force Research Laboratory, United States

Existing optical character recognition (OCR) software tools can perform text image detection and pattern recognition with fairly high accuracy, however their performance will be significantly impaired when the image of the character is partially blocked or smudged. Such missing information does not hinder the human perception because we predict the missing part based on the word level and sentence level context of the character. In order to mimic the human cognitive behavior, we developed a hybrid cognitive architecture combining two neuromorphic computing models, i.e. brain-state-in-a-box (BSB) and cogent confabulation, to achieve context-aware text recognition. The BSB model performs the character recognition from input image while the confabulation models perform the context- aware prediction based on the word and sentence knowledge bases. The software tool is implemented on an 1824-core computing cluster. Its accuracy and performance are analyzed in the paper.

12:00PM *Improving Question Retrieval in Community Question Answering [no. 96]*

Wei Wang, Baichuan Li and Irwin King, The Chinese University of Hong Kong, Hong Kong; ATTLabsResearch, Hong Kong

Community question answering services (CQA), which provides a platform for people with diverse backgrounds to share information and knowledge, has become an increasingly popular research topic recently as made popular by sites such as Yahoo! Answers, answerbag, zhidao , etc. Question retrieval (QR) in CQA can automatically find the most relevant and recent questions that have been solved by other users. Current QR approaches typically consider using diverse retrieval models, but they fail to analyze users' intention. User intentions such as finding facts, interacting with others, seeking reasons, etc. reflect what the users really want to know. Hence, we propose to integrate user intention analysis into QR. Firstly, we classify questions into different and multiple types of users' intentions. Another practical problem is that there naturally exist some preferences among the possible questions types. The more relevant type should be ranked higher than types which are not so relevant. Therefore, we propose to utilize a novel label ranking method, which is a machine learning algorithm that aims to predict a ranking among all the possible labels, to perform question classification. Secondly, based on the result of question classification, we integrate user intentions with translation-based language models to explore whether a user's intention does help to improve the performance. We conduct a series of experiments with Yahoo data, and the experimental results demonstrate that our proposed improved question retrieval can indeed enhance the performance of traditional question retrieval model.

12:20PM *Cell Assemblies for Query Expansion in Information Retrieval [no. 138]*

Isabel Volpe, Viviane P. Moreira and Christian Huyck, UFRGS, Brazil; Middlesex University, England

One of the main tasks in Information Retrieval is to match a user query to the documents that are relevant for it. This matching is challenging because in many cases the keywords the user chooses will be different from the words the authors of the relevant documents have used. Throughout the years, many approaches have been proposed to deal with this problem. One of the most popular consists in expanding the query with related terms with the goal of retrieving more relevant documents. In this paper, we propose a new method in which a Cell Assembly model is applied for query expansion. Cell Assemblies are reverberating circuits of neurons that can persist long beyond the initial stimulus has ceased. They learn through Hebbian Learning rules and have been used to simulate the formation and the usage of human concepts. We adapted the Cell Assembly model to learn relationships between the terms in a document collection. These relationships are then used to augment the original queries. Our experiments use standard Information Retrieval test collections and show that some queries significantly improved their results with our technique.

Session Tu2-6: Evolutionary Learning

Tuesday, August 2, 11:40AM-12:40PM, Room: Santa Clara, Chair: Carlo Franscesco Morabito

11:40AM *A Self-Organizing Neural Network Using Hierarchical Particle Swarm Optimization [no. 181]*

Cheng-Jian Lin, Chin-Ling Lee and Chun-Cheng Peng, National Chin-Yi University of Technology, Taiwan; National Taichung Institute of Technology, Taiwan

This paper introduces a hierarchical particle swarm optimization (HPSO) algorithm strategy for self-organizing neural network design. The proposed CHPSO can determine the structure of the neural network and tune the parameters in the neural network automatically. The structure learning is based on the genetic algorithm (GA) and the parameter learning is based on the particle swarm optimization (PSO). The advantages of the proposed learning algorithm can obtain fine structure and performance for neural network (NN). The prediction of simulation example has been given to illustrate the performance and effectiveness of the proposed model.

12:00PM *Modularity Adaptation in Cooperative Coevolution of Feedforward Neural Networks [no. 158]*

Rohitash Chandra, Marcus Frean and Mengjie Zhang, School of Engineering and Computer Science, Victoria University of Wellington, New Zealand

In this paper, an adaptive modularity cooperative coevolutionary framework is presented for training feedforward neural networks. The modularity adaptation framework is composed of different neural network encoding schemes which transform from one level to another based on the network error. The proposed framework is compared with canonical cooperative coevolutionary methods. The results show that the proposal outperforms its counterparts in terms of training time, success rate and scalability.

12:20PM *Automatic Design of Neural Networks with L-Systems and Genetic Algorithms - A Biologically Inspired Methodology [no. 261]*

Lidio Campos, Mauro Roisenberg and Roberto Oliveira, Federal University of Para in Castanhal, Brazil; Federal University of Santa Catarina, Brazil; Federal University of Para, Brazil

In this paper we introduce a biologically plausible methodology capable to automatically generate Artificial Neural Networks (ANNs) with optimum number of neurons and adequate connection topology. In order to do this, three biological metaphors were used: Genetic Algorithms (GA), Lindenmayer Systems (L-Systems) and ANNs. The methodology tries to mimic the natural process of nervous system growing and evolution, using L-Systems as a recipe for development of the neurons and its connections and the GA to evolve and optimize the nervous system architecture suited for an specific task. The technique was tested on three well known simple problems, where recurrent networks topologies must be evolved. A more complex problem, involving time series learning was also proposed for application. The experiments results shows that our proposal is very promising and can generate appropriate neural networks architectures with an optimal number of neurons and connections, good generalization capacity, smaller error and large noise tolerance.

Tuesday, August 2, 1:50PM-2:50PM

Plenary Talk Tu-Plen2: Plenary Session: From Brains to Machines B

Tuesday, August 2, 1:50PM-2:50PM, Room: Oak, Chair: Jose Principe

1:50PM *Cognitive Computing: Neuroscience, Supercomputing, Nanotechnology*
Dharmendra Modha, IBM Almaden Research Center, United States

The ultimate goal of the DARPA SyNAPSE project is to build brain-like cognitive computing chips that scale to human cortex by moving beyond the von Neumann architecture and become the brains behind IBM's Smarter Planet vision. The project leverages neuroscience, supercomputing, and nanotechnology and is currently a collaboration of four universities (Cornell, Columbia, Wisconsin-Madison, UC Merced) and five IBM sites (Almaden, Austin, East Fishkill, India, Yorktown).

Tuesday, August 2, 3:20PM-5:20PM

Special Session Tu3-1: Smart Grid and Energy Applications I

Tuesday, August 2, 3:20PM-5:20PM, Room: Cedar, Chair: Ganesh K. Venayagamoorthy and Lingfeng Wang

3:20PM *Characterization and Modeling of a Grid-Connected Photovoltaic System Using a Recurrent Neural Network [no. 371]*
Daniel Riley and Ganesh Venayagamoorthy, Missouri University of Science and Technology, United States

Photovoltaic (PV) system modeling is used throughout the photovoltaic industry for the prediction of PV system output under a given set of weather conditions. PV system modeling has a wide range of uses including: pre-purchase comparisons of PV system components, system health monitoring, and payback (return on investment) times. In order to adequately model a PV system, the system must be characterized to establish the relationship between given weather inputs (e.g., irradiance, spectrum, temperature) and desired system outputs (e.g., AC power, module temperature). Traditional approaches to system characterization involve characterizing and modeling each component in a PV system and forming a system model by successively using component models. This paper lays the groundwork for using a Recurrent Neural Network (RNN) to characterize and model an entire PV system without the need to characterize or model the individual system components. Input/output relationships are "learned" by the RNN using measured system performance data and correlated weather data. Thus, this method for characterizing and modeling PV systems is useful for existing PV system installations with several weeks of correlated system performance and weather data.

3:40PM *Real-time State Estimation on Micro-grids [no. 300]*
Ying Hu, Anthony Kuh, Aleksandar Kavcic and Dora Nakafuji, University of Hawaii at Manoa, United States; Hawaiian Electric Company, United States

This paper presents a new probabilistic approach of the real-time state estimation on the micro-grid. The grid is modeled as a factor graph which can characterize the linear correlations among the state variables. The factor functions are defined for both the circuit elements and the renewable energy generation. With the stochastic model, the linear state estimator conducts the Belief Propagation algorithm on the factor graph utilizing real-time measurements from the smart metering devices. The result of the statistical inference presents the optimal estimates of the system state. The new algorithm can work with sparse measurements by delivering the optimal statistical estimates rather than the solutions. In addition, the proposed graphical model can integrate new models for solar/wind correlation that will help with the integration study of renewable energy. Our state-of-art approach provides a robust foundation for the smart grid design and renewable integration applications.

4:00PM *Optimal Operation via a Recurrent Neural Network of a Wind- Solar Energy System [no. 460]*
Manuel Gamez, Edgar Sanchez and Luis Ricalde, CINVESTAV-IPN, Unidad Guadalajara, Mexico; Universidad AUtonomade Yucatan, Mexico

This paper focuses on the optimal operation of a wind-solar energy system, interconnected to the utility grid; moreover, it incorporates batteries for energy storing and supplying, and an electric car. It presents a neural network optimization approach combined with a multi-agent system (MAS). The objective is to determine the optimal amounts of power for wind, solar, and batteries, including the one of the electric car, in order to minimize the amount of energy to be provided by the utility grid. Simulation results illustrate that generation levels for each energy source can be reached in an optimal form using the proposed method.

4:20PM *Widely Linear Adaptive Frequency Estimation In Three-Phase Power Systems Under Unbalanced Voltage Sag Conditions [no. 360]*
Yili Xia, Scott Douglas and Danilo Mandic, Imperial College London, United Kingdom; Southern Methodist University, United States

A new framework for the estimation of the instantaneous frequency in a three-phase power system is proposed. It is first illustrated that the complex-valued signal, obtained by the alpha beta transformation of three-phase power signals under unbalanced voltage sag conditions, is second order noncircular, for which standard complex adaptive estimators are suboptimal. To cater for second order noncircularity, an adaptive widely linear estimator based on the augmented complex least mean square (ACLMS) algorithm is proposed, and the analysis shows that this allows for optimal linear adaptive estimation for the generality of system conditions (both balanced and unbalanced). The enhanced robustness over the standard CLMS is illustrated by simulations on both synthetic and real-world voltage sags.

4:40PM *Inferring Cascading Network-Power Disruptions and Sustainability [no. 645]*
Supaporn Erjongmanee, Chuanyi Ji and James Momoh, Gatech, United States; Howard Univ., United States

In this work, we study cascading disruptions between communication networks and power, using heterogeneous measurements and learning. We define sustainability of communication using distributed energy sources upon power outages, and estimate the sustainability for example networks.

5:00PM *Composite Power System Reliability Evaluation Using Support Vector Machines on a Multicore Platform [no. 528]*
Robert Green II, Lingfeng Wang and Mansoor Alam, University of Toledo, United States

Monte Carlo Simulation (MCS) is a very powerful and flexible tool when used for sampling states during the probabilistic reliability assessment of power systems. Despite the advantages of MCS, the method begins to falter when applied to large and more complex systems of higher dimensions. In these cases it is often the process of classifying states that consumes the majority of computational time and resources. This is especially true in power systems reliability evaluation where the main method of classification is typically an Optimal Power Flow (OPF) formulation in the form of a linear program (LP). Previous works have improved the computational time required for classification by using Neural Networks (NN) of varying types in place of the OPF. A method of classification that is lighter weight and often more computationally efficient than NNs is the Support Vector Machine (SVM). This work couples SVM with the MCS algorithm in order to improve the computational time of classification and overall reliability evaluation. The method is further extended through the use of a multi-core architecture in order to further decrease computational time. These formulations are tested using the IEEE Reliability Test Systems (IEEE-RTS79 and IEEE-RTS96). Significant improvements in computational time are demonstrated while a high level of accuracy is maintained.

Session Tu3-2: Fuzzy Methods

Tuesday, August 2, 3:20PM-5:20PM, Room: Pine, Chair: Carlo Franscesco Morabito

3:20PM *Traffic Flow Breakdown Prediction using Feature Reduction through Rough-Neuro Fuzzy Networks [no. 407]*
Carlos Affonso, Renato Sassi and Ricardo Ferreira, UNESP, Brazil; UNINOVE, Brazil

To predict the traffic behavior could help to make decision about the routing process, as well as enables the improvement in effectiveness and productivity on its physical distribution. This need motivates the search for technological improvements in the Routing performance in metropolitan areas. The purpose of this paper is to present computational evidence that Artificial Neural Network ANN could be use to predict the traffic behavior in a metropolitan area such Sao Paulo (around 16 million inhabitants). The proposed methodology involves the application Rough-Fuzzy Sets to define inference morphology for insert the behavior of Dynamic Routing into a structured rule basis, without human expert aid. The attributes of the traffic parameters are described through membership functions. Rough Sets Theory identifies the attributes that are important, and suggest Fuzzy relations to be inserted on a Rough Neuro Fuzzy Network (RNFN) type Multilayer Perceptrons (MLP) and type Radial Basis Function (RBF), in order to get an optimal surface response. To measure the performance of the proposed RNFN, the responses of the unreduced rule basis are compared with the reduced rule basis. The results show that by making use of the Feature Reduction through RNFN, it is possible to reduce the need for human expert in the construction of the Fuzzy inference mechanism in such flow process like traffic breakdown.

3:40PM *A Sequential Learning Algorithm for Meta-Cognitive Neuro-Fuzzy Inference System for Classification Problems [no. 516]*
Suresh Sundaram and Kartick Subramanian, Nanyang Technological University, Singapore; Naynang Technological University, Singapore

A neuro-fuzzy classifier based on the metacognitive principle of human self-regulated learning (Mc-FIS) is proposed in this paper. The network decides what-to-learn, when-to-learn and how-to-learn based on the current information present in the classifier and the new information present in the sample. The classifier utilizes self-regulating error based criterion to decide which sample to learn and when to learn. A rule is pruned if its significance is below a particular threshold, based on class specific information. This results in a compact network and sample deletion helps overfitting. Class specific information is used in executing the above tasks. The algorithm is evaluated on balanced and unbalanced benchmark problems from UCI machine learning repository. The results clearly indicate the superiority of the developed algorithm.

4:00PM *Guided fuzzy clustering with multi-prototypes [no. 499]*
Shenglan Ben, Zhong Jin and Jingyu Yang, Nanjing University of Science and Technology, China

A new fuzzy clustering algorithm using multi-prototype representation of clusters is proposed in this paper to discover clusters with arbitrary shapes and sizes. Intra-cluster non-consistency and inter-cluster overlap are proposed as two mistake measurements to guide the splitting and merging step of the algorithm. In the splitting step, clusters with the largest intra- cluster non-consistency are iteratively split such that the resulting subclusters only contain data from the same class. In the following merging step, subclusters with the largest inter-cluster overlap are

iteratively merged until a pre-determined cluster number is achieved. A multi-prototy-pe representation of clusters is used in the merging step to handle the clusters with different size and shapes. Experimental results on synthetic and real datasets demonstrate the effectiveness and robustness of the proposed algorithm.

4:20PM *Adaptive Neuro-Fuzzy Control of Dynamical Systems [no. 557]*
Alok Kanti Deb and Alok Juyal, IIT Kharagpur, India

In this paper, the an adaptive neuro-fuzzy control that combines the features of fuzzy sets and neural networks have been implemented and applied for the control of SISO and MIMO systems. Duffing forced oscillation system was considered as the SISO plant while the Twin Rotor laboratory set up that closely mimics helicopter dynamics was considered as the MIMO plant. The tracking performance of the controller has been demonstrated for time varying inputs. Robust performance of the controller was demonstrated by applying a pulse disturbance when the controlled plant had reached a steady state. Real time implementation of the controller has been demonstrated on the Twin Rotor system.

4:40PM *A Rough-Fuzzy Hybrid Approach on a Neuro-Fuzzy Classifier for High Dimensional Data [no. 570]*
Chang Su Lee, Edith Cowan University, Australia

A new Rough-Neuro-Fuzzy (RNF) classifier is proposed in this paper for pattern classification scheme on high dimensional data as an extension of the previous work. The rough set theory is utilized to reduce the given knowledge into a compact form and to obtain a minimal set of decision rules. The proposed Rough-Neuro-Fuzzy classifier is constructed based on the structure of ANFIS (Adaptive-Network-Based Fuzzy Inference System), except its connections determined by the reduced data and the generated decision rules obtained by the rough sets-based approach. This provides the compact and minimal number of configurations for the network to adjust itself towards a faster learning. The learning scheme for the proposed approach is adopted from the one in ANFIS. The TS-type fuzzy inference model is employed to perform the decision making process. The proposed system is applied on a number of data sets for pattern classification tasks using 10-fold cross validation. The number of attributes is reduced significantly and the minimal rules are generated effectively by the rough set-based approach in the proposed system. Experimental results showed that results produced by the proposed rough-neuro-fuzzy classifier may be competitive compared to the previous work and the other existing approaches.

5:00PM *Neuro-fuzzy Dynamic Pole Placement Control of Nonlinear Discrete-time Systems [no. 330]*
Juri Belikov and Eduard Petlenkov, Institute of Cybernetics at Tallinn University of Technology, Estonia; Tallinn University of Technology, Estonia

An algorithm for control of nonlinear discrete-time systems is presented in the paper. Controlled system is linearized by dynamic output feedback so that the linearized closed loop system is equivalent to a predefined discrete-time transfer function representing reference model of the control system. Choice of the reference model provides placement of zeroes and poles of the closed loop system. In the proposed approach at least one of the poles is not fixed and moves during the time of transient process. Evolution of the pole occurs according to certain rules formalized and implemented in the algorithm by means of fuzzy logic. Therefore, the parameters of the transfer function of the linearized closed loop system may be understood as nonlinear functions which depend on the current control error and its derivative. Thus the poles of the closed loop system are placed dynamically according to the predefined rules providing necessary behavior of the control system. Controlled system has to be represented by a nonlinear model with no couplings between different time instances what can be performed by training an Artificial Neural Network of the specific structure. The developed theory and control algorithm are illustrated by means of numerical example.

Special Track Tu3-3: From Brains to Machines II

Tuesday, August 2, 3:20PM-5:20PM, Room: Oak, Chair: Steven Bressler

3:20PM *Neural adaptations to a brain-machine interface*
Jose Carmena, University of California, Berkeley, United States

The advent of multi-electrode recordings and brain-machine interfaces (BMIs) has provided a powerful tool for the development of neuroprosthetic systems for people with sensory and motor disabilities. BMIs are powerful tools that use brain-derived signals to control artificial devices such as computer cursors and robots. By recording the electrical activity of hundreds of neurons from multiple cortical areas in subjects performing motor tasks we can study the spatio-temporal patterns of neural activity and quantify the neurophysiological changes occurring in cortical networks, both in manual and brain control modes of operation. In this talk I will present exciting results from our lab showing that the brain can consolidate prosthetic motor skill in a way that resembles that of natural motor learning. Using stable recording from ensembles of units from primary motor cortex in two macaque monkeys we demonstrate that proficient neuroprosthetic control reversibly reshapes cortical networks through local effects. This will be followed by an outline on the emerging directions the field is taking towards the development of neuroprosthetic devices for the impaired.

4:00PM *Cyborg Beetles: Building Interfaces Between Synthetic and Multicellular*
Michel Maharbiz, University of California Berkeley, United States

In this talk, I will discuss some recent work in my lab's ongoing exploration of the remote control of insects in free flight via an implantable radio-equipped miniature neural stimulating system. The basic systems consisted of a pronotum-mounted radio transceiver-equipped microcontroller, a microbattery and neural and muscular stimulators. Flight initiation, cessation and elevation control were accomplished through neural stimulus of the brain which elicited, suppressed or modulated wing oscillation. Turns were triggered through the direct muscular stimulus of either of the basalar muscles. We have characterized the response times, success rates, and free-flight trajectories elicited by our neural control systems in remotely-controlled beetles. New results, new sensor modalities and extreme miniaturization directions will be discussed.

4:40PM *Biomimetic Models and Microelectronics for Neural Prosthetic Devices that Support Memory Systems of the Brain*

Theodore Berger, University of Southern California, United States

Dr. Berger leads a multi-disciplinary collaboration with Dr. Sam Deadwyler (Wake Forest Univ.), Dr. John Granacki (USC), Dr. Vasilis Marmarelis (USC), and Dr. Greg Gerhardt (Univ. of Kentucky), that is developing a microchip-based neural prosthesis for the hippocampus, a region of the brain responsible for long-term memory. Damage to the hippocampus is frequently associated with epilepsy, stroke, and dementia (Alzheimer's disease), and is considered to underlie the memory deficits characteristic of these neurological conditions. The essential goals of Dr. Berger's multi-laboratory effort include: (1) experimental study of neuron and neural network function -- how does the hippocampus encode information?, (2) formulation of biologically realistic models of neural system dynamics -- can that encoding process be described mathematically to realize a predictive model of how the hippocampus responds to any event?, (3) microchip implementation of neural system models -- can the mathematical model be realized as a set of electronic circuits to achieve parallel processing, rapid computational speed, and miniaturization?, and (4) creation of hybrid neuron-silicon interfaces -- can structural and functional connections between electronic devices and neural tissue be achieved for long-term, bi-directional communication with the brain? By integrating solutions to these component problems, the team is realizing a microchip-based model of hippocampal nonlinear dynamics that can perform the same function as part of the hippocampus. Through bi-directional communication with other neural tissue that normally provides the inputs and outputs to/from a damaged hippocampal area, the biomimetic model can serve as a neural prosthesis. A proof-of-concept will be presented using rats that have been chronically implanted with stimulation/recording micro-electrodes throughout the dorso-ventral extent of the hippocampus, and that have been trained using a delayed, non-match-to-sample task. Normal hippocampal functioning is required for successful delayed non-match-to-sample memory. Memory/behavioral function of the hippocampus is blocked pharmacologically, and then in the presence of the blockade, hippocampal memory/behavioral function is restored by a multi-input, multi-output model of hippocampal nonlinear dynamics that interacts bi-directionally with the hippocampus. The model is used to predict output of the hippocampus in the form of spatio-temporal patterns of neural activity in the CA1 region; electrical stimulation of CA1 cells is used to "drive" the output of hippocampus to the desired (predicted) state. These results show for the first time that it is possible to create "hybrid microelectronic-biological" systems that display normal physiological properties, and thus, may be used as neural prostheses to restore damaged brain regions.

Special Session Tu3-5: Competition: Machine Learning for Traffic Sign Recognition

Tuesday, August 2, 3:20PM-5:20PM, Room: Carmel, Chair: Johannes Stallkamp

3:20PM *The German Traffic Sign Recognition Benchmark: A multi-class classification competition [no. 312]*

Johannes Stallkamp, Marc Schlipsing, Jan Salmen and Christian Igel, Institut fuer Neuroinformatik, Ruhr Universitaet Bochum, Germany; Department of Computer Science, University of Copenhagen, Denmark

The "German Traffic Sign Recognition Benchmark" is a multi-category classification competition held at IJCNN 2011. Automatic recognition of traffic signs is required in advanced driver assistance systems and constitutes a challenging realworld computer vision and pattern recognition problem. A comprehensive, lifelike dataset of more than 50,000 traffic sign images has been collected. It reflects the strong variations in visual appearance of signs due to distance, illumination, weather conditions, partial occlusions, and rotations. The images are complemented by several precomputed feature sets to allow for applying machine learning algorithms without background knowledge in image processing. The dataset comprises 43 classes with unbalanced class frequencies. Participants have to classify two test sets of more than 12,500 images each. Here, the results on the first of these sets, which was used in the first evaluation stage of the two-fold challenge, are reported. The methods employed by the participants who achieved the best results are briefly described and compared to human traffic sign recognition performance and baseline results.

3:40PM *Traffic Sign Classification using K-d trees and Random Forests [no. 446]*

Fatin Zaklouta, Bogdan Stanciulescu and Omar Hamdoun, Mines ParisTech, France

In this paper, we evaluate the performance of K-d trees and Random Forests for traffic sign classification using different size Histogram of Oriented Gradients (HOG) descriptors and Distance Transforms. We use the German Traffic Sign Benchmark data set containing 43 classes and more than 50,000 images. The K-d tree is fast to build and search in. We combine the tree classifiers with the HOG descriptors as well as the Distance Transforms and achieve classification rates of up to 97% and 81.8% respectively.

4:00PM *Traffic Sign Recognition with Multi-Scale Convolutional Networks [no. 578]*

Pierre Sermanet and Yann Lecun, New York University, United States

We apply Convolutional Networks (ConvNets) to the task of traffic sign classification as part of the GTSRB competition. ConvNets are biologically- inspired multi-stage architectures that automatically learn hierarchies of invariant features. While many popular vision approaches use hand-crafted features such as HOG or SIFT, ConvNets learn features at every level from data that are tuned to the task at hand. The traditional ConvNet architecture was modified by feeding 1st stage features in addition to 2nd stage features to the classifier. The system yielded the 2nd-best accuracy of 98.97% during phase I of the competition (the best entry obtained 98.98%), above the human performance of 98.81%, using 32x32 color input images. Experiments conducted after phase 1 produced a new record of 99.17% by increasing the network capacity, and by using greyscale images instead of color. Interestingly, random features still yielded competitive results (97.33%).

4:20PM *A Committee of Neural Networks for Traffic Sign Classification [no. 402]*
Dan Ciresan, Ueli Meier, Jonathan Masci and Juergen Schmidhuber, IDSIA, USI, SUPSI, Switzerland

We describe the approach that won the preliminary phase of the German traffic sign recognition benchmark with a better-than-human recognition rate of 98.98%. We obtain an even better recognition rate of 99.15% by further training the nets. Our fast, fully parameterizable GPU implementation of a Convolutional Neural Network does not require careful design of pre-wired feature extractors, which are rather learned in a supervised way. A CNN/MLP committee further boosts recognition performance.

Session Tu3-4: Kernel Methods and SVM II

Tuesday, August 2, 3:20PM-5:20PM, Room: Monterey, Chair: Vladimir Cherkassky

3:20PM *An Outpost Vector Placement Evaluation of an Incremental Learning Algorithm for Support Vector Machine [no. 76]*
Piyabute Fuangkhon and Thitipong Tanprasert, Assumption University, Thailand

Outpost Vector model synthesizes new vectors at the boundary of two classes of data in order to increase the level of accuracy of classification. This paper presents a performance evaluation of four different placements of outpost vectors in an incremental learning algorithm for Support Vector Machine (SVM) on a non-complex problem. The algorithm generates outpost vectors from selected new samples, selected prior samples, both samples, or generates no outpost vector at all. After that, they are included in the final training set, as well as new samples and prior samples, based on the specified parameters. The experiments are conducted with a 2-dimension partition problem. The distribution of training and test samples is created in a limited location of a 2-dimension donut ring. There are two classes of data which are represented as 0 and 1. The context of the problem is assumed to shift 45 degrees in counterclockwise direction. Every consecutive partition is set to have different class of data. The experimental results show that the placement of outpost vectors generated from only selected new samples yields the highest level of accuracy of classification for both new data and old data. As a result, using samples from different part of the algorithm to generate outpost vectors affects the level of accuracy of classification.

3:40PM *Extended Kalman Filter Using a Kernel Recursive Least Squares Observer [no. 304]*
Pingping Zhu, Badong Chen and Jose Principe, University of Florida, United States

In this paper, a novel methodology is proposed to solve the state estimation problem combining the extended Kalman filter (EKF) with a kernel recursive least squares (KRLS) algorithm (EKF-KRLS). The EKF algorithm estimates hidden states in the input space, while the KRLS algorithm estimates the measurement model. The algorithm works well without knowing the linear or nonlinear measurement model. We apply this algorithm to vehicle tracking, and compare the performances with traditional Kalman filter, EKF and KRLS algorithms. Results demonstrate that the performance of the EKF-KRLS algorithm outperforms these existing algorithms. Especially when nonlinear measurement functions are applied, the advantage of the EKF-KRLS algorithm is very obvious.

4:00PM *Adaptive Tree Kernel by Multinomial Generative Topographic Mapping [no. 352]*
Davide Bacciu, Alessio Micheli and Alessandro Sperduti, Universita di Pisa, Italy; Universita di Padova, Italy

Learning the kernel function from data is a challenging open issue in structured data processing. In the paper, we propose a novel adaptive kernel, defined over a generative learning model, that exploits a novel multinomial extension of the Generative Topographic Mapping for Structured Data (GTM-SD). We show how the proposed kernel effectively exploits the GTM-SD continuity and smoothness properties to provide dense kernels characterized by an high discriminative power even with small topographic maps. Experimental evaluations on challenging structured XML document repositories show the effectiveness of the proposed approach against state-of-the-art syntactic and adaptive convolutional kernels.

4:20PM *Momentum Sequential Minimal Optimization: an Accelerated Method for Support Vector Machine training [no. 99]*
Alvaro Barbero and Jose R. Dorronsoro, Universidad Autonoma de Madrid and Instituto de Ingenieria del Conocimiento, Spain

Sequential Minimal Optimization (SMO) can be regarded as the state--of--the--art approach in non-linear Support Vector Machines training, being the method of choice in the successful LIBSVM software. Its optimization procedure is based on updating only a couple of the problem coefficients per iteration, until convergence. In this paper we notice that this strategy can be interpreted as finding the sparsest yet most useful updating direction per iteration. We present a modification of SMO including a new approximate momentum term in the updating direction which captures information from previous updates, and show that this term presents a trade-off between sparsity and suitability of the chosen direction. We show how this novelty is able to provide substantial savings in practice in SMO's number of iterations to convergence, without increasing noticeably its cost per iteration. We study when this saving in iterates can result in a reduced SVM training times, and the behavior of this new technique when combined with caching and shrinking strategies.

4:40PM *Nonlinear Extension of Multiobjective Multiclass Support Vector Machine Based on the One-against-all Method [no. 329]*
Keiji Tatsumi, Masato Tai and Tetsuzo Tanino, Osaka University, Japan

Recently, some kinds of extensions of the binary support vector machine(SVM) to multiclass classification have been proposed. In this paper, we focus on the multiobjective multiclass support vector machine based on the one-against-all

method (MMSVM-OA), which is an improved new model from one-against-all and all- together methods. The model finds a weighted combination of binary SVMs obtained by the one-against-all method whose weights are determined in order to maximize geometric margins of its multiclass discriminant function for the generalization ability similarly to the all-together method. In addition, the model does not require a large amount of computational resources, while it is reported that it outperforms than one-against-all and all-together methods in numerical experiments. However, it is not formulated as a quadratic programming problem unlike to standard SVMs, it is difficult to apply the kernel method to it. Therefore, in this paper, we propose a nonlinear model derived by a transformation of the MMSVM-OA, which the kernel method can apply to, and show the corresponding multiclass classifier is obtained by solving a convex second- order cone programming problem. Moreover, we show the advantage of the proposed model through numerical experiments.

5:00PM *Convergence of Algorithms for Solving the Nearest Point Problem in Reduced Convex Hulls [no. 109]*
Jorge Lopez and Jose R. Dorronsoro, Universidad Autonoma de Madrid - Instituto de Ingenieria del Conocimiento, Spain

In this paper we establish a framework for the convergence of two algorithms for solving the Nearest Point Problem in Reduced Convex Hulls (RCH-NPP), namely the RCH-GSK method proposed in Mavroforakis et al. and the RCH-MDM method suggested in Lopez et al. This framework allows us to show the asymptotic convergence of both methods in a very simple way. Moreover, it allows to justify a shrinking strategy for RCH-MDM.

Session Tu3-6: Applications I

Tuesday, August 2, 3:20PM-5:20PM, Room: Santa Clara, Chair: Leonid Perlovsky

3:20PM *Learning Random Subspace Novelty Detection Filters [no. 472]*
Fatma Hamdi and Younes Bennani, LIPN - UMR 7030 - University of Paris 13 - CNRS., France

In this paper we propose a novelty detection framework based on the orthogonal projection operators and the bootstrap idea. Our approach called Random Subspace Novelty Detection Filter (RS-NDF) combines the sampling technique and the ensemble idea. RS-NDF is an ensemble of NDF, induced from bootstrap samples of the training data, using random feature selection in the NDF induction process. Prediction is made by aggregating the predictions of the ensemble. RS-NDF generally exhibits a substantial performance improvement over the single NDF. Thanks to an online learning algorithm, the RS-NDF approach is also able to track changes in data over time. The RS-NDF method is compared to single NDF and other novelty detection methods with tenfold cross-validation experiments on publicly available datasets, where the methods superiority is demonstrated. Performance metrics such as precision and recall, false positive rate and false negative rate, F-measure, AUC and G-mean are computed. The proposed approach is shown to improve the prediction accuracy of the novelty detection, and have favorable performance compared to the existing algorithms.

3:40PM *The Application of Evolutionary Neural Network for Bat Echolocation Call Recognition [no. 246]*
Golrokh Mirzaei, Mohammad Wadood Majid, Mohsin Jamali, Jeremy Ross and Joseph Frizado, University of Toledo, United States; Bowling Green State University, United States

An Evolutionary Neural Network (ENN) is developed to identify bats by their vocalization characteristics. This is in an effort to quantify local bat population size as a large number of bat fatalities near wind turbines has been reported. It is based on the Genetic Algorithm, which can be used for optimization of the weight selection of the neural network. We then compare ENN with different classification techniques. In the scope of bat call classification, ENN is a new technique that can be effectively used as a bat- call classifier. This research will help in developing mitigation techniques for reducing bat fatalities.

4:00PM *Neural Network Estimation of Photovoltaic I-V Curves under Partially Shaded Conditions [no. 295]*
Jacques Dolan, Ritchie Lee, Yoo-Hsiu Yeh, Chiping Yeh, Daniel Nguyen, Ben-Menehem Shahar and Ishihara Abraham, University of Minnesota - Twin Cities, United States; Carnegie Mellon University Silicon Valley, United States; Cornell University, United States; University of California, Berkeley, United States

In this paper, we present a neural network algorithm to estimate the I-V curve of a photovoltaic module under non-uniform temperature and shading distributions. We first present a novel photovoltaic simulation model which includes the interaction of (1) heat transfer including conduction, convection, and radiation (long and short wavelength), (2) an electro-optical two diode model including ohmic heat dissipation, and (3) environmental influences including shading, irradiance, and wind dependencies. The neural network trains on inputs which consist of shading and temperature patterns of each cell of the module, and predicts the current versus voltage and power versus voltage landscapes. This information can be used for maximum power point tracking under non-uniform conditions. The neural network was validated on the simulation model and on data collected from our rooftop PV lab.

4:20PM *Gradient-based Morphological Approach for Software Development Cost Estimation [no. 143]*
Ricardo Araujo, Adriano Oliveira, Sergio Soares and Silvio Meira, Informatics Center - Federal University of Pernambuco, Brazil

In this paper we present a gradient-based morphological approach to solve the software development cost estimation (SDCE) problem. The proposed approach consists of a dilation-erosion perceptron (DEP) trained by a gradient steepest descent method using the back propagation (BP) algorithm and a systematic approach to overcome the problem of nondifferentiability of morphological operators. Furthermore, we compare the proposed approach with other neural and statistical models using five complex SDCE problems.

4:40PM *Yearly and Seasonal Models for Electricity Load Forecasting [no. 316]*

Irena Koprinska, Mashud Rana and Vassilios Agelidis, University of Sydney, Australia; University of New South Wales, Australia

We present new approaches for building yearly and seasonal models for 5-minute ahead electricity load forecasting. They are evaluated using two full years of Australian electricity load data. We first analyze the cyclic nature of the electricity load and show that the autocorrelation function captures these patterns and can be used to extract useful features, as the data is highly linearly correlated. Using the selected feature sets, we then evaluate the predictive performance of four algorithms, representing different prediction paradigms. We found linear regression to be the most accurate and fastest algorithm, outperforming the industry model based on backpropagation neural networks and all baselines. Our results also show that there is no accuracy gain in building models for each season in comparison to building a single yearly model.

5:00PM *A MLP-SVM Hybrid Model for Cursive Handwriting Recognition [no. 185]*

Washington Azevedo and Cleber Zanchettin, UFPE - Federal University of Pernambuco, Brazil

This paper presents a hybrid MLP-SVM method for cursive characters recognition. Specialized Support Vector Machines (SVMs) are introduced to significantly improve the performance of Multilayer Perceptron (MLP) in the local areas around the surfaces of separation between each pair of characters in the space of input patterns. This hybrid architecture is based on the observation that when using MLPs in the task of handwritten characters recognition, the correct class is almost always one of the two maximum outputs of the MLP. The second observation is that most of the errors consist of pairs of classes in which the characters have similarities (e.g. (U, V), (m, n), (O, Q), among others). Specialized local SVMs are introduced to detect the correct class among these two classification hypotheses. The hybrid MLP-SVM recognizer showed improvement, significant, in performance in terms of recognition rate compared with an MLP for a task of character recognition.

Tuesday, August 2, 5:30PM-6:30PM

Special Session Tu4-1: Smart Grid and Energy Applications II

Tuesday, August 2, 5:30PM-6:30PM, Room: Cedar, Chair: Danilo Mandic and Lingfeng Wang

5:30PM *Back to Basics: Operationalizing Data Mining and Visualization Techniques for Utilities [no. 651]*

Dora Nakafuji, Thomas Aukai, Lisa Dangelmaier, Chris Reynolds, Jennifer Yoshimura and Ying Hu, Hawaiian Electric Company, United States; Hawaiian Electric Light Company, United States; Maui Electric Light Company, United States

Today, the family of Hawaiian Electric utilities, consisting of Hawaii Electric Light Company (HELCO) on the Big Island of Hawaii, Maui Electric Company (MECO) on the islands of Maui, Molokai and Lanai and Hawaiian Electric Company (HECO) on the island of Oahu, are contending with PV penetrations in excess of 20 percent during high electricity demand days (e.g. weekdays) and over 60 percent penetration during light load demand days (e.g. weekends) on certain distribution circuits. With the emergence of more, low-cost photovoltaic (PV) systems and consumer self-generation programs, such as net energy metering and feed-in-tariffs, today's utilities are facing a fundamental shift towards a need to get more visibility to customer-sited, distributed generating resources (DG). The Hawaiian utilities are among an emerging set of utilities around the world leading the nation in contending with high levels of renewable penetration on their distribution systems. Hawaiian Electric Utilities are pursuing efforts to gather, evaluate and target (GET) relevant resource datasets in conjunction with time synchronized system data to enable planning, forecasting and operations with high penetration of variable, distributed renewable resources.

5:50PM *Neural Network Identification for Biomass Gasification Kinetic Model [no. 398]*

Rocio Carrasco, Edgar Sanchez and Salvador Carlos-Hernandez, CINVESTAV-IPN, Unidad Guadalajara, Mexico; CINVESTAV-IPN, Unidad Saltillo, Mexico

This paper presents a neural network application to identify a kinetic model for the char reduction zone of a solid fuel gasification process. The considered model consists of six differential equations which represent the production of six components (carbon, hydrogen, carbon monoxide, water, carbon dioxide and methane) and are obtained from reaction rate equations of the four main reactions in the char reduction zone of a fluidized bed gasifier. On the other hand, the identification presented in this work is based on a discrete-time high order neural network (RHONN), which is trained with an extended Kalman filter (EKF) algorithm. The objective is to reproduce with the neural network the different components production under various operating conditions. The neural identifier performance is illustrated via simulation.

6:10PM *Application of Neural Networks in the Classification of Incipient Faults in Power Transformers: A Study of Case [no. 653]*

Luciana Castanheira, Joao Vasconcelos, Agnaldo Reis, Paulo Magalhaes and Savio Silva, Federal University of Ouro Preto, Brazil; Federal University of Minas Gerais, Brazil

The power transformer is one of the most important equipment in an electric power system. If this equipment is out of order in an unplanned way, the damage for both society and electric utilities are very significant. In this work, multi-layer perceptrons have been trained via Rprop algorithm to classify incipient faults in power transformers. The proposed procedure has been applied to real databases derived from chromatographic tests of power transformers. The results obtained here show that the proposed technique generates concordance rates between 75 and 90% most of the time. Neural classifiers can be seen as a key component in power transformer predictive maintenance.

Session Tu4-2: Radial Basis Functions

Tuesday, August 2, 5:30PM-6:30PM, Room: Pine, Chair: Alessandro Sperduti

5:30PM *Selective Adjustment of Rotationally-Asymmetric Neuron Sigma-Widths [no. 309]*
Nathan Rose, Swinburne University of Technology, Australia

Radial Basis Networks are a reliable and efficient tool for performing classification tasks. In networks that include a Gaussian output transform within the Pattern Layer neurons, the method of setting the sigma-width of the Gaussian curve is critical to obtaining accurate classification. Many existing methods perform poorly in regions of the problem space between examples of differing classes, or when there is overlap between classes in the data set. A method is proposed to produce unique sigma values for each weight of every neuron, resulting in each neuron having its own Gaussian 'coverage' area within problem space. This method achieves better results than the alternatives on data sets with a significant amount of overlap and when the data is unscaled.

5:50PM *An Improved Geometric Radial Basis Function Network for Hand-Eye Calibration [no. 286]*
Eduardo Vazquez-Santacruz and Eduardo Bayro-Corrochano, CINVESTAV Unidad Guadalajara, Mexico

In this paper we present the application of a new hypercomplex-valued Radial Basis Network (RBF) to estimate unknown geometric transformations such as in the case of the Hand-Eye Calibration problem. This network constitutes a generalization of the standard real-valued RBF. The network fed with geometric entities can be used in real time to estimate changes in the linear transformation between the coordinate system of the camera and the coordinate system of the end-effector. This approach is more efficient than standard batch methods particularly because our method works in real time, estimating the rigid transformation under temporal perturbation. In contrast, the standard methods need to recalibrate each time first by collecting data and then by computing a batch procedure often using SVD or optimization techniques.

6:10PM *Radial Basis Function Network for Well Log Data Inversion [no. 239]*
Kou-Yuan Huang, Liang-Chi Shen and Li-Sheng Weng, National Chiao Tung University, Taiwan; University of Houston, United States

We adopt the radial basis function network (RBF) for well log data inversion. We propose the 3 layers RBF. Inside RBF, the 1-layer perceptron is replaced by 2-layer perceptron. It can do more nonlinear mapping. The gradient descent method is used in the back propagation learning rule at 2-layer perceptron. The input of the network is the apparent conductivity (Ca) and the output of the network is the true formation conductivity (Ct). 25 simulated well log data are used in the training. From experimental results, the network with 10 input data, first layer with 27 nodes, second layer with 9 hidden nodes and 10 output nodes can get the smallest average mean absolute error in the training. After training in the network, we apply it to do the inversion of the real field well log data to get the inverted Ct. Result is good. It shows that the RBF can do the well log data inversion.

Special Track Tu4-3: From Brains to Machines II (cont.)

Tuesday, August 2, 5:30PM-6:30PM, Room: Oak, Chair: Steven Bressler

5:30PM *How to Work Towards a Mathematical Understanding of the Brain*
Dileep George, Vicarious Systems, United States

This talk has three parts. In the first part I will argue why understanding the computational principles of the brain could be a necessary step in building intelligent machines. However, brains are extremely complex and computationally relevant principles can easily be lost amidst biological details. This makes learning useful principles from biologically realistic simulations extremely hard. In the second part of the talk I will describe a framework to look at the brain that could let a researcher focus on the relevant principles. I will then describe a process using techniques from machine learning and graphical models to encode the principles learned from neuroscience, thereby reducing the complexity of building practical systems that work like the brain. This approach could be simpler and more practical compared to detailed neurobiological approaches. I will illustrate this process with results learned from building a biologically inspired vision system. In the third part of the talk I will describe how building practical models can actually teach us more about the brain. Relevant paper:http://www.ploscompbiol.org/doi/pcbi.1000532

6:10PM *Discussion - Part II*
Theodore Berger, Jose Carmena, Dileep George, Michel Maharbiz and Dharmendra Modha, University of Southern California, United States; University of California, Berkeley, United States; Vicarious Systems, United States; IBM Almaden Research Center, United States

Special Session Tu4-5: Computational Intelligence Research in Driver Fatigue and Distraction

Tuesday, August 2, 5:30PM-6:30PM, Room: Carmel, Chair: Dev Kochhar and Mahmoud Abou-Nasr

5:30PM *Genetic Feature Selection in EEG-Based Motion Sickness Estimation [no. 98]*

Chun-Shu Wei, Li-Wei Ko, Shang-Wen Chuang, Tzyy-Ping Jung and Chin-Teng Lin, Brain Research Center and the Department of Electrical Engineering, National Chiao-Tung University, Hsinchu, Taiwan; Brain Research Center and the Department of Biological Science and Technology, National Chiao-Tung University, Hsinchu, Taiwan; Swartz Center for Computational Neuroscience, Institute for Neural Computation, University of California San Diego, CA, United States

Motion sickness is a common symptom that occurs when the brain receives conflicting information about the sensation of movement. Many motion sickness biomarkers have been identified, and electroencephalogram (EEG)-based motion sickness level estimation was found feasible in our previous study. This study employs genetic feature selection to find a subset of EEG features that can further improve estimation performance over the correlation-based method reported in the previous studies. The features selected by genetic feature selection were very different from those obtained by correlation analysis. Results of this study demonstrate that genetic feature selection is a very effective method to optimize the estimation of motion-sickness level. This demonstration could lead to a practical system for noninvasive monitoring of the motion sickness of individuals in real-world environments.

5:50PM *EEG-based Brain Dynamics of Driving Distraction [no. 319]*

Chin-Teng Lin, Shi-An Chen, Li-Wei Ko and Yu-Kai Wang, Department of Electrical and Control Engineering, National Chiao-Tung University, Hsinchu, Taiwan, Taiwan; Brain Research Center, National Chiao-Tung University, Hsinchu, Taiwan, Taiwan

Distraction during driving has been recognized as a significant cause of traffic accidents. The aim of this study is to investigate Electroencephalography (EEG) -based brain dynamics in response to driving distraction. To study human cognition under specific driving task, this study utilized two simulated events including unexpected car deviations and mathematics questions in a simulated driving experiment. The raw data were first separated into independent brain sources by Independent Component Analysis. Then, the EEG power spectra were used to evaluate the time-frequency brain dynamics. Results showed that increases of theta band and beta band power were observed in the frontal cortex. Further analysis demonstrated that reaction time and multiple cortical EEG power had high correlation. Thus, this study suggested that the features extracted by EEG signal processing, which were the theta power increases in frontal area, could be used as the distracted indexes for early detecting driver's inattention in the real driving.

6:10PM *Audio Visual Cues in Driver Affect Characterization: Issues and Challenges in Developing Robust Approaches [no. 628]*

Ashish Tawari and Mohan Trivedi, UCSD, United States

Computer vision, speech and machine learning technologies play an important role and are increasingly used in today's vehicles to improve the safety as well as comfort in the car. Driving in particular presents a context in which a user's emotional state plays a significant role. Emotions have been found to affect cognitive style and performance. Even mildly positive feeling can have a profound effect on the flexibility and efficiency of thinking and problem solving. In this paper, we review some of the existing approaches for analyzing invehicle driver affect using audio and visual cues. We will discuss challenges in developing robust system and hopefully provide some insight in practical realization of such system. In particular, we present our ongoing efforts in collecting driving data using simulator as well as real world driving testbeds, and propose to utilize a multilevel audio-visual fusion scheme to utilize contextual information often available in co-existing tasks in an intelligent system.

Session Tu4-4: Information Theoretic Methods

Tuesday, August 2, 5:30PM-6:30PM, Room: Monterey, Chair: Bruno Apolloni

5:30PM *A Nonparametric Information Theoretic Approach for Change Detection in Time Series [no. 281]*

Songlin Zhao and Jose Principe, University of Florida, United States

This paper presents an online nonparametric methodology based on the Kernel Least Mean Square (KLMS) algorithm and the surprise criterion, which is based on an information theoretic framework. Surprise quantifies the amount of information a datum contains given a known system state, and can be estimated online using Gaussian Process Theory. Based on this concept, we use the KLMS algorithm together with surprise criterion to detect regime change in nonstationary time series. We test the methodology on a synthesized chaotic time series to illustrate this criterion. The results show that surprise criterion is better than the conventional segmentation based on the error criterion.

5:50PM *Adaptive Background Estimation using an Information Theoretic Cost for Hidden State Estimation [no. 125]*

Goktug Cinar and Jose Principe, University of Florida, United States

Hidden state estimation in linear systems is a popular and broad research topic which became a mainstream research area after Rudolf Kalman's seminal paper. The Kalman Filter (KF) gives the optimal solution to the estimation problem in a setting where all the processes are Gaussian random processes. However because of the suboptimal behavior of the KF in non-Gaussian settings, there is a need for a new filter that can extract higher order information from the signals. In this paper we propose using an information theoretic cost function utilizing the similarity measure Correntropy as a performance index. This results in a different perspective on hidden state estimation. We present the superior performance of the new filter on both synthetic data and on adaptive background estimation problem and discuss future research directions.

6:10PM *Closed-form Cauchy-Schwarz pdf Divergence for Mixture of Gaussians [no. 526]*
Kittipat Kampa, Erion Hasanbelliu and Jose Principe, Department of Electrical and Computer Engineering, University of Florida, Gainesville, FL 32611, United States

This paper presents an efficient approach to calculate the difference between two probability density functions (pdfs), each of which is a mixture of Gaussians (MoG). Unlike Kullback-Leibler divergence (D_{KL}), the authors propose that the Cauchy-Schwarz (CS) pdf divergence measure (D_{CS}) can give an analytic, closed-form expression for MoG. This property of the D_{CS} makes fast and efficient calculations possible, which is tremendously desired in real-world applications where the dimensionality of the data/features is very high. We show that D_{CS} follows similar trends to D_{KL}, but can be computed much faster, especially when the dimensionality is high. Moreover, the proposed method is shown to significantly outperform D_{KL} in classifying real-world 2D and 3D objects, and static hand posture recognition based on distances alone.

Session Tu4-6: Classification

Tuesday, August 2, 5:30PM-6:30PM, Room: Santa Clara, Chair: Marley Vellasco

5:30PM *Incremental Object Classification Using Hierarchical Generative Gaussian Mixture and Topology Based Feature Representation [no. 203]*
Sungmoon Jeong and Minho Lee, Kyoungpook National University, Korea, Republic of

This paper presents an adaptive object classification based on incremental feature extraction/representation and a hierarchical feature classifier that offers plasticity to accommodate variant input dimension and reduces forgetting problem of previously learned information. The proposed feature representation method applies incremental prototype generation with a cortex-like mechanism to conventional feature representation method to enable an incremental reflection of various object characteristics in learning process. A classifier based on a hierarchical generative model recognizes various objects with variant feature dimensions during the learning process. Experimental results show that the adaptive object classification model successfully classifies an object class against background with enhanced stability and flexibility.

5:50PM *Multinomial Squared Direction Cosines Regression [no. 634]*
Naveed Iqbal and Georgios Anagnostopoulos, Florida Institute of Technology, United States

In this paper we introduce Multinomial Squared Direction Cosines Regression as an alternative Multinomial Response Model. The proposed model offers an intuitive geometric interpretation to the task of estimating posterior class probabilities in multi-class problems. In specific, the latter probabilities correspond to the squared direction cosines between a given pattern and representative class exemplars that form a basis in the decision space. We demonstrate that the model allows for efficient training via a trust region based Newton's Method, provided that the number of model parameters is not too large. Experimental results on several benchmark classification problems show that it compares competitively against Logistic Regression Classifiers, Support Vector Machines, and the Classification and Regression Tree models.

6:10PM *Online-Learned Classifiers for Robust Multitarget Tracking [no. 279]*
Shuqing Zeng and Yanhua Chen, General Motors Research and Development, United States; University of Michigan, Ann Arbor, United States

In this paper, we propose an online-learned classifiers for data association of multitarget tracking. The classifiers are dynamically constructed and online incrementally learned using image patches, which are associated based on location separativeness. A biological inspired architecture is used to compute the classification label of image patch. The extracted image patches are coded and learned by a 3-layer neural network that implements in-place learning. We employ minimum-cost network flow optimization to associate tracks with the image patches based on their appearance and location proximities. The presented framework is applied to learn 11 objects encountered in a PETS2009 data set. Cross validation results show that the overall recognition accuracy is above 94\ %. The comparison with other learning algorithms is promising. The result of the implemented multitarget tracker demonstrates the effectiveness of the approach.

Tuesday, August 2, 7:30PM-9:30PM

Poster Session Tu-PB: Poster Session B

Tuesday, August 2, 7:30PM-9:30PM, Room: Bayshore Ballroom, Chair: Cesare Alippi

P301 *Synapse Maintenance in the Where-What Network [no. 580]*

Yuekai Wang, Xiaofeng Wu and Juyang Weng, Department of Electronic Engineering, Fudan University, Shanghai, China; Department of Computer Science and Engineering,Michigan State University, East lansing, Michigan, United States

General object recognition in complex backgrounds is still challenging. On one hand, the various backgrounds, where object may appear at different locations, make it difficult to find the object of interest. On the other hand, with the numbers of locations, types and variations in each type (e.g., rotation) increasing, conventional model-based approaches start to break down. The Where-What Networks (WWNs) were a biologically inspired framework for recognizing learned objects (appearances) from complex backgrounds. However, they do not have an adaptive receptive field for an object of a curved contour. Leaked-in background pixels will cause problem when different objects look similar. This work introduces a new biologically inspired mechanism -- synapse maintenance and uses both supervised (motor-supervised for class response) and unsupervised learning (synaptic maintenance) to realize objects rocognition. Synapse maintenance is meant to automatically decide which synapse should be active firing of the post-synaptic neuron. With the synapse maintenance, the network has achieved a significant improvement in the network performance.

P302 *Learning confidence exchange in Collaborative Clustering [no. 190]*

Nistor Grozavu, Mohamad Ghassany and Younes Bennani, LIPN-UMR 7030, Paris 13 University, France

The aim of collaborative clustering is to reveal the common structure of data which are distributed on different sites. The topological collaborative clustering (based on Kohonen Self-Organizing Maps) allows to take into account other maps without recourse to the data in an unsupervised learning. In this paper, the approach is presented in the case of SOM and valid for all classifications based on prototypes. The strength of the collaboration between each pair of datasets is determined by a fixed parameter for the both, vertical and horizontal topological collaborative clustering. In this study, learning the confidence exchange is presented for the both topological collaborative clustering approaches by using the topological knowledge. The gradient based optimization is used to set the value of the confidence parameter for each collaboration. The paper presents the formalism of the approach and its validation. The proposed approach has been validated on several datasets and experimental results have shown very promising performance.

P303 *Neuromorphic Motivated Systems [no. 607]*

James Daly, Jacob Brown and Juyang Weng, Michigan State University, United States

Although reinforcement learning has been extensively modeled, few agent models that incorporate values use biologically plausible neural networks as a uniform computational architecture. We call biologically plausible neural network architecture neuromorphic. This paper discusses some theoretical constraints on neuromorphic intrinsic value systems [1]. By intrinsic, we mean a value system that is likely programmed by the genes, whose value bias has already taken a shape at the birth time. Such an intrinsic value system plays an important role in developing extrinsic values through the agent's own experience during its life span. Based on our theoretical constraints, we model two types of neurotransmitters, serotonin and dopamine, to construct a neuromorpic intrinsic value system based on a uniform architecture of neural network. Serotonin represents punishment and stress, while dopamine represents reward and pleasure. Experimentally, this model allows our simulated robot to develop an attachment to one entity and fear another. REFERENCES [1] E. Deci and R. Ryan. Intrinsic motivation and self-determination in human behaviour. Plenum Press, New York, 1985. James

P304 *A Solution to Harmonic Frequency Problem: Frequency and Phase Coding-Based Brain-Computer Interface [no. 440]*

Chi Man Wong, Boyu Wang, Feng Wan, Peng Un Mak, Pui In Mak and Mang I Vai, University of Macau, Macau

In this paper, we propose a modified visual stimulus generation method and feature detection algorithm to design a frequency and phase coding steady-state visual evoked potential (SSVEP) based brain-computer interface (BCI). By utilizing both frequency and phase information, we solve the harmonic frequency problem in our proposed SSVEP-BCI system. The offline experimental results show that the proposed feature detection algorithm can enhance the classification rate over 10% (from 69% to 82%) even though only one signal electrode is used and the harmonic frequencies (6.67Hz, 13.33Hz, 8.57Hz and 17.14Hz) are employed.

P305 *An Improved BCI Paradigm of Motor Imagery for Real-Time Dynamic System Control [no. 694]*

Jun Jiang, Jingwei Yue, Nan Zhang, Zongtan Zhou and Dewen Hu, National University of Defense Technology, China; The First Aviation Institute of Air Force, China

Objective Electroencephalogram (EEG) signals of left and right hand Motor Imagery (MI) are widely employed in Brain-Computer Interface (BCI) to operate external devices. However, if only Mu or Beta rhythm is used, as present in most typical BCI paradigms, it's difficult to control unstable dynamic systems, such as an inverted pendulum. To address this problem, we proposed a new BCI paradigm which combines two types of brain signals, Mu rhythm and Movement- Related Cortical Potential (MRCP) during MI. Method EEG signals were acquired from six healthy subjects during left and right hand MI with two speeds (fast and slow). A band-pass filter (8-13Hz) was applied on the data to encompass the Mu rhythm. After that, the common spatial pattern (CSP) algorithm and Fischer's linear discriminant analysis (FLDA) classifier were utilized to discriminate the two classes of left and right hand MI. Raw EEG data from a single electrode was selected basing on classification result and the rebound rate of MRCP was computed to estimate the MI speed. After off- line training, a virtual inverted pendulum control system was designed and implemented to evaluate the improved BCI paradigm. Result Four of the participants got accuracy of 89% on average, with the highest up to 95%, while the other two cannot execute the MI task though much off-line training had been performed. In our study, the virtual pendulum was set to 5 meters and 500 grams to obtain better controllability. Subjects could balance the pendulum for about 2 minutes when MI and MRCP

information were combined, in contrast with about 1 minute if only Mu rhythm was employed. Discussion In our paradigm, subjects could send control commands which consisted of not only directions but also intensities by imaging his/her hands move at different speeds. With this progress, the inverted pendulum system got a smaller overshoot and a stronger robustness that extended the control time of the pendulum compared with typical BCI paradigms. In conclusion, the BCI paradigm utilizing Mu rhythm and MRCP was proved to be more effective than that utilizing Mu rhythm only in controlling an unstable dynamic system. It is promising to control physical unstable system on line and to operate more complex external devices without muscle movements. Supported by National Natural Science Foundation of China (Project 90820304). References 1. Jonathan R. Wolpaw, Dennis J. McFarland. Control of a Two-Dimensional Movement Signal by a Nonincasive Brain-Computer Interface in Humans. PNAS. 2004. 101(51): p. 17849-17854. 2. G. Pfurtscheller, F.H. Lopes da Silva. Event-related EEG or MEG Synchronization and Desynchronization: Basic Principles. Clin Neurophysiol, 1999(110): p. 1842-1857. 3. Benjamin Blankerz, Ryota Tomioka, Steven Lemm, Motoki Kawanabe, Klaus- Robert Muller. Optimizing Spatial Filters for Robust EEG Single-Trial Analysis. IEEE Sig. Proc. Mag., 2008. 4. Guido Dornhege, Benjamin Blankertz, Matthias Krauledat, Florian Losch, Gabriel Curio, Klaus-Robert Muller. Combined Optimization of Spatial and Temporal Filters for Improving Brain-Computer Interfacing. IEEE Trans. Biomed. Eng., 2006.

P306 *A brain-computer interface (BCI) using two components of event-related potentials: P300 and transient visual evoked potential [no. 695]*

Xianpeng Meng, Ming Zhang, Yu Ge, Zongtan Zhou and Dewen Hu, National University of Defense Technology, China; Xu Chang University, China

Objective: P300 BCIs are developed for multiple objects selection by repeating a stimulus sequence. However, the information transfer rate (ITR) is limited by the repetitions, which ensures acceptable classification accuracy. So it is considerable to find a trade-off between the ITR and the repetitions. In this study, early event-related potential (ERP) components in addition to P300 are employed for feature extraction to get a higher ITR on condition that the accuracy is acceptable. Method: A paradigm was designed to present a 6 7 matrix of 42 items, which were randomly enlarged. Participants were asked to gaze on the target to select it. The enlargement duration and the inter-stimuli interval (ISI) were both set to 80ms, 60ms and 40ms respectively in three groups of experiments. And the enlargement coefficient was set to 2. Each item was composed of a static symbol and a white block, and the latter is considered as background which was randomly enlarged twice in a trial. EEG signals acquired from 5 electrodes (P3, P4, Pz, Cz and Oz) were spatial-filtered and linearly classified. 5 participants performed the online task. The performance of the proposed BCI was evaluated by the accuracy and ITR. Results: Offline analyses showed that the difference between the amplitudes of ERP within 150ms and the amplitudes of baseline increased while the P300 amplitudes decreased when the ISI and the stimulus duration were both reduced from 80ms. The online classification accuracy was 94.4% and the ITR was 137.9 bits/min. As the ISI and the stimulus duration increased, the amplitudes of the early ERP components declined, resulting in the fall of the ITR. Discussion: These results demonstrate that the reduction of the ISI and stimulus duration in single enlargement can improve the performance of ERP- based BCI by combining the P300 with early ERP components which make it possible to reduce the stimulus repetitions. The early ERP components which contribute to increasing the classification accuracy are considered to be transient visual-evoked potentials (TVEP). It has been widely assumed that P300 paradigm does not depend on the user's eye gaze on the character to spell. However, the present study shows that eye gaze can help evoke the TVEPs, which contribute to the online classification. The results can be applied to increase the ITR of ERP-based BCI by reducing the stimulus repetitions. In addition, optimization of parameters such as ISI, stimulus duration and matrix size can give better performance by adjusting the proportion of TVEP and P300 in ERP. Supported by National Natural Science Foundation of China (Project 90820304) and Natural Science Research Projects of He'nan Educational Committee (Project 2009B510014). References: 1. Wolpaw JR, Birbaumer N, McFarland DJ, Pfurtscheller G, Vaughan TM. Brain- computer interfaces for communication and control. Clin Neurophysiol 2002;113:767-791. 2. McFarland DJ, McCane LM, David SV, Wolpaw JR. Spatial filter selection for EEG-based communication. Electroencephalogr Clin Neurophysiol 1997;103:386-394. 3. Brunner P, Joshi S, Briskin S, Wolpaw JR, Bischof H, Schalk G. Does the 'P300' speller depend on eye gaze? J Neural Eng 2010;7:56013. 4. McFarland DJ, Sarnacki WA, Townsend G, Vaughan T, Wolpaw JR. The P300-based brain-computer interface (BCI): Effects of stimulus rate. Clin Neurophysiol 2010.

P307 *Semi-supervised feature extraction with local temporal regularization for EEG Classification [no. 42]*

Wenting Tu and Shiliang Sun, Department of Computer Science and Technology, East China Normal University, China

Extreme energy ratio (EER) is a recently proposed feature extractor to learn spatial filters for electroencephalogram (EEG) signal classification. It is theoretically equivalent and computationally superior to the common spatial patterns (CSP) method which is a widely used technique in brain-computer interfaces (BCIs). However, EER may seriously overfit on small training sets due to the presence of large noise. Moreover, it is a totally supervised method that cannot take advantage of unlabeled data. To overcome these limitations, we propose a regularization constraint utilizing local temporal information of unlabeled trails. It can encourage the temporary smoothness of source signals discovered, and thus alleviate their tendency to overfit. By combining this regularization trick with the EER method, we present a semi-supervised feature extractor termed semi-supervised extreme energy ratio (SEER). After solving two eigenvalue decomposition problems, SEER recovers latent source signals that not only have discriminative energy features but also preserve the local temporal structure of test trails. Compared to the features found by EER, the energy features of these source signals have a stronger generalization ability, as shown by the experimental results. As a nonlinear extension of SEER, we further present the kernel SEER and provide the derivation of its solutions.

P308 *Performance and Features of Multi-Layer Perceptron with Impulse Glial Network [no. 520]*

Chihiro Ikuta, Yoko Uwate and Yoshifumi Nishio, Tokushima University, Japan; Tokushima university, Japan

We have proposed the glial network which was inspired from the feature of the brain. The glial network is composed by glias connecting each other.All glias generate oscillations and these oscillations propagate in the glial network. We confirmed that the glial network improved the learning performance of the Multi- Layer Perceptron (MLP).In this article, we investigate the MLP with the impulse glial network. The glias generate only impulse output, however they make the complex output by correlating with each other.We research the proposed networks' parameter dependency.Moreover, we show that the proposed network possess better learning performance and better generalization capability than the conventional MLPs.

P309 *Autoassociative Pyramidal Neural Network for Face Verification [no. 338]*

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In this paper, the face verification problem is addressed. A neural network with autoassociation memory and receptive fields based architecture is proposed. It is called AAPNet (AutoAssociative Pyramidal Neural Network). The proposed neural network integrates feature extraction and image reconstruction in the same structure. For a given recognition task, at least one instance of the AAPNet must be trained for each known class. Thus, the AAPNet outputs how similar is a given probe image to its class. The AAPNet is applied in a face verification task using thumbnail-sized faces and achieves better results when compared to state-of-the- art models

P310 *Nomen Meum Earl : Teaching Machines to Imitate [no. 90]*

Chris Lanz, SUNY-Potsdam, United States

We propose a unifying machine learning algorithm, in which the same processes, data structures and memory management can be used in simultaneously active realms: conversation, musical composition, and robotics. A central aspect of Earl is setting up learning modules that can absorb and use relationships in the input -- relationships neither analyzed, predicted nor perceived by the programmer. The data, internal objects, and actions available to the program exist as fuzzy points in a quasi-Cartesian, multi-dimensional knowledge space whose geometry is determined by meaning. This space allows us to take advantage of content-addressable memory, table-driven program control, and massively-parallel processing. The Earl Project is an attempt to answer the question: how varied and advanced a set of robot behaviors can we cause to evolve in a single unit? Early experiments addressed simulation tasks concerning virtual automata, games, music, conversation, character recognition, and robotics: for example, the musical application created examples that were indistinguishable from those in its training set. An instance of Earl (hereinafter, "an Earl") is an interactive program that learns to imitate whatever behavior it can perceive. Current experiments involve 1) an "adult" version of the program that starts with a great deal of dictionary-like information, and 2) an "infant" version of the program that starts with as little such knowledge as possible. Training comes from combinations of 1) corpora of recorded behavior or data sets, 2) direct coaching by an expert, or 3) observation of some ongoing process. Earl should be seen as a black box that resides logically between sets of well-defined input and output channels; this is the most interesting location, in our view. Earls have properties of supervised and reinforcement learning systems. In contrast to typical learning algorithms, Earl's approach is model agnostic. The program abstracts knowledge from the realms, and only the lowest level of I/O is realm specific. Because Earl uses no preliminary realm-analysis beyond I/O, Earl is general across realms. The same structural principles that allow generality across realms also allow generality across information levels. Other aspects of the philosophy of Earl include = avoiding preliminary analysis; = requiring that behavior be generated in any serviceable realm, and that behavior "improve"; = writing code (at least, that beyond I/O) that is used in all of the realms and for objects at all levels; = generalizing reinforcement wherever possible; = finding infant Earls able to start with less programmed ability; and = imitating Nature: the Earl Project chooses to imitate the pattern present in the biological evolution of processing. Combinatorial explosion of the task space and the "curse of dimension" are ever-present realities in the world of high-dimensional computation. Earl sidesteps parts of the curse in various ways which we describe. We also respect the "Generalized Eliza Effect" as described in (1). Even so, we believe that the tools Earl uses could be valuable parts of the A.I. programmer's bag of tricks. 1. H.R. Ekbia: Artificial Dreams: The Quest for Non-Biological Intelligence Cambridge University Press New York, NY, USA 2008

P311 *Cooperation between reinforcement and procedural learning in the basal ganglia [no. 187]*

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Describing cognition as cooperating learning mechanisms [1] is a fruitful way to approach its complexity and its dynamics. In a simple model, we explore a possible cooperation between a long lasting procedural memory and a dynamical reinforcement learning, supposed to be respectively located in the parietal cortex and in the basal ganglia. In [2], the authors describe the visual system not only as perceiving features but also as preparing appropriate motor outputs elicited by perceived features. They state that this association is built in the parietal cortex. The selection of action is one of the goals of reinforcement learning [3] and aims at triggering the action that maximizes the expectation of reward. The basal ganglia have been proposed as a substratum for this selection [4]. Few models of the basal ganglia consider that the selection of action could operate on a restricted set of pre-activated actions. We have recently incorporated in the RDDR model (Reinforcement Driven Dimensionality Reduction [5]) realistic physiological and behavioral characteristics, including neuronal formalism of computation, protocol of learning and cerebral information flows. Concerning the latter characteristic, the network is composed of a sensorimotor cortical axis and a basal loop, intersecting in a cortical motor area. The cortical flow is the result of a perceptive analysis in a visual area and an associative matching in a parietal area. This results in the pre-activation of possible actions in the motor area. The basal loop integrates the cortical information in the input structure, the striatum, and compresses it in the output structure (GPi/SNr) where a strong reduction of dimensionality takes place. The selection of action is made at this level, thanks to the modulatory effect of the reward. The resulting effect is sent back to the motor area. The parietal pre-activation of the motor area is not sufficient to trigger an action but is sufficient to activate the striatum and to make selection operate on a restricted set of action. It will consequently speed up the convergence of reinforcement learning. As often required in reinforcement learning, an exploration mechanism is added to compensate the only exploitation of current knowledge and allows sometimes to trigger an action never associated before and thus to discover new rewarding rules. This new perception-action association, if validated by delivery of reward, will also modify the associative learning in the cortex. An interplay between two systems of memory is consequently observed: a procedural memory limits the choices for the selection of action by reinforcement learning and is in turn fed by the results of that selection, made by exploitation and exploration. [1] L.R. Squire, (2004). "Memory systems of the brain: a brief history and current perspective". Neurobiology of Learning and Memory, 82(3), 171-177. [2] M.A. Goodale, and G. K. Humphrey: "The objects of action and perception", Cognition 67, pp. 181-207, 1998. [3] R.S. Sutton, and A.G. Barto, (1998). Reinforcement Learning: An Introduction. The MIT Press Cambridge, MA. [4] P. Redgrave, T.J. Prescott, and K. Gurney. (1999), The basal ganglia: a vertebrate solution to the selection problem?, Neuroscience, 89:1009-1023. [5] I. Bar-Gad, G. Morris, and H. Bergman, (2003). Information processing, dimensionality, reduction and reinforcement in the basal ganglia. Progr. Neurobiol.71:439-477.

P312 *Multiple Declarative Memory Systems: Classification with Machine Learning Techniques [no. 373]*

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Neuropsychological theories postulate multiple memory systems in the brain, but many assume declarative memory to be a unitary system. In this study, we were able to classify two distinct declarative memory acquisition mechanisms from physiological data by the use of machine learning techniques on functional MRI (fMRI) scans of subjects. Subjects acquired identical declarative information, but used different mechanisms in doing so. Machine learning was used to identify the physiological difference underlying these two mechanisms. This was achieved by using the multi-voxel pattern analysis approach for classification of neural information obtained from fMRI signal. SVM (Support Vector Machines) and NN (Neural Networks) based classifiers learned memory patterns from complex, high dimensional and noisy fMRI activations evoked by participants while they acquired novel information in one of two methods: "fast mapping" encoding and explicit encoding. In fast mapping participants were shown a well-known object (e.g. Apple), contrasted with a completely novel object (e.g. Chayote) that was tagged implicitly by the researcher. Thus, the two images were introduced with questions such as "Does the Chayote have leaves?" creating an implicit inductive association between the novel term "chayote" and the presented novel item. In explicit encoding trials both objects and labels were presented explicitly ("Try to remember the Tenrec"). For each type of encoding, the classifiers were able to predict in a non-random manner a success of the subsequent recollection attempt. In addition, the classifiers learned to distinguish the type of encoding used for novel knowledge acquisition - fast mapping or explicit encoding. Traditional univariate analysis of fMRI data is usually based on the information contained in the time course of individual voxels. A multivariate analysis takes advantage of the knowledge contained in activity patterns across space, from multiple voxels. Considering the high dimensionality of data used in current study, feature selection procedure was performed in order to decide which voxels should be included into the multivariate classification analysis. Four different feature selection strategies were explored: 1) ranking voxels according to the registered activity level; 2) ranking voxels according to their discriminative power in univariate analysis; 3) ranking voxels according to the time-series reproducibility with reservoir computing methods; 4) evolutionary strategies. The basic question being addressed in the current study is whether the registered fMRI signal carries information about the particular patterns of knowledge acquisition and retrieval, or pattern discrimination. For the next stage, we will leverage these results to try to address the question as to where the discriminative patterns reside in the brain - pattern mapping. Previous research demonstrated that patients with hippocampal lesions and impaired explicit encoding declarative memory were intact on "fast mapping" declarative memory. Investigating the role of the hippocampus and surrounding medial-temporal cortices for relational memory functioning remains an active area of in the neuroscientific research. Studies based on empirical fMRI data and advanced machine learning techniques are likely to contribute to the discussion. *Authors listed in alphabetical order.

P313 *Categorization by Competitive Learning Networks with Spiking Neurons: Design Rules for Converting Rate into Spiking Neural Networks [no. 133]*

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Many neural network models use rate coding where the activity of a neuron is typically represented by time-averaging its spiking activity. These models have shown many useful functions for perception, cognition, and action. Rate models are, however, less amenable for scalable hardware implementations whose circuits contain billons of neurons and trillions of synapses. To deal with such immense computational complexity, the brain adopts a hybrid strategy where neurons integrate analog input currents but transmit information between neurons with digital spike, or pulse-based, signals. Modern neuromorphic electronics systems have adopted this strategy to enable scaling while minimizing power consumption. Here we present design rules to transform the functional properties of rate models into the spiking domain in a way that is amenable to hardware implementation. In particular, neuronal, synaptic, competitive, and learning dynamics are systematically translated from the rate to spiking domain to design a novel spiking version of the classical rate-coded competitive learning network, which used Instar learning synapses. Computer simulations compare the performance of Instar, spike-timing-dependent-plasticity (STDP), and post- synaptically gated STDP (Instar STDP) learning laws for categorization tasks. Acknowledgements: The authors gratefully acknowledge the support for this work by Defense Advanced Research Projects Agency (DARPA) SyNAPSE contract HRL0011- 09-C-001. Distribution Statement "A" (Approved for Public Release, Distribution Unlimited): The views expressed are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

P314 *Pattern Separation with Polychronous Spiking [no. 476]*

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Patterns of polychronous activity emerge in spiking neural networks [Izhikevich 2006]. Spiking neurons featuring spike time dependent plasticity and axonal delays exhibit rich and adaptive spatiotemporal activity in response to inputs. Once the synaptic weights in a network have reached equilibrium, this polychronous activity can faithfully represent input patterns which can be decoded through another layer of delay-adapted readout neurons (Paugum-Moisy 2008). Network size, inhibition level, and the range of axonal delays are critical to the richness of polychronous spiking activity and its subsequent decoding. For neural memory systems, the ability to discriminate similar inputs depends on building separable representations. We studied this aspect by constructing spiking inputs that varied in 2 orthogonal dimensions: space and time. These inputs were applied to a 3 layer network. The input layer consisted of 10 neurons with feedforward connectivity to a polychronous spiking layer (PSL) of 60 neurons. The PSL had a recurrent fanout of 30%, and full feedforward connectivity to a layer of 2 readout neurons. Readout neurons did not contain recurrent or feedback connections. The network was trained to decode input stimuli into 2 classes, where the earliest spike from a readout neuron indicated the class. The first set of input stimuli tested the ability of the network to discriminate between input neurons firing coincidently, where the classes shared 0 - 8 of the neurons (0-80% overlap). The second set of input stimuli tested the ability of the network to discriminate between the sequential firing of neurons, where the latter half of the sequence was the same between the classes (50% overlap). Polychronous

activity from inputs overlapping in space or time was not sufficiently discriminable (chance level - 50%) in the 3 layer network. We tested whether adding another PSL to that network, inspired by features from the hippocampus, would improve classification. Similar to the initial stages of processing in the perforant pathway, the first layer (entorhinal cortex) provided feedforward input to the second layer (dentate gyrus). As an initial approximation to the sparse representations built in the dentate gyrus, the size of the second PSL was constructed to be 3x that of the first PSL while keeping the total number of PSL neurons between single-PSL and multi-PSL networks constant. The multi-PSL network had the same level of inhibition, fanout connectivity, and range of axonal delays. Interestingly, this hierarchical organization allows the multi-PSL network to separate both spatially and temporally overlapping patterns compared to the single PSL network ($p<0.05$; $n=20$). Our key finding is that density of spiking activity or the temporal extent of polychronous spiking activity are not predictors for discriminable responses to stimuli. Other mechanisms, such as sparse, separated representations built in the second PSL provide more discriminable polychronous spiking activity for neural memory systems. Izhikevich, E.M., "Polychronization: Computation with Spikes," Neural Computation, 2006, 18:2, 245-282 Paugum-Moisy, H., Martinez, R., Bengio, S., "Delay learning and polychronization for reservoir computing," Neurocomputing, 2008, 71, 1143-1158

P315 *Learning sameness is difficult for Simple Recurrent neworks: an exploration using TLU networks [no. 177]*

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Simple recurrent networks (SRNs) are extremely powerful devices, in the sense that they can be designed to have Universal Turing Computational capabilities. Their learning capacities are also impressive, something that makes the SRN one of the most popular models in Cognitive Science. Nevertheless several criticisms have targeted the way learning proceeds on this particular type of neural network. For instance it has been shown that for recurrent networks of moderate size, the VC dimension can go to infinity depending on the task at hand. We explore one task that seems to be particularly difficult to neural networks despite being relatively easy for natural nervous systems. In particular we consider the ability of SRNs to learn and generalize sameness. Sameness is the function that assigns an output of 1 to two successive (almost) identical vectors and 0 otherwise. We train replicates of several SRNs (varying -besides replication- the hidden unit numbers, initial connectivity and initial states) to distinguish whether two successive vectors in a sequence of vectors are the same or not. Provided a sufficient number of training epochs are used, all the networks we trained could learn the training set, but all of our examples failed to generalize sameness to the corresponding test sets. To unravel the difficulties immanent in this type of function, we retort to SRNs consisting of Threshold Logic Units (TLUs). If the input vectors are 1-dimensional Boolean the task is to learn equivalence through time (ETT). We show that the minimal network that can learn ETT 2 hidden units per input unit. We show that this minimal network cannot generalize to an arbitrary sequence of 0s and 1s and that in order for the network to correctly respond, all possible cases have to be trained. We conclude by considering the consequences our findings have for persistent discussions in Connectionism and Cognitive Science with respect to learning and generalization.

P316 *Modeling Knowledge Representation in Neuronal Networks [no. 701]*

Garrett Evans and John Collins, Pennsylvania State University, United States

Semantic networks model knowledge as linkages among entities, concepts, and relations. The brain's neuronal networks are systems of interconnected spiking neurons. We seek to explore how the second might physically embody the first and how the first might be an organizational principle for the second. The relationship we suggest is not as simple as a direct mapping between the nodes and links of the two types of networks . Drawing upon two important experimental neuroscience results--the detection of synchronous activity among neurons corresponding to the features of a bound entity (Singer, 1999) and the existence of neurons which selectively respond to the presence of high-level entities such as famous actresses (Quiroga, 2005), we propose a localist connectionist model of cognition in which the correlation of activity among units plays a critical role. Our model achieves semantic representation of the relational structure within and among entities while utilizing only weighted, directed linkages among a single class of units, which correspond to a variety of cognitive elements including sensations, objects, relations, intentions, productions and actions. Units should be interpreted as corresponding to populations of neurons and possibly sub-neuronal biological structures such as dendritic branches and spines. Read-out of semantic networks is achieved by the dynamics of network activity in the event that this dynamics results in activity among action units corresponding to behavior that is intelligent and informed by the knowledge stored in the network. We propose dynamical principles which could cause this to take place. Critical to our model is the postulation of two dual semantic networks--one for the representation of stored information and another for the representation of information in working memory. We theorize that the network corresponding to stored information is embodied by physical connections between unit correlates and that the working memory network is embodied by correlated spiking with directionality encoded by a consistent bias in the time lag. We propose algorithms for the interplay of the two networks which allow the storage network to update and learn new entities and linkages and the working memory network to recover stored information. References: R. Quian Quiroga et al. (2005). "Invariant visual representation by single neurons in the human brain." Nature 435, 1102-1107. Wolf Singer (1999). "Neuronal Synchrony: A Versatile Code for the Definition of Relations." Neuron:49-65, 111-25.

P317 *How do little hippocampal neurons learn to code big spaces? Coordinated learning of entorhinal grid cells and hippocampal place cells [no. 116]*

Praveen Pilly and Stephen Grossberg, Boston University, United States

Understanding how spatial representations develop in the brain and how they guide adaptive navigation through space are important scientific questions that have immense potential for robust mobile robotic applications. The hippocampus (HC) and medial entorhinal cortex (MEC) are key brain areas for spatial learning and memory. Place cells in HC fire whenever the animal is located in a specific compact region, or "place", in the environment. The question of how these cells learn to maximally represent just one place in a big environment has perplexed neuroscientists for a long time. Grid cells discovered in superficial layers of MEC provide inputs to place cells. Individual grid cells exhibit remarkable regular hexagonal spatial firing patterns that tessellate a whole environment during navigation. They also exhibit a gradient of spatial scales along the dorsoventral axis of the MEC, with neighboring cells having offset spatial phases. A previous self-organizing model has shown how linear velocity path integration inputs can be used to learn periodic regular hexagonal firing fields of grid cells. Other models have shown how a self-organizing map based on hand-crafted grid cell activations, corresponding to multiple spatial scales and phases, can be used to learn place fields whose spatial scale is much larger and thus suitable for representing large environments. The current model unifies and extends these separate contributions by showing how a hierarchy of self-organizing maps can respond to realistic rat trajectories to learn periodic regular hexagonal firing fields of grid cells, and to use these self-organizing grid cell activations to also self-organize two-dimensional hippocampal place fields.

Moreover, these entorhinal and hippocampal self-organizing maps obey the same computational rules, which amplify and code the most frequent co-occurrences of their inputs. The model hereby shows how little hippocampal neurons may learn to code big spaces as an animal navigates in the world. These results go beyond related prior work by showing how developing two-dimensional grid fields can trigger learning of two-dimensional place fields that can represent much larger spatial environments; by identifying a minimal neural circuit and synaptic learning law sufficient to learn both grid and place cell spatial firing properties; and by self-organizing a much larger map that responds to a novel trajectory on each learning trial. In this way, the model simulates data concerning the development of grid cells and place cells when rat pups begin to actively explore their environments. In comparison to the alternative grid cell learning model, our results also show development of more apparent hexagonal grid structures at multiple spatial scales as the model animal explores an open environment along realistic trajectories. As learning progresses, each emerging place cell receives maximal projections from grid cells whose emerging hexagonal grid fields stabilize to be in phase at some spatial region. Learned grid and place field distributions gradually become more sensitive to and selective for more frequently visited spatial regions. Recurrent competition among map cells contributes to learning distributed spatial phases of the grid fields at each spatial scale and uncorrelated spatial fields of the learned place cells.

P318 *Dynamic of Neural Plasticity in a Brain Control Task, Prediction from Modeling. [no. 500]*

Frederic Simard and Sam Musallam, McGill University, Canada

Optimizing information representation in a recorded pool of neurons is important to advance the development of a brain machine interface (BMI) aimed at restoring motor function in patients with motor dysfunction. Previously it has been shown that when subjects learn to operate a BMI or to perform a novel task, the subject's neural activity adapts to change its representation of information to enhance reward outcome. These modifications of the behaviour involve modification in the sensitivity of a neuron toward one or many stimulus. The representation over a plane of the sensitivity over the stimuli space is called a tuning curve. Several mechanisms, by which neurons change their behaviour, have been identified and include: tuning curve shift, also referred to as rotation; narrowing or broadening of the tuning curve; and local modulation of the firing rate. Shift is the mechanism by which a neuron changes its preferred direction, narrowing (broadening) increases (decrease) the neuron's activity specificity for a preferred region of the stimuli space, while local modulation affects the neuron's importance relative to other neuron of the pool that implements a population code. Here we propose a description of the dynamic underlying these changes. We hypothesize that most neurons undergo a phase of exploration, during which the selectivity of the population decrease, followed by a phase of exploitation, during which the selectivity of the population increase and that identified mechanism correspond, in fact, to different stages of the transition. We also suggest that changes identified as tuning curve shift don't require the expression of intermediate preferred stimulation and can in fact be supported by local modulation. We have developed an artificial neural network model of neurons within the parietal reach region (PRR) of the posterior parietal cortex (PPC) and analysed its behaviour when adapting to a task analog to a brain control task. The model succeeded at replicating the mechanisms of plasticity previously reported and demonstrated that the transition between neural tuning occurs according to the stated exploration and exploitation mechanism. These findings are important because understanding how the brain adapts its neural behaviour upon exposure to various conditions could lead to the development of training strategies intended to guide the neural activity to improve information representation within the brain. This would improve the information transfer at the BMI and could help shortening and facilitating the training period required from a subject operating a BMI.

P319 *An Improved Architecture for Probabilistic Neural Networks [no. 202]*

Bala Chandra and Venkata Naresh Babu Kuppili, Professor,Indian Institute of Technology ,Delhi, India; PhD Student, Indian Institute of Technology, Delhi, India

The paper proposes an improved architecture for Probabilistic Neural Networks (IAPNN) with an aggregation function based on f-mean of training patterns. The improved architecture has reduced number of layers and that reduces the computational complexity. Performance of the proposed model was compared with the traditional Probabilistic Neural Networks on various benchmark datasets. It is observed from the performance evaluation on various benchmark datasets that the IAPNN outperforms in terms of classification accuracy. The redeeming feature of IAPNN is that the computational time for classifying datasets using IAPNN is drastically reduced.

P320 *Utilizing Hubel Wiesel Models for Semantic Associations and Topics Extraction from Unstructured Text [no. 196]*

Sandeep Tiwari and Kiruthika Ramanathan, Singapore MIT Alliance, Singapore; Data Storage Institute, Agence for Science, Technology and research, Singapore

There is a desire to extract and make better use of unstructured textual information available on the web. Semantic cognition opens new avenues in the utilization of this information. In this research, we extended the Hubel Wiesel model of hierarchical visual representation to extract semantic information from text. The unstructured text was preprocessed to a suitable input for Hubel Wiesel model. The threshold at each layer for neuronal growth was chosen as a ramp function of the level. Probabilistic approach was used for all post processing steps like prediction, word association, labeling, gist extraction etc. Equivalence with the Topics model was used to arrive at conditional probabilities in our model. We validated our model on three datasets and the model generated reasonable semantic associations. We evaluated the model based on top level clustering, label generation and word association.

P321 *A Novel Neural Network Inspired from Neuroendocrine-Immune System [no. 492]*

Bao Liu, Junhong Wang and Huachao Qu, China University of Petroleum, China

Inspired by the modulation mechanism of Neuroendocrine-Immune System (NEIs), this paper presents a novel structure of artificial neural network named NEI-NN as well as its evolutionary method. The NEI-NN includes two parts, i.e. positive sub-network (PSN) and negative sub-network (NSN). The increased and decreased secretion functions of hormone are designed as the neuron functions of PSN and NSN, respectively. In order to make the novel neural network learn quickly, we redesign the novel neuron, which is different from those of conventional neural networks. Besides the normal input signals, two control signals are also considered in the proposed solution. One control signal is the enable/disable signal, and the other one is the slope control signal. The former can modify the structure of NEI-NN, and the later can regulate the evolutionary speed of NEI-NN. The NEI-NN can obtain the optimized network structure during the evolutionary process of weights. We chooses a second order with delay model to examine the performance of novel neural network. The experiment results show that the optimized structure and learning speed of NEI- NN are better than the conventional neural network

P322 *Chaotic Complex-valued Multidirectional Associative Memory with Variable Scaling Factor --- One-to-Many Association Ability [no. 282]*
Akio Yoshida and Yuko Osana, Tokyo University of Technology, Japan

In this paper, we propose a Chaotic Complex-valued Multidirectional Associative Memory (CCMAM) with variable scale factor which can realize one-to-many associations of M-tuple multi-valued patterns. The proposed model is based on the Multidirectional Associative Memory, and is composed of complex-valued neurons and chaotic complex-valued neurons. In the proposed model, associations of multi-valued patterns are realized by using complex-valued neurons, and one-to-many associations are realized by using chaotic complex-valued neurons. Moreover, in the proposed model, the appropriate parameters of chaotic complex-valued neurons can be determined easily than in the original Chaotic Complex-valued Multidirectional Associative Memory. We carried out a series of computer experiments and confirmed that the proposed model has superior one-to-many association ability than that of the conventional model.

P323 *A Multi-state Model of Cortical Memory [no. 51]*
Jean-Philippe Thivierge, Frederic Dandurand and Denis Cousineau, Indiana University, United States; Universite de Montreal, Canada

A fundamental property of cortical pathways is the ability to retain information beyond time-delimited environmental events. Here, we propose that the neural connectivity between different regions of cortex directly contributes to the preservation of memory traces. A structural network of macaque cortex was obtained from the CoCoMac database. A computational model was then employed to simulate the flow of information between regions of interest (ROIs). This model assigned discrete states to each of 47 ROIs, and allowed exchanges between ROIs as well as random memory decay over time. The rate at which memory decayed over time depended on the network topology; it was found to be markedly less in primate cortex than in a random connectivity that preserved the experimental degree distribution. These results suggest that evolutionary constraints may promote a large-scale cortical anatomy that is optimized for the continuity of memory in time.

P324 *A Hubel Wiesel Model of Early Concept Generalization Based on Local Correlation of Input Features [no. 165]*
Sepideh Sadeghi and Kiruthika Ramanathan, Data Storage Institute, Singapore

Hubel Wiesel models, successful in visual processing algorithms, have only recently been used in conceptual representation. Despite the biological plausibility of a Hubel-Wiesel like architecture for conceptual memory and encouraging preliminary results, there is no implementation of how inputs at each layer of the hierarchy should be integrated for processing by a given module, based on the correlation of the features. In our paper, we propose the input integration framework - a set of operations performed on the inputs to the learning modules of the Hubel Wiesel model of conceptual memory. These operations weight the modules as being general or specific and therefore determine how modules can be correlated when fed to parents in the higher layers of the hierarchy. Parallels from Psychology are drawn to support our proposed framework. Simulation results on benchmark data show that implementing local correlation corresponds to the process of early concept generalization to reveal the broadest coherent distinctions of conceptual patterns. Finally, we applied the improved model iteratively over two sets of data, which resulted in the generation of finer grained categorizations, similar to progressive differentiation. Based on our results, we conclude that the model can be used to explain how humans intuitively fit a hierarchical representation for any kind of data.

P325 *Modeling the Cholinergic Innervation in the Infant Cortico-Hippocampal System and its Contribution to Early Memory Development and Attention [no. 305]*
Alexandre Pitti and Yasuo Kuniyoshi, JST ERATO Asada project/university of Tokyo, Japan

Infants present impressive developmental changes during the first year in almost all domains marked by memory categorization and variability. We propose that one important actor for this developmental shift is the cholinergic innervation of the cortico-hippocampal circuits. Based on neurological observations and developmental studies done in infants, we model how the neuromodulator acetylcholine could be gradually released from the fetal period till the first year in the hippocampal system to support the detection and the sustaining of novel signals. By doing so, the cholinergic system realizes the functional reorganization of the cortico-hippocampal system which can progressively operate then as a working memory for novelty

P326 *Bio-Inspired Balanced Tree Structure Dynamic Network [no. 71]*
Fengchen Liu, Yongsheng Ding and Weixun Gao, College of Information science and technology, Donghua Univeristy, Shanghai, China, China

Bio-networks have the natural advantages of autonomy, scalability, and adaptability which are challenges for computer networks, especially P2P networks. We present a bio-inspired dynamic balanced tree structure network (called bio-block) based dynamic network. Every bio-block is a unique bio-entities' collection with emergent service. This network has two parts, non-Service part (bio-entity is unit node) and in-Service part (bio-block is unit node). Useful bio-entities are dynamically transferring between these two part to keep the balance, and improve resources usage. This network inherits the balanced structure and $ O(nlogN) $ search steps with total N resources and n resources service request. It also eliminates redundancies by taking advantage of strong adaptability of bio-network which are composed of bio-entities. Any node in this balanced tree structured network can join and leave dynamically. Intensive experimental results show that the state of this network is converged when service distribution is stable. Moreover, theoretical results support an efficient search operation.

P327 *Cellular Neural Networks with Switching Two Types of Templates [no. 308]*
Yoshihiro Kato, Yasuhiro Ueda, Yoko Uwate and Yoshifumi Nishio, Tokushima University, Japan; Tokushima university, Japan

In this study, we propose Cellular Neural Networks with switching two types of templates. In the CNN, space varying system is known that it can perform complex processing. Generally, the space varying CNN is not easy to design. However, we can set existing template on each cell of CNN by the proposed method. In binarization, complex portions of input image are not processed well by using the conventional CNN. On the other hand, the complex portion can be processed well by the proposed method. In the edge detection, the indistinct portion is not detected by the conventional CNN with "Edge detection" template of 3 times 3 matrix. It is difficult for CNN to recognize that it is the edge or not. Additionally, the detected edge is too bold and some noises are left with"Edge detection" template of 5 times 5 matrix. By switching these templates in case, we can detect edge in indistinct position. In pattern formation, generally, simple pattern is formed by using one template. On the other hand, some complex patterns are formed by the proposed method. From some simulation results, we confirm that the proposed method is effective for various image processing.

P328 *Adaptive Spiking Neural Networks with Hodgkin-Huxley Neurons and Hebbian Learning [no. 57]*

Lyle Long, The Pennsylvania State University, United States

This paper will describe a numerical approach to simulating adaptive biologically-plausible spiking neural networks, with the primary application being simulating the early stages of mammalian vision. These are time dependent neural networks with a realistic Hodgkin-Huxley (HH) model for the neurons. The HH model uses four nonlinear, coupled ordinary differential equations for each neuron. In addition, the learning used here is biologically plausible as well, being a Hebbian approach based on spike timing dependent plasticity (STDP). To make the approach very general and flexible, neurogenesis and synaptogenesis have been implemented, which allows the code to automatically add or remove neurons (or synapses) as required. Traditional rate-based and spiking neural networks have been shown to be very effective for some tasks, but they have problems with long term learning and "catastrophic forgetting." Typically, once a network is trained to perform some task, it is difficult to adapt it to new applications. The software is written in C++ and is efficient and scalable, it also requires minimal memory per neuron and synapse. A 2.4 GHz MacBook laptop ran 100 million synapses (1 million neurons) for 0.1 simulated seconds (100,000 timesteps) in 5.2 hours (a mouse has roughly 10 million neurons and 81 billion synapses [5]). This case required only 200 MBytes of memory.

P329 *A General Framework for Development of the Cortex-like Visual Object Recognition System: Waves of Spikes, Predictive Coding and Universal Dictionary of Features [no. 322]*

Sergey Tarasenko, JST ERATO Asada Synergistic Intelligence Project, Japan

This study is focused on the development of the cortex-like visual object recognition system. We propose a general framework, which consists of three hierarchical levels (modules). These modules functionally correspond to the V1, V4 and IT areas. Both bottom-up and top-down connections between the hierarchical levels V4 and IT are employed. The higher the degree of matching between the input and the preferred stimulus, the shorter the response time of the neuron. Therefore information about a single stimulus is distributed in time and is transmitted by the waves of spikes. The reciprocal connections and waves of spikes implement predictive coding: an initial hypothesis is generated on the basis of information delivered by the first wave of spikes and is tested with the information carried by the consecutive waves. The development is considered as extraction and accumulation of features in V4 and objects in IT. Once stored a feature can be disposed, if rarely activated. This causes update of feature repository. Consequently, objects in IT are also updated. This illustrates the growing and dynamical change of topological structures of V4, IT and connections between these areas.

P330 *Comparative Study on Dimension Reduction Techniques for Cluster Analysis of Microarray Data [no. 387]*

Daniel Araujo, Adriao Doria Neto, Allan Martins and Jorge Melo, Federal University of Rio Grande do Norte, Brazil

This paper proposes a study on the impact of the use of dimension reduction techniques (DRTs) in the quality of partitions produced by cluster analysis of microarray datasets. We tested seven DRTs applied to four microarray cancer datasets and ran four clustering algorithms using the original and reduced datasets. Overall results showed that using DRTs provides a improvement in performance of all algorithms tested, specially in the hierarchical class. We could see that, despite Principal Component Analysis (PCA) being the most widely used DRT, its was overcome by other nonlinear methods and it did not provide a substantial performance increase in the clustering algorithms. On the other hand, t-distributed Stochastic Embedding (t-SNE) and Laplacian Eigenmaps (LE) achieved good results for all datasets.

P331 *Application of Cover's Theorem to the Evaluation of the Performance of CI Observers [no. 221]*

Frank Samuelson and David Brown, US Food and Drug Administration, United States

For any N points arbitrarily located in a d-dimensional space, Thomas Cover popularized and augmented a theorem that gives an expression for the number of the possible two-class dichotomies of those points that are separable by a hyperplane. Since separation of two-class dichotomies in d dimensions is a common problem addressed by computational intelligence (CI) decision functions or "observers," Cover's theorem provides a benchmark against which CI observer performance can be measured. We demonstrate that the performance of a simple perceptron approaches the ideal performance and how a single layer MLP and an SVM fare in comparison. We show how Cover's theorem can be used to develop a procedure for CI parameter optimization and to serve as a descriptor of CI complexity. Both simulated and micro-array genomic data are used.

P332 *The Time Course of Gamma-band Responses to Subjective Contour in Different Task Paradigms [no. 434]*

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In present study we measured variations of gamma band activity on the human scalp in different task paradigms. The subjective contours were delivered in varied task relevance conditions: (1) a passive perception, in which subjective squares were presented as a stimuli to the subjects; (2) a simple reaction task, in which the same stimulus required as fast as possible button pressing; (3) a choice-reaction task, in which subjective triangle and star were added as the test stimuli and motor reaction (button pressing) was required to target (GO) and ignored to non-target (NOGO) stimulus. The experiment was designed to allow the comparison of four different types of perception of the same subjective contour - illusory square. To quantify changes in gamma band oscillatory activity we used the method based on a time-frequency wavelet decomposition of EEG signal. The time course of gamma response probability for each task condition was calculated. Latency analysis of single-sweep envelopes showed that time course of gamma band responses to subjective square depends on the task paradigm. Gamma band oscillatory activity arises before 150 ms after stimulus onset in all paradigms. However, probability of gamma band responses tends to be higher to target and non-target at frontal, left occipital and parietal electrodes. Only in GO it increases within 200-250 ms time window at occipital electrodes. At Cz and C3 it increases to stimulus in the simple reaction task within 250 -350 ms, while to target in choice condition - after 350 ms of stimulus onset. We suggest that both bottom-up and top-down factors can influence gamma band activity recorded at EEG over parieto-occipital areas as early as 150 ms after stimulus presentation. On the one hand these early gamma responses could reflect feed-forward propagation of information from the primary visual cortex. On the other hand in this time window we observed a simultaneous increase in probability of gamma band responses over frontal and left parieto-occipital areas in choice condition. That was, probably, caused by the match of stimulus related information (bottom-up factor) and working memory context (top-down factor). The late gamma band responses are likely to reflect the correction of processing results and using this information for organization of the following motor reaction.

P333 *Self-segmentation Based on Predictability Measure in Multimodal Autonomous System [no. 211]*

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1. Introduction Knowing self for an autonomous system, named as self-segmentation, is one of the computationally complicated problems, while it is easily performed in nervous system. The current research suggests that predictability is a sufficient condition to recognize self among other sensory inputs. This study specifically targets on segmenting the effector of an autonomous system (e.g. a robot) in its vision based on predictability. Two experiments simulating a simple robotic arm that has vision ability are performed here. 2. Method The hypothesis on self-segmentation of the current research is that the object predictable with a high probability is the system itself. This research focuses on segmenting self in vision based on predictability of motion. To show this, we proceeded two experiments; 1) Preprocessing is done based on the colors of objects. The system, that includes a robotic arm, discriminates its own arm by tracing the most predictable object. 2) Without preprocessing that helps discrimination between objects, we performed segmentation of the robotic arm in vision based on graph-cut algorithm [1] where we give more probability to the local features that are highly predictable in its motion. In the first experiment, the robotic arm has color-marked tip at the end. The system is assumed to know all positions of the arm in vision corresponding to its motor output; then it could estimate expected position of its tip in vision for given motor plan, continuously. We may assume that the object which actually follows the predicted trajectory for a sufficient period of time is the system itself. Then the system can successfully recognize itself from randomly moving color-marked distractors. In the second experiment, the system is assumed to be able to get motion vectors of all arbitrary small sets of pixels in vision. The system estimates which pixels actually follows given predicted motor plans; then the system could infer which pixels are more probable to be the arm. According to the probabilities of each pixel, the graph-cut algorithm [1] segments the system itself compared to non-predictable ones. 3. Result In the first experiment the system successfully discriminated its arm by pursuing highly predictable object among preprocessed objects in its vision, regardless of number and motion of distractors. In the second experiment, the system also successfully segmented its arm regardless of number, shape and motion of distractors. Moreover, for an experiment with two same systems with similar visual fields but moving independently on each other, both systems segmented their own arm without confusion. 4. Conclusion As the results showed, both experiments successfully discriminate or segment the robotic arm in vision based on predictability for given motor plan. We may suggest that predictability is the sufficient condition to recognize the input of itself among mass of sensory inputs. Furthermore, by using the criteria proposed in the current research, we could extend this paradigm to self- segmentation of other types of sensory input without preprocessing for object segmentation. 5. References [1] Y. Boykov and G. Funka-Lea, Graph cuts and efficient n-d image segmentation, International Journal of Computer Vision 70 (2006), pp. 109-131

P334 *Two-way MLP [no. 118]*

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The two-way MLP is a proposal to link patterns. This network performs unsupervised learning and can be used by robots to learn concepts of distance, link audio to video, and other associations. Its structure is that of a conventional MLP but each output is also an input and vice versa. Therefore an application that combines audio and video works as follows: each frame of video is used as input to infer the audio captured at the same time of the video, and this audio is used to attempt to infer that associated video frame. This proposal has the same biological inspiration than the self organizing maps (SOM). The same principle is also seen in children's learning: linking words to meanings, touch to vision, action to the consequence.

P335 *Overriding Racial Stereotypes: A Multilevel Neural Network Implementation of the Iterative Reprocessing Model of Social Evaluation [no. 698]*

Stephen Read and Phillip Ehret, University of Southern California, United States; Loyola Marymount University, United States

We present a multi-level neural network of the iterative reprocessing (IR) model of evaluation and attitudes (Cunningham, Zelazo, Packer, and Van Bavel, 2007). The IR model argues that evaluation of social stimuli (attitudes, stereotypes) is the result of the iterative processing of stimuli in a hierarchy of neural systems: the evaluation of social stimuli develops and changes over processing. This iterative processing system contrasts with the variety of dual-process or dual-attitudes models that dominate social psychology. This model has a single, multilevel, and bi-directional feedback evaluation system that integrates initial perceptual processing and later developing cortical processing. In line with recent research, the model has separate positive and negative evaluations. This overall construction allows the network to process stimuli (e.g. the features and surrounding context of an individual) over repeated iterations, with each iteration activating higher levels of semantic processing. As a result, the network's evaluations of social stimuli evolve over iterations. Separate positive and negative evaluative systems allow for a more accurate analysis of evaluation change over time and for the ability of the model to exhibit ambivalence. We discuss the implications of this model for understanding evaluation in social processes. Further, the success of this model supports the IR model framework and provides new insights into attitude theory. Cunningham, W. A., Zelazo, P., Packer, D. J., and Van Bavel, J. J. (2007). The iterative reprocessing model: A multilevel framework for attitudes and evaluation. Social Cognition, 25(5), 736-760.

P336 *Retrospective Learning of Spatial Invariants During Object Classification by Embodied Autonomous Neural Agents [no. 444]*

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This paper presents a new semi-supervised neural architecture that learns to classify objects at a distance through experience. It utilizes Fuzzy LAPART extended with two temporal integrator subnetworks to create time-stamped perceptual memory codes in an unsupervised manner during object approach, and to retrospectively learn class code inferences at contact. Fuzzy LAPART, Temporal Integrators and the integrated architecture are presented. Next, the agent-based modeling and neural simulator tools used to model this architecture are described. Finally, a study is presented that illustrates the learning performance of this architecture embodied in a simple simulated agent moving in a 2D environment.

P337 *Integrating multi-sensory input in the body model - a RNN approach to connect visual features and motor control [no. 585]*

Malte Schilling, ICSI Berkeley, United States

An internal model of the own body can be assumed to be a central and early representation as such a model is already required in simple behavioural tasks. More and more evidence is showing that such grounded internal models are applied in

higher level tasks. Internal models appear to be recruited in service for cognitive function. Understanding what another person is doing seems to rely on the ability to step into the shoes of the other person and map the observed action onto ones own action system. This rules out dedicated and highly specialized models, but presupposes a flexible internal model which can be applied in different context and fulfilling different functions. Here, we are going to present a recurrent neural network approach of an internal body model. The model can be used in the context of movement control, e.g. in reaching tasks, but can also be employed as a predictor, e.g. for planning ahead. The introduced extension allows to integrate visual features into the kinematic model. Simulation results show how in this way the model can be to utilised in perception.

P338 *Discovery of Pattern Meaning from Delayed Rewards by Reinforcement Learning with a Recurrent Neural Network [no. 311]*
Katsunari Shibata and Hiroki Utsunomiya, Oita University, Japan

In this paper, by the combination of reinforcement learning and a recurrent neural network, the authors try to provide an explanation for the question: why humans can discover the meaning of patterns and acquire appropriate behaviors based on it. Using a system with a real movable camera, it is demonstrated in a simple task that the system discovers pattern meaning from delayed rewards by reinforcement learning with a recurrent neural network. When the system moves its camera to the direction of an arrow presented on a display, it can get a reward. One kind of arrow is chosen randomly among four kinds at each episode, and the input of the network is 1,560 visual signals from the camera. After learning, the system could move its camera to the arrow direction. Some hidden neurons represented the arrow direction not depending on the presented arrow pattern and kept it after the arrow disappeared from the input image, even though no arrow was seen when it was rewarded and no one told the system that the arrow direction is important to get the reward. Generalization to some new arrow patterns and associative memory function also can be seen to some extent.

P339 *A Neural Circuit Model for nCRF's Dynamic Adjustment and its Application on Image Representation [no. 111]*
Hui Wei and Xiao-Mei Wang, Fudan University, China

According to Biology there is a large disinhibitory area outside the classical receptive field (CRF), which is called as non-classical receptive field (nCRF). Combining CRF with nCRF could increase the sparseness, reliability and precision of the neuronal responses. This paper is aimed at the realization of the neural circuit and the dynamic adjustment mechanism of the RF with respect to nCRF. On the basis of anatomical and electrophysiological evidences, we constructed a neural computational model, which can represent natural images faithfully, simply and rapidly. And the representation can significantly improve the subsequent operation efficiency such as segmentation or integration. This study is of particular significance in the development of efficient image processing algorithms based on neurobiological mechanisms. The RF mechanism of ganglion cell (GC) is the result of a long term of evolution and optimization of self-adaptability and high representation efficiency. So its performance evaluation in natural image processing is worthy of further study.

P340 *Attention Selection Model Using Weight Adjusted Topological Properties and Quantification Evaluating Criterion [no. 92]*
Yu Fang, Xiaodong Gu and Yuanyuan Wang, Fudan University, China

Topological properties have important function in human beings visual attention. TPQFT (Topological properties based Phase spectrum of Quaternion Fourier Transform) model is an attention selection model using topological properties expression we have introduced. A new quantification criterion to evaluate every channel's contribution and model's performance is proposed in this paper and used in TPQFT. This paper improves TPQFT model in several aspects and WTPQFT (Weight Adjusted Topological properties based Phase spectrum of Quaternion Fourier Transform) model is introduced. The experimental results show that WTPQFT model reflects the real attention selection more accurately than TPQFT and PQFT (Phase spectrum of Quaternion Fourier Transform) method.

P341 *Natural Language Generation Using Automatically Constructed Lexical Resources [no. 214]*
Naho Ito and Masafumi Hagiwara, Keio University, Japan

One of the practical targets of neural network research is to enable conversation ability with humans. This paper proposes a novel natural language generation method using automatically constructed lexical resources. In the proposed method, two lexical resources are employed: Kyoto University's case frame data and Google N-gram data. Word frequency in case frame can be regarded to be obtained by Hebb's learning rule. The co-occurence frequency of Google N-gram can be considered to be gained by an associative memory. The proposed method uses words as an input. It generates a sentence from case frames, using Google N-gram as to consider co-occurrence frequency between words. We only use lexical resources which are constructed automatically. Therefore the proposed method has high coverage compared to the other methods using manually constructed templates. We carried out experiments to examine the quality of generated sentences and obtained satisfactory results.

P342 *Neural Model for Counting and Subitizing [no. 242]*
Zong-En Yu, Shyh-Kang Jeng and Michael Arbib, National Taiwan University, Taiwan; University of Southern California, United States

Subitizing [1] refers to the ability to "suddenly" judge how many items lie within the visual scene, when the number of items falls in the range of 1 to 4, more or less. For larger collections, recognizing how many objects are present requires an explicit process of adding the sizes of subsets subitized on each fixation. This reduces, in the case where one object is subitized on each fixation, to the familiar process of counting. By contrast, patients with simultanagnosia (agnosia for simultaneous perception of multiple objects) tend to be unable to recall the contents of prior fixations [2] and it turns out they are unable to integrate local elements into a global object or scene. Evidence has linked the deficits of simultanagnosic patients to the impairment of bilateral parietal regions [3]. Such impairment may disrupt the function of the lateral intraparietal sulcus, where neurons discharge in response to the onset of visual stimuli within their receptive field [4]. Subitizing and counting and their impairment may involve the collaboration between the visual-spatial sketchpad memory and the internal number process. We present a model which integrates data from both human and animal studies. Here we propose a neural model that simulates the activation of related functional brain regions involved in counting and subitizing. Input stimuli are binary image arrays embedded in a blank background. We build the neural network model on the following functional modules: 1. The lateral intraparietal sulcus (LIP): its neural activations represent the position of each salient stimulus. 2. The prefrontal cortex (PFC): a recurrent network which sustainably represents the location and identity of the objects which need to be memorized. 3. The frontal eye field (FEF): its neural activation represents the saliency map which guides the saccades. 4. The superior colliculus (SC): generates the saccade vector and provides an efferent copy to update the internal representation of the image stimuli. 5. Early visual processing: a series of visual processes starting from V1 to higher cortical

area V4 which innervates LIP and give rise to the saliency map. We model the case of recognizing the number of objects, comparing the data collected from simulation for normal subjects and simultanagnosic patients with those data collected from corresponding psychophysical experiments [2] . References: [1] E. L. Kaufman, et al., "The discrimination of visual number," American Journal of Psychology, vol. 62, pp. 498-525, 1949. [2] S. Dehaene and L. Cohen, "Dissociable mechanisms of subitizing and counting: Neuropsychological evidence from simultanagnosic patients," Journal of Experimental Psychology-Human Perception and Performance, vol. 20, pp. 958-975, 1994. [3] R. Balint, "Seelenlahmung des Schauens, optische Ataxie, raumliche Storung der Aufmerksamkeit," Monatsschr Psychiatr Neurol, vol. 25, pp. 51-81, 1909. [4] C. L. Colby, et al., "Visual, presaccadic, and cognitive activation of single neurons in monkey lateral intraparietal area," Journal of Neurophysiology, vol. 76, p. 2841, 1996.

P343 *Neuromorphic vision for intelligent transportation system [no. 696]*

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A way of implementing the neuromorphic vision is proposed by mimicking the primary visual cortex, based on the neurophysiological neuron model by Hodgkin-Huxley formalism and the experimentation of Hubel and Wiesel. The elements of neuromorphic implementation are presented with the visual orientation selectivity by synaptic connections and the spiking neuron, based on the electronically programmable MOSFET conductance. The feasibility of neuromorphic vision is investigated by demonstrated vision applications for passengers in the vehicle or intelligent transportation applications. The bio-inspired neuromorphic vision is demonstrated as a feasible way of detecting pedestrian by mimicking the primitive function of visual cortex. The neuromorphic vision showed the robustness and flexibility required in constantly changing condition that is of moving vehicle and in various applications like detecting the airbag activation at the vehicle accident. This system was initially tested on images taken inside a car to prove its robustness. In this case a commercially available car black box with resolution of 640 x 480 was used, without directly facing the camera. The detection of passengers was successfully demonstrated for various driving conditions in day or night, where the positions and postures of passengers were detected for dealing with post-accident cases since in severe crashes it is crucial to dispatch the proper emergency service. For detection of pedestrians using the proposed system, orientation features from the input image is extracted as the previous one. The images for detection of pedestrian were captured from the second deck of a typical bus in city of London. The number of different orientation angles to be extracted will be different depending on the type of the target to be extracted. For example, a vehicle or man-made objects tend to have lot of straight edges whereas a biological object such as pedestrian do not have much of pre-defined features so much more orientation feature extractors are used. In accidents, deployment of the airbag would indicate, in some sense, the severity of the accident. With this in mind, the detection of airbag was attempted with the proposed system. The detection of the airbag did not pose as a simple task as the material property of the airbag was quite shiny so it holds very high intensity value. This presented some difficulty as orientation extraction, which is the functioning of simple cells, is affected by the intensity change. For this case, fuzzy function was added after the neural network is applied in order to improve the detection of airbag. The current system showed robustness as its strength however the current set-up requires setting of the system (such as template image for neural network) for each application. Implementation of the idea electronically is also very much feasible in the industry standard 0.18um CMOS technology. The future work is the training of neural network instead of template for automatic adjustment, i.e. one step nearer to bio-vision. [References] [1] D. H. Hubel and T. Wiesel, "Receptive fields of single neurones in the cat's striate cortex", J. Physiol., 148, 1959, pp 574-591. [2] M. Risenhuber and T. Poggio, "Hierachical models of object recognition in cortex", Nature Neuroscience, 1999, pp 1019-1025. [3] I. S. Han, "Mixed-signal neuron- synapse implementation for large scale neural networks", Journal of Neurocomputing, pp. 1860-1867, 2006.

P344 *Implementation of the COVIS theory of categorization with a Feature Extracting Bidirectionnal Associative Memory with Self-Organizing Maps [no. 686]*

Laurence Morissette, Sylvain Chartier and Denis Cousineau, University of Ottawa, Canada; University of Montreal, Canada

In psychology, the issue of modeling the categorization process has been ongoing for the better part of 50 years. Over the years many models have been proposed. One example is the COVIS dual model of categorization [1]. COVIS posits the existence of two distinct systems of categorization, namely an implicit system responsible for learning non-verbalizable rules and an explicit system responsible for learning verbalizable rules. This connexionnist model is composed of two networks. The first one is a Perceptron-like network that models the implicit system. The second network uses a rule-selection algorithm that models the explicit system. Finally, competition between the two determines which system is used. We wanted to take advantage of the property of SOMs that permits similar items to be represented topologically near one another to create the areas of mental space separated by the decision bound, as proposed by [1]. In this study, it is proposed an implementation of the COVIS model using Feature-Extracting Bidirectional Associative Memories coupled with Self-Organising Maps (FEBAM-SOM). This model was developed to show unsupervised learning of perceptual patterns (through input compression), the concurrent encoding of proximities in a multidimensional space and the reconstruction of perfect outputs from incomplete and noisy patterns [2]. This type of network allows the development of attractors centered on the k highest activated units surrounded by a neighbourhood function, representing the areas of mental space. In the proposed implementation, the implicit system is a FEBAM-SOM that process the whole stimulus, giving the same importance to all features. The explicit system decomposes the stimulus into its features and starts the categorization with a simple rule (1 feature) and elaborates it in function of its performance. The rule-choosing criterion is a ratio of the intra-category resemblance over the inter-category resemblance. Each of the rules and the implicit system all iterated the same fixed amount of times. Finally a comparison of this same ratio present in the final categorization of each system determines which system is to be used. The model was tested on 3 sets of 24 stimuli composed of 5 features, belonging to one of two categories. Each set represent one of three different types of categorization task; namely an information integration task, a conjunctive rule-based task or a disjunctive rule-based task. The stimuli are 5 x 10 x 10 tensors with continuous values ranging from -1 to 1. Results show that effective categorization were obtained for all 3 tasks with the model with the creation of an attractor for each category and the use of each system as predicted by the hypothesis, namely the implicit system for the information integration task and the explicit system for each of the rule-based tasks. [1] Ashby, F. G., Alfonso-Reese, L. A., Turken, U. and Waldron, E. M. (1998). A Neuropsychological Theory of Multiple Systems in Category Learning. Psychological Review, 105(3), 442-481. [2] Chartier, S., Giguere, G. and Langlois, D. (2009). A new bidirectional heteroassociative memory encompassing correlational, competitive and topological properties. Neural Networks, 2009 Special Issue, 568-578.

P345 *Artificial Neural Network Performance Degradation Under Network Damage: Stuck-At Faults [no. 114]*

Robert Nawrocki and Richard Voyles, University of Denver, United States

Biological neural networks are spectacularly more energy efficient than currently available man-made, transistor-based information processing units. Additionally, biological systems do not suffer catastrophic failures when subjected to physical damage, but experience proportional performance degradation. Hardware neural networks promise great advantages in information processing tasks that are inherently parallel or are deployed in an environment where the processing unit might be susceptible to physical damage. This paper, intended for hardware neural network applications, presents analysis of performance degradation of various architectures of artificial neural networks subjected to 'stuck-at-0' and 'stuck-at-1' faults. This study aims to determine if a fixed number of neurons should be kept in a single or multiple hidden layers. Faults are administered to input and hidden layers, and analysis of unoptimized and optimized, feedforward and recurrent networks, trained with uncorrelated and correlated data sets is conducted. A comparison of networks with single, dual, triple, and quadruple hidden layers is quantified. The main finding is that 'stuck-at-0' faults administered to input layer result in least performance degradation in networks with multiple hidden layers. However, for 'stuck-at-0' faults occurring to cells in hidden layers, the architecture that sustains the least damage is that of a single hidden layer. When 'stuck-at-1' errors are applied to either input or hidden layers, the networks that offer the most resilience are those with multiple hidden layers. The study suggests that hardware neural network architecture should be chosen based on the most likely type of damage that the system may be subjected to.

P346 *Reinforcement Learning and Dimensionality Reduction: a model in Computational Neuroscience [no. 184]*

Nishal Shah and Frederic Alexandre, LORIA, France; INRIA, France

Basal Ganglia, a group of sub-cortical neuronal nuclei in the brain, are commonly described as the neuronal substratum to Reinforcement Learning. Since the seminal work by Schultz, a huge amount of work has been done to deepen that analogy, from functional and anatomic points of view. Nevertheless, a noteworthy architectural hint has been hardly explored: the outstanding reduction of dimensionality from the input to the output of the basal ganglia. Bar-Gad et al. have suggested that this transformation could correspond to a Principal Component Analysis but did not explore the full functional consequences of this hypothesis. In this paper, we propose to study this mechanism within a model more realistic from a computational neuroscience point of view. Particularly, we show its feasibility when the loop is closed, in the framework of Action Selection.

P347 *A Novel Facial Feature Extraction Method Based on ICM Network for Affective Recognition [no. 415]*

Fania Mokhayeri and Mohammad Reza Akbarzadeh-T, Islamic Azad University of Mashhad, Iran; Ferdowsi University of Mashhad, Iran

This paper presents a facial expression recognition approach to recognize the affective states. Feature extraction is a vital step in the recognition of facial expressions. In this work, a novel facial feature extraction method based on Intersecting Cortical Model (ICM) is proposed. The ICM network which is a simplified model of Pulse-Coupled Neural Network (PCNN) model has great potential to perform pixel grouping. In proposed method the normalized face image is segmented into two regions including mouth, eyes using fuzzy c-means clustering (FCM). Segmented face images are imported into an ICM network with 300 iteration number and pulse image produced by the ICM network is chosen as the face code, then the support vector machine (SVM) is trained for discrimination of different expressions to distinguish the different affective states. In order to evaluate the performance of the proposed algorithm, the face image dataset is constructed and proposed algorithm is performed on it and seven basic expressions including happiness, sadness, fear, anger, surprise and hate are classified. The experimental results confirm that ICM network has great potential for facial feature extraction and proposed method for human affective recognition is promising. Fast feature extraction is most advantage of this method which can be useful for real world application.

P348 *New Insights into the Cortical Neural Substrate for Goal-Directed Cognitive Control [no. 457]*

Jennie Si, Arizona State University, United States

New Insights into the Cortical Neural Substrate for Goal-Directed Cognitive Control Unveiling the fundamental neural mechanism associated with intelligent, goal-directed behaviors remains elusive. However, this has not prevented scientists from conducting many studies designed to address a piece of the puzzle. Neuroscientists have worked diligently and successfully on the anatomy of the brain circuit, on the function of each and every part of the brain, and recently, on stimulating and emulating the brain. Stable multi-channel single unit recordings have provided unprecedented opportunities for researchers to tackle the ultimate question of relating the fundamental computing units in the brain, neurons, to behaviors. With this in mind, I will introduce some of my lab results contributing to a possible understanding of cognitive control in relation to cortical neural representation. Our results center on a behavioral apparatus used by rats while multichannel chronic recordings were obtained from the rat's motor and premotor areas. The experiment involves a self-paced, freely moving rat learning by trial and error to switch a directional light cue to a center location from one of five locations. The movement of the light can be controlled by the rat with a press of either a left or a right lever. The experiment involves a complete cycle from perception to action. Significant amount of behavioral and neuronal data have been collected while rats learn to perform the described control task from a naive stage. Our extensive data analyses show that 1) motor control may employ a hierarchical mechanism with different roles for premotor and motor cortices, and neural modulation related to motor planning happens earlier and primarily in PM compared with MI and that the acquisition of a new cognitive control strategy could be associated with neural adaptation in the premotor area; 2) in addition to commonly believed neuronal plasticity and roles for motor cortical areas, they may also be useful in storing and representing sequential movement information; 3) as the rat improves his behavioral trial success rate, his neural firing activities become more organized in a way that they result in more clear and accurate predictions of his control decisions and motor control behaviors. Several useful techniques, from neural firing rate to spike timing synchrony, statistical inference and functional models based on a neuronal ensemble were used for obtaining the results herein. Acknowledgements: 1) Research supported in part by NSF under grants ECCS-0702057 and 1002391. 2) Research assistants and lab assistants who have contributed to this project (alphabetical order): R. Austin, B. Cheng, , A. Dbeis, H. Mao, A. Spinrad, C. Yang, and Y. Yuan.

P349 *Do Basal Ganglia amplify willed action by stochastic resonance? A model. [no. 691]*

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Basal ganglia (BG) are attributed a role in facilitating willed action, which is found to be impaired in Parkinson's disease (PD) a pathology of BG. We hypothesize that BG possess the machinery to amplify a will signal, presumably weak, by stochastic resonance. Recently we proposed a model of Parkinsonian reaching, in which the contributions from BG aid the motor cortex in learning to reach (Magdoom et al, 2011). The model is cast in reinforcement learning framework with the following associations: dopamine as temporal difference error, striatum as the critic, and the indirect pathway as the explorer. By a combination of hill-climbing over value function and stochastic search, BG discover muscle activations that would take the arm to the target; these muscle activations are then learnt by the motor cortex. We now show that the above BG model has all the ingredients of stochastic resonance process: the value function as the potential function, the exploratory dynamics of the indirect pathway as the perturbative noise, and the external signal as a willed command. We consider the problem of moving an arm from a rest position to a target position: the two positions correspond to two extrema of the value function. A single "kick" (a half wave of sinusoid, of sufficiently low amplitude) given to the system in resting position, succeeds in taking the system to the target position, only at a critical noise level. For lesser noise levels, the arm fails to reach the target often, a situation that resembles akinetic rigidity of Parkinsonian movements. When the noise is too high, the arm position shows uncontrolled movements, reminescent of Parkinsonian tremor. Analogous to experimentally observed correlated spiking of the indirect pathway of BG in dopamine deficient conditions, when colored noise is used in the model, reaching probability dropped significantly. References: 1. Magdoom KN, Subramanian D, Chakravarthy VS, Ravindran B, Amari S, Meenakshisundaram N. Modeling basal ganglia for understanding Parkinsonian reaching movements, Neural Comput., 2011 23:477-516.

P350 *Predictive neural fields for improved tracking and attentional properties [no. 346]*

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Predictive capabilities are added to the competition mechanism known as the Continuum Neural Field Theory, in order to improve and extend its attentional properties. In order to respect the distributed and bio-inspired nature of the model, the prediction is introduced as an internal stimulation, directly determined by the past field activity. Building on mathematical developments and optimization techniques, performance is ascertained on a 2D tracking application where the system must robustly focus on a target despite rapid movements, noise and distracters. In addition to a consistent gain on previously observed capabilities, the extended model can also track stimuli with full occlusions and static obstacles on the trajectory.

P351 *Visual attention using spiking neural maps [no. 449]*

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Visual attention is a mechanism that biological systems have developed to reduce the large amount of visual information in order to efficiently perform tasks such as learning, recognition, tracking, etc. In this paper, we describe a simple spiking neural network model that is able to detect, focus on and track a stimulus even in the presence of noise or distracters. Instead of using a regular rate-coding neuron model based on the continuum neural field theory (CNFT), we propose to use a time-based code by means of a network composed of leaky integrate-and-fire (LIF) neurons. The proposal is experimentally compared against the usual CNFT-based model.

P352 *Reconstructing the Stochastic Evolution Diagram of Dynamic Complex Systems [no. 254]*

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The behavior and dynamics of complex systems are in focus of many research fields. In many of such areas, complex systems demonstrate strong similarities, with large topological changes over time and natural division into a modular structure being the most common features [2,3,4,5]. The problem of detecting and characterizing the dynamics of modular structure of a complex system is of an outstanding importance [3], and has motivated the present work. The complexity of a system originates not only from the number of its elements, but also from the unavoidable emergence of new properties of the system, which are not just a simple summation of the properties of its elements. The behavior of a system with emergent properties can be fitted with a number of well developed models, which, however, tend to either consider only the modularity of the system, ignoring the evolution of its modules, or describe the dynamics of the system without taking its modularity into account. As a result, the investigator cannot fully understand the structure and dynamics of the system. In this work, we propose a generalized model that addresses these issues. Our model is developed within the Random Set Theory's framework. Based on the Hidden-Set Markov Model, Multiple Hidden-Sets Markov Model, and cluster process concepts defined for random finite sets [1], we introduce the concept of "stochastic evolution diagram" to denote a collection of Markov chains, in which some of the chains are tied together at certain time points. We demonstrate how to reconstruct the stochastic evolution diagrams of complex systems. Our generalized model can be applied in various research fields that deal with complex systems. In particular, in our work the model has been tested and verified on the datasets that represent time series of gene expression profiles. The second main part of this work is about how to use the evolution diagram to reconstruct the underlying dynamic-topology Bayesian networks of a complex system. Analogy to Dynamic Bayesian networks (DBN) which is the extension of BN for temporal Markov processes, we have shown that how to extend BN for temporal complex systems under cluster processes. 1. Mahler, R.P.S. Detecting, tracking, and classifying group targets: a unified approach. Proceedings of SPIE 4380, 217-228 (2001). 2. Lieberman, E., Hauert, C. Nowak, M.A. Evolutionary dynamics on graphs. Nature 433, 312-316 (2005). 3. Newman, M.E.J. Modularity and community structure in networks. Proceedings of the National Academy of Sciences of the United States of America 103, 8577-8582 (2006) 4. Luscombe, N.M. et al. Genomic analysis of regulatory network dynamics reveals large topological changes. Nature 431, 308-312 (2004). 5. Hartwell, L.H., Hopfield, J.J., Leibler, S. Murray, A.W. From molecular to modular cell biology. Nature 402, 47-52 (1999).

P353 *Bayesian Inference by Spiking Neurons: A model of optimal state estimation in the vestibulo-cerebellum. [no. 685]*

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The dynamics of compensatory eye movements during head movements suggest that eye control signals are generated from Bayesian inference about head kinematic state based on vestibular and other sense data. We present experimental data

from bullfrog vestibular primary afferent neurons showing that individual sensory spikes can be interpreted as measurements of head state, because the posterior density of head states at spike times of a given neuron has lower entropy than the density at arbitrary times. We present a model in which the posterior distribution of head state is represented by the spatial density of spikes in brainstem vestibular neurons. The dynamic prior density for each sensory spike can be computed from the posterior density based on previous spikes, using natural neuron-like operations on spikes. Similarly, the posterior at spike arrival times can be computed by a simple coincidence rule. Head movement dynamics together with Bayes rule determine the architecture of the required neural network. Given the value of fast, accurate dynamical state predictions you might expect that if it is possible for brains to evolve a mechanism that could instantly compute Bayesian posterior distributions from sensory spikes, without waiting to compute average firing rates or examine temporal patterns of spikes, then they would have. The neural particle filter model suggests that it is possible. This is a testable model of Bayesian neural computation using spikes as operands.

P354 *A Manifold Representation of Aging in Human Brain using Resting-State Functional Connectivity MRI [no. 682]*

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Background: There is compelling evidence from neuroimaging studies that resting-state functional connectivity changes with age [1, 2]. However, the dynamic process of this alteration remains unclear. In this study, we hypothesized that the aging process in human brain could be represented by a low-dimensional manifold embedded in the functional connectivity feature space, and further evaluated whether there are predictable common pattern of aging among individuals. Methods: We proposed a framework of age prediction via nonlinear regression on the aging manifold of the resting-state functional network. 51 subjects (aged 19-79 years, 22 males) were included in the experiments, each of which had two resting-state scans. After data preprocessing [1], brain images were divided into 116 regions according to the anatomically labeled template. Regional mean time series were then correlated using Pearson's correlation. This resulted in a resting-state functional network with 6670 functional connections, which were used as the features for age prediction. In the training phase, we firstly used feature filtering based on a correlation coefficient method to initially select features with high prediction power. Then, the Laplacian Eigenmap algorithm [3] was used to find a sufficient low-dimensional manifold that embodies the aging process in the brain. Finally, we modeled the manifold representation with a nonlinear support vector regression procedure. In the test phase, the low- dimensional embedding features of new test samples were extracted and fitted with the learned regression model to make prediction of their brain ages. The performance of our method was tested using a leave-one-out cross-validation strategy. Results: Manifold learning result indicated that the aging process underlying human brain can be effectively represented by a significant manifold with a "V" curve. Subjects distributed on the curve of manifold in the chronological way. The mean prediction error of support vector regression based on the aging manifold was 9.06, with a standard deviation of 8.07. These experiment results validated the effectiveness of sophisticated machine learning techniques in revealing the common aging process among different individuals. Statistical analysis showed that about 80% of the features with greatest prediction power exhibited decreasing connectivity, suggesting a chronological deterioration of the resting-state functional network during brain aging. Interestingly, half of the decreasing functional connections are longer than 80mm, while no increasing connection exceeds that length. We conjecture that aging in human brain would result in declines of functional integration between distant brain areas by the weakening of long-range functional connections. Conclusion: In conclusion, the present study showed that aging process in the resting-state functional network can be effectively represented by a low- dimensional manifold. The acquired functional connectivity knowledge may also provide insight into the physiological mechanisms of aging in human brain. [1] Dosenbach NUF, et al. (2010) Science 329:1358-1361. [2] Zuo XN, et al. (2010) J Neurosci 30:15034-15043. [3] Belkin M, Niyogi P (2003) Neural Computation 15:1373-1396.

P355 *Biological Validation of the Compartmental Model of Nitric Oxide Diffusion [no. 689]*

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Cellular communication is a fundamental mechanism in the brain, it allows going from nerve cells to cognition. At present, there exists a different type of process for signaling between cells, the Volume Transmission (VT). VT is based on neuroactive substances and diffusive-type signals, like nitric oxide (NO), in the extracellular space (ECS) [1]. NO is a signalling molecule that is synthesized in a range of tissues by the NO synthases with capabilities to regulate its own production. It is liposoluble, membrane permeable and with a high diffusibility in both aqueous and lipid environments. NO can be involved in several recruitment, control and plasticity processes in both Central and Peripheral Nervous System (CNS/PNS), like LTP process, learning, memory formation [2], the sleep-wake cycle control, control for cardiovascular system, among others. In the absence of determinant experimental data for understanding how NO functions as a neural signalling molecule, we have developed a computational NO diffusion model based on Compartmental Systems and transportation phenomena [3]. Here we address one of the three stages of a modelling process, the model validation, focusing in a biological validation. We demonstrate the model kindness and that our approach can be used successfully for the analysis of NO behaviour and effects on biological and artificial environment where it is spreading. A computational evaluation of the model by means of a reproduction of the biological experiment about diffusion of NO in the Aorta [4] is presented. We perform an implementation of our model with two compartments, using real measurements of NO synthesis and diffusion processes in the endothelial cell and in the smooth muscle cells in the aorta with a distance of 100 +- 2 microns between them. A fitting procedure to the observed NO dynamics was executed, through this process the model allows to provide hypothesis related to the different processes in the NO dynamics (synthesis, diffusion and self-regulation/recombination). Our findings provide evidence that the compartmental model of NO diffusion has allowed designing a theoretical/computational framework [5] for studying and determining the dynamics of synthesis, diffusion and self-regulation of NO in the brain and in artificial environments. We will also show that this model is highly powerful to study these phenomena due to it allows to incorporate all the biological features and existing constraints in the NO release and diffusion and in the environment where NO diffusion processes take place. This approach can essentially consider the realism of the ECS, like anisotropy and no-homogeneity. Finally, from the obtained results, we can conclude the high capability of the compartmental model of NO diffusion for emulating different biological behaviour of NO dynamics. The proposed model has been validated in the biological environment, concretely in the endothelium. It also showed that our model represents an important tool for designing and interpreting biological experiments on underlying processes of the NO dynamics, the NO behavior and its effect on both, brain structure and function and artificial neural systems. References [1]Sykova E., The Neuroscientist 3, pp28-41, 1997 [2]Huizhong W. et al., PNAS 98, N. 20, pp11009-11015, 2001 [3]Suarez

Araujo C.P. et al., IJCAS 18, pp172-186, 2006 [4]Malinski T. et al., BBRC 193, N. 3, pp:1076-1082, 1993 [5]Suarez Araujo C.P., CAS AIP 517, pp:296-307, 2000

P356 *Artificial neural networks to investigate the significance of PAPP-A and b-hCG for the prediction of chromosomal abnormalities [no. 409]*

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A systematic approach has been done, to investigate different neural network structures for the appraisal of the significance of the free b-human chorionic gonadotrophin (b-hCG) and the pregnancy associated plasma protein-A (PAPP-A) as important parameters for the prediction of the existence of chromosomal abnormalities in fetuses. The database that has been used was highly unbalanced. It was composed of 35,687 cases of pregnant women. In the vast majority of cases (35,058) there had not been any chromosomal abnormalities, while in the remaining 629 (1.76%) some kind of chromosomal defect had been confirmed. 8,181 cases were kept as a totally unknown database that was used only for the verification of the predictability of each network, and for evaluating the importance of PAPP-A and b-hCG as significant predicting factors. In this unknown data set, there were 76 cases of chromosomal defects. The system was trained by using 8 input parameters that were considered to be the most influential at characterizing the risk of occurrence of these types of chromosomal anomalies. Then, the PAPP-A and the b-hCG were removed from the in-puts in order to ascertain their contributory effects. The best results were obtained when using a multilayer neural structure having an input, an output and two hidden layers. It was found that both of PAPP-A and b-hCG are needed in order to achieve high correct classifications and high sensitivity of 88.2% in the totally unknown verification data set. When both the b-hCG and PAPP-A were excluded from the training, the diagnostic yield dropped down to 65%.

P357 *Neural Networks Based Minimal or Reduced Model Representation for Control of Nonlinear MIMO Systems [no. 361]*

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This paper raises the issue of finding reduced/minimal state-space form for MIMO systems based on neural networks. Two cases are studied: when system is given as a "black-box" model and when order of the controlled system is known a priori. Modified structure of the standard NN-ANARX (Additive Nonlinear AutoRegressive with eXogenous inputs based on Neural Networks) allows to eliminate all reduced interconnections between neurons and thus to get the minimal state-space representation in the second case. If we deal with unknown dynamical system then we reduce model and find optimal structure of the neural network automatically using genetic algorithm. After the model was found parameters of the NN can be used to design a state controller for the control of nonlinear MIMO systems using the linearization feedback.

P358 *Explorations on System Identification via Higher-Level Application of Adaptive-Critic Approximate Dynamic Programming [no. 152]*

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In previous work it was shown that Adaptive-Critic-type Approximate Dynamic Programming could be applied in a "higher-level" way to create autonomous agents capable of using experience to discern context and select optimal, context-dependent control policies. Early experiments with this approach were based on full a priori knowledge of the system being monitored. The experiments reported in this paper, using small neural networks representing families of mappings, were designed to explore what happens when knowledge of the sys-tem is less precise. Results of these experiments show that agents trained with this approach perform well when subject to even large amounts of noise or when employing (slightly) imperfect models. The results also suggest that aspects of this method of context discernment are consistent with our intuition about human learning. The insights gained from these explorations can be used to guide further efforts for developing this approach into a general methodology for solving arbitrary identification and control problems.

P359 *A system for segmentation and follow-up of brain tumors in MRI scans [no. 670]*

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Background: To determine the proper treatment for patients with brain tumors, it is crucial to accurately quantify the gross tumor volume. For many types of tumors it is also important to quantify the volume of the tumor components, e.g. cyst, enhancing, edema, necrotic etc. [1,2]. In fact, the most important information for treatment assessment is the volume change of the tumor and its components over time, rather than the absolute value of the tumor volume at a specific time point. When performed manually, tumor volume quantification is time consuming and may suffer from inconsistencies of the delineated tumor boundaries over time [3]. This phenomenon, known as the inter/intra observer variability may mislead the physician's evaluation about the progression of the tumor growth, which can result in an improper treatment decision. In addition, there are cases where parts of the tumor boundaries appear fuzzy in the scans due to the surrounding tissues with overlapping signal intensity values, the uneven tumor ingrowth into nearby structures, and the imaging partial volume effect. This phenomenon may mislead the physician's evaluation about the progression of the tumor growth, which might result with an improper treatment decision. Method: We developed a new algorithm for the study of longitudinal brain tumors. The method can be implemented for a variety of brain tumors. It uses several consecutive multi-spectral MRI datasets of the same patient and is based on an initial manual tumor delineation of the first scan of the patient. The method starts with overlaying the delineated tumor boundaries on a follow-up scan and defining the boundaries that remain the same in the follow up scan to guarantee repeatable delineation of these boundaries. Then, the method classifies the follow-up image, in the known borders of the tumors while using as prior knowledge the provided tumor components delineation of the base image. The resulting classification serves as the basis to a statistical model which is then used to redefine the boundaries that were changed in the follow-up image. We also developed an application that manages the MR scans of the patients, and

enables proper examination of the tumor development and the natural history of the patient. Results: We condected a retrospective quantitative evaluation of our method with clinical multi-spectral MRI datasets of four Neurofibromatosis (NF) patients. Subjects were pediatric patients 3-7 years old with Optic Pathway Gliomas (OPGs). Experimental results on 16 datasets yield a mean surface distance error of 0.22mm and a mean volume overlap difference of 12.34% as compared to manual segmentation. Our experimental results indicate that our method accurately segments and classifies OPG in the the follow-up scheme. The volume overlap error is significantly lower than the one provided by methods of similar applications, thanks to the strong prior of the tumor delineation of the baseline image. [1]J. Liu et. al., "A system for brain tumor volume estimation via MR imaging and fuzzy connectedness," Comput. Med. Imag. Grap. 29(1):21-34, 2005. [2]J.J. Corso et. al., "Efficient multilevel brain tumor segmentation with integrated bayesian model classification," IEEE T. Med. Imaging 27(5):629-640, 2008. [3]C. Fiorino et al., "Intra and interobserver variability in contouring prostate and seminal vesicles: implications for conformal treatment planning," Radiother. Oncol. 47:285-292,1998.

P360 *Abnormal brain oscillations in Alzheimer's disease: a study using a neural mass computational model [no. 721]*

Basabdatta Sen Bhattacharya, Damien Coyle, Liam Maguire and Martin McGinnity, University of Ulster, United Kingdom

Alzheimer's disease (AD) [1], a progressive neurodegenerative disorder of the brain, is marked by a decrease in the overall frequency of brain oscillatory activity, which is correlated with electroencephalography (EEG) [2]. Specifically, a decrease in the peak frequency within the alpha band (8-13 Hz) is now known to be a hallmark in the EEG of AD patients. Based on a previous study using a seminal thalamocortical model which simulates brain alpha rhythms [3], we have proposed a thalamo-cortico-thalamic model [4] with synaptic connectivity based on experimental data. The thalamic module in the model has three cell populations representing the excitatory Thalamo-cortical relay cells (TCR), the inhibitory Interneurons (IN) and the inhibitory cells of the Thalamic Reticular Nucleus (TRN). The cortical module is based on more recent research by Ursino et al (2010) and consists of four cell populations representing the Pyramidal cells (PY), the excitatory Interneurons (eIN) and the fast (fIN) and slow (sIN) inhibitory Interneurons. We have studied the model behaviour when the synaptic connectivity parameters in the model are at their 'basal' values (initially assigned based on physiological data), simulating conditions of a functional brain, and when the parameters are varied about their basal values, simulating conditions of the dysfunctional brain. Analysis of the model output shows that conditions of altered brain oscillations in AD may be simulated by varying the synaptic connectivities of the inhibitory (GABAergic) pathway. This is consistent with pathological studies implicating anomalous afferents to the inhibitory thalamic cell population, as well as with autopsy studies showing affected GABAergic cortical pathways in AD [5]. Furthermore, overall synaptic atrophy in the model, a pathological hallmark in the AD affected brain, has a significant effect on the model oscillatory behaviour. [1] K. Maurer, "Historical background of Alzheimer's research done 100 years ago", J Neural Transm (2006),113:1597-1601. [2] H. Soininen et al, "Slowing of electroencephalogram and choline acetyltransferase activity in post mortem frontal cortex in definite Alzheimer's disease", Neuroscience (1992),49:529-535. [3] B. Sen Bhattacharya, D. Coyle, L. Maguire, "Thalamocortical circuitry and alpha rhythm slowing: an empirical study based on a classic computational model", Proceedings of the International Joint Conference on Neural Networks (IJCNN at WCCI 2010), pp. 3912-3918, Barcelona, Spain, 18-23 July 2010. [4] B. Sen Bhattacharya, D. Coyle, L. Maguire, "A thalamo-cortico-thalamic neural mass model to study alpha rhythms in Alzheimer's Disease", (in press) Neural Networks Sp. Issue on Brain Disorders, 2011. doi:10.1016/j.neunet.2011.02.009 [5] P. T. Francis et al, "The cholinergic hypothesis of Alzheimer's disease: a review of progress", J Neurol Neurosurg Psychiatry 1999, 66:137-147.

P361 *Hyperlearning: A Hypothesis of Dopamine and Storytelling in Schizophrenia [no. 710]*

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No current laboratory test can reliably identify patients with schizophrenia. Instead, key symptoms are observed via language, including derailment, where patients cannot follow a coherent storyline, and delusions, where false beliefs are repeated as fact. Brain processes underlying these and other symptoms remain unclear, and characterizing them would greatly enhance our understanding of schizophrenia. In this situation, computational models can be valuable tools to formulate testable hypotheses and to complement clinical research. This research aims to capture the link between biology and schizophrenic symptoms using DISCERN, a connectionist model of human story processing. Competing illness mechanisms proposed to underlie schizophrenia are simulated in DISCERN, and are evaluated at the level of narrative language, the same level used to diagnose patients. The result is the first simulation of a speaker with schizophrenia. Of all illness models, hyperlearning, a simulation of dopamine-driven, overly intense memory consolidation, produced the best fit to patient data, as well as compelling models of delusions and derailments. It also predicts how clinical subtypes of schizophrenia could emerge from a common brain mechanism. If validated experimentally, the hyperlearning hypothesis could advance the current understanding of schizophrenia, and provide a platform for simulating the effects of future treatments.

P362 *Modeling Normal/Epileptic Brain Dynamics with Potential Application in Titration Therapy [no. 650]*

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The KIV (K-4) model is based on biological attributes found in the limbic system of a salamander [4]. Higher forms of organisms including human have a limbic system which incorporates the sensory cortex, hippocampus and entorhinal cortex/amygdala of the brain. The KIV model has traditionally been used for classification and time series prediction research. We propose the use of the KIV model as a metaphor of the limbic system of the human brain. The brain states of normal /pathological (seizure)/restoration are modeled to further understand the pathological states of the brain and propose a titration therapy through this model.

P363 *Synchronization of a class of partially unknown chaotic systems with integral observer basing orthogonal neural networks [no. 654]*

Yuye Wang, Shen Wei, Jingwen Wang and Guangrui Xu, Harbin Engineering University, China

Chaos is a quasi-stochastic phenomenon appearing in deterministic nonlinear dynamic system. Since Pecora and Carroll have proposed the theory of chaos synchronization, the theory has become a research hotspot for its widely use in secure communication, signal processing and other fields. To discuss a class of chaotic systems with unknown parameters when both of the states and the output of the systems are perturbed, an adaptive integral observer scheme for chaos synchronization is proposed. The designed method achieves chaos synchronization using integral observer theory and the nonlinear approximation ability of the orthogonal neural networks based on the linear portion of chaotic system can be copied. Using the scheme the disturbances are eliminated and unknown parameters

are identified. Based on Lyapunov stability theory, the sufficient criterion of gain matrix which can synchronize the drive system and the response system globally is given. Then, the criterions are transformed into a Linear Matrix Inequality (LMI) using Schur complements. Finally, the numerical simulations are done with the LMI toolbox in Matlab. The Genesio system is simulated to verify the effectiveness of the proposed scheme.

P364 *Estimation of Input Information Applied to Neurons by Local Adaptive Kernel Density Function [no. 706]*

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Neurons code input information and generate spike trains. The generated spike trains reflect the input information. To understand how the information is coded by the neurons, it is an important issue to reconstruct input information from spike trains. From this point of view, methods for reconstructing hidden input information applied to neurons have been proposed (see e.g. T. Sauer, PRL, 72(24), 3811- 3814, 1994; H. Suzuki et al., Biol. Cybern., 82, 305-311, 2000). To address this issue, we have already proposed a method by using a kernel density function (K. Kuroda et al., IEICE Trans. Fund. (Japanese edition), J94-A(2), 64-72, 2011). Although our method can reconstruct hidden input information efficiently, the method fails when the input time-series has a broad frequency range because the bandwidth of the kernel density function is fixed. In this study, to resolve this issue, we applied a local adaptive kernel bandwidth method and investigated performance of the proposed method. In our method, we transformed an observed spike train into a continuous time-series by the kernel density function. We convolve a spike train with a kernel function in this method. It is important to select bandwidth because the transformed time-series are changed by the bandwidth for this method. Thus, we optimized the bandwidth using a local adaptive kernel method which is proposed by Shimazaki et al. (H. Shimazaki et al., J. Comput. Neurosci., 29(1-2), 171-182, 2010). To evaluate our method, we used a leaky integrate-and-fire (LIF) model to which sinusoidal currents are applied. In the simulation, we used the following two sinusoidal currents: the frequency of the sinusoidal currents is constant and the frequency of the sinusoidal currents is modulated by the second variable of the Lorenz equations (E. N. Lorenz, J. Atmos. Sci. 20, 130-141, 1963). The second case corresponds to the situation that the input currents have a broad frequency range. We evaluated the correlation coefficients between the input time-series and the transformed time-series from spike trains. For the case that the frequency of the sinusoidal function is constant, the correlation coefficients of both methods are 0.99. However, for the case that the frequency is modulated by the second variable of the Lorenz equations, the correlation coefficient between the input time-series and the transformed time-series with the fixed bandwidth is low (0.6). The reason is that the frequency range becomes broad for this case, then the fixed kernel bandwidth method cannot adapt. On the other hand, the correlation coefficient between the input time-series and the transformed time-series with the local adaptive kernel bandwidth becomes 0.94. These results clearly show that the proposed method can adapt its bandwidth to local firing frequencies in observed spike trains, then it can adaptively reconstruct hidden input information. As a result, the transformed time-series with the local adaptive kernel bandwidth is more similar to the input time-series than that with the fixed kernel bandwidth when the input time-series has a broad frequency range.

P365 *An Analog Circuit Silicon Neuron Developed Using Dynamical Systems Theory Approach [no. 709]*

Eric Basham, Aravind Sheshadri and Parent David, San Jose State University, United States

We present a neuromorphic discrete component analog circuit implementing a silicon (hardware) neuron based on dynamical systems theory. The approach detailed in this work bypasses the Hodgkin Huxley formalism, leading to circuits that have a reduced set of tuning parameters, yet still display a rich set of neural-like behaviors including variable frequency spiking, excitability and bistability through bifurcation. To enable the dynamic systems approach, we developed a circuit design strategy, which is then used to design one dimensional discrete neuromorphic circuit. The described circuit topology allows real time alteration of internal gain, which in turn alters the dynamics of the system. Real time access to parameter values and timescales of similar order to biological preparations are often lacking in integrated circuit implementations. Discrete circuit implementations also have the advantage of being widely available to the research community because they do not require access to expensive prototype integrated circuits or specialized testing equipment. These characteristics make this circuit ideal for interfacing to biological neural preparations and motor control systems. For example, the circuit may be employed as a whole cell instance for dynamic clamping hybrid biological system experiments. To characterize the circuitry behavior, we present results from a biologically relevant parameter extraction routine analogous to electrophysiological measurement of biological neural preparations.

P366 *Ion-Channel and Synaptic Noise in a Cortical Neuromorphic Circuit [no. 293]*

Mohammad Mahvash and Alice C Parker, University of Southern California, United States

Noise or variability is a prominent feature of neural behavior. At the neuronal level, variability plays a central role in the behavior of the neurons in the nervous system. One source of variability is noise. In this paper, the design of a neuromorphic cortical neuron with injected noise is presented. Two main sources of intrinsic noise, ion-channel noise and synaptic release noise, are studied and then they are modeled at the circuit level using carbon nanotube circuit elements. The variability injected can actually be random noise or a mathematically-defined deterministic waveform. In particular, Gaussian noise or a chaotic signal is applied to a synapse circuit to vary the neurotransmitter release in an unpredictable manner, modeling synaptic release noise. Variation in neurotransmitter concentration in the synaptic cleft causes a change in the peak post-synaptic potential. In order to model ion-channel noise, two variable signals are applied to the axon hillock circuit: one could force the neuron to fire if the noise amplitude were sufficient and the other one could prevent the neuron from firing. The signals act in a complementary fashion. Both signals are independent of the post-synaptic potential and are either Gaussian noise or chaotic analog signals. When there is no post-synaptic potential applied to the axon hillock (the cell membrane is at resting potential), an injected signal forcing the neuron to fire in fact models the spontaneous firing of the neuron. The paper also presents a chaotic signal generator using carbon nanotube transistors. The circuit uses a chaotic piecewise linear one-dimensional map and it's implemented by switched-current circuits, that can operate at high frequencies. The design was simulated using carbon nanotube SPICE models.

P367 *Why NeuroElectroDynamics is Better than Spike timing Models? [no. 679]*

Dorian Aur and Mandar Jog, Stanford University, United States; University of Western Ontario, Canada

It is generally believed that spike timing features (firing rate, ISI) are the main characteristics that well describe the neural code. Contrary to this common belief, changes in charge density within spikes and resulting spike directivity patterns [1] provide better results in discriminating categories of visual object recognition [2] or behavioral changes during a procedural T-maze task [3]. Many analyzes of electrophysiological recordings fail to reveal these subtle hidden changes in neuronal activity since the main focus is processing information embedded in the time patterns [4]. Many spike timing models restrict their formalism to optimal signal reconstruction of sensory stimuli from temporal data. Such description builds an increased dichotomy between short time memory models and long term information storage. In addition these models maintain a strong gap between temporal description and molecular computation formalism. Information processing in the brain requires a combination of different forms of computation. Neuroelectrodynamics (NED) is a new theoretical model that describes computation as an ongoing process shaped by the dynamics and interactions of electric charges under direct influence of neurotransmitter release. The new model of interactive computation is fundamentally a non-Turing phenomenon that highlights the ability of the neuron to process, store and communicate information using electrical interactions. Complex molecular regulatory mechanisms from gene selection/ expression, DNA computations to membrane properties are involved in computation and determine the occurrence of electrical patterns. Specific electrostatic changes are actively involved in information processing and memory storage, can drive conformational dynamics, alter genes and affect protein loop regulation. Since memories are stored in the molecular structures within densities of electric charges this process of interaction is essential to access information stored, to write additional information and to intrinsically build semantics. This natural model of computing by interaction allows stronger computability power than the classical models [5, 6]. In order to implement the model of interaction on a digital computer we used difference equations and particle swarm algorithms for optimization. NED can be explained based on universal laws of physics and provides interesting testable predictions which are commonly unavailable for spike timing theories. The most recent success of applying these techniques is a better understanding of visual object recognition in medial temporal lobe and the existence of physical mechanisms involved in seizure generation. 1. Aur, D., Connolly, C.I., and Jog, M.S, (2005), Computing spike directivity with tetrodes, Journal of Neuroscience Methods, Volume 149, Issue 1, 30, pp. 57-63; 2 Aur D, Where is the 'Jennifer Aniston neuron'? Nature Precedings, 3.Aur D, and Jog MS, (2007) Reading the Neural Code: What do Spikes Mean for Behavior? Nature Precedings 4. Aur D., Jog M. Neuroelectrodynamics: Understanding the brain language. IOS Press 2010. 5. Goldin D., Wegner, P., (2008) The interactive nature of computing: Refuting the strong Church-Turing Thesis , Minds and Machines 18 (1), pp. 17-38. 6.Siegelmann H. T, (1996) The simple dynamics of super Turing theories Theoretical Computer Science 168 461-472 7. Aur, D. (2010)The Physical Mechanism in Epilepsy - Understanding the Transition to Seizure, Nature Precedings

P368 *Chaotic Simulated Annealing in Feed-Forward Neural Networks with Varying Learning Rates [no. 213]*

Lipo Wang, Nanyang Technological University, Singapore

Chaotic simulated annealing (CSA) has been extensively discussed in associative recurrent neural networks (ARNN). It is well-known that the traditional ARNNs proposed by Amari and Hopfield have energy functions and hence ARNNs exhibit fixed-point dynamics. Nozawa showed that negative self-feedback to each neuron in the Euler approximation of the continuous-time ARNN (EACT ARNN) can cause chaos which is beneficial in searching for optima in optimization problems. Chen and Aihara named the processing of reducing the negative feedback as a bifurcation parameter from a large value "chaotic simulated annealing" and developed theoretical foundation for CSA. We pointed out earlier that the Euler time-step in the EACT ARNN is also a bifurcation parameter that may be used for CSA. We now draw an analogy between the error function in a feed-forward neural network (FFNN) and the energy function in ARNN: the training process of a FFNN is to search for optima in the error function and the learning rate in back- propagation training may be considered a bifurcation parameter. Chaos can occur when the learning rate is sufficiently large, whereas gradient descent occurs when the learning rate is small. CSA in FFNN is achieved by starting with a large learning rate and gradually reducing it during training. Numerical simulations show that chaos is beneficial in searching for optima during FFNN training as in ARNN and training results can be better comparable with the Levenberg-Marquardt algorithm. CSA in FFNNs was previously discussed by Shaw and Kinsner; however, their approach was to perturb weights in FFNN using chaotic noise, which is quite different from the main ideas of CSA in ARNN discussed here.

P369 *Functional Roles of Coherence Resonance in an Inhibitory Network Model of Stellatte Cells [no. 608]*

Kazuki Nakada, Kyushu University, Japan

In this work, we discuss possible functional roles of probabilistic firing in a network model of the Stellate cells with global inhibition [1]. As spiking neuron models, we consider the Stellate cell in the Entorhinal Cortex (EC), which acts as a resonator, and a fast spiking neuron as an interneuron with global projections. We constructed the entire network from the Stellate cells with feedforward excitation and one global interneuron with feedback inhibition. In the network, the feedforward excitation from the Stellate cells cause the global interneruon to fire irregularly. The feedback inhibition from the interneuron leads to synchronization at a theta frequency range. Such synchronization depend on parameters of the Stellate cells as a resonator, such as an equilibrium membrane voltage determined by a common bias input and a reset voltage corresponding to the degree of after-hyperbolization (AHP). We evaluate statistical properties of fluctuations in the network in view of Coherence Resonance (CR) [2]. We further discuss its mechanism relevant to cycle skipping that is particular in resonators [3]. [1] J. Igarashi, M. Yoshida, K. Tateno, H. Hayashi, "Synchronized subthreshold oscillations and phase coding in a network model of the entorhinal cortex", In Proc IJCNN, pp. 3119-3123, 2004. [2] A. S. Pikovsky, J. Kurths, "Coherence resonance in a noise-driven excitable system," Physical Review Letters, vol. 78, pp. 775-778, 1997. [3] C. D. Acker, N. Kopell, J. A. White, "Synchronization of strongly coupled excitatory neurons: relating network behavior to biophysics," J. Computational Neuroscience, vol. 15, no. 1, pp. 71-90, 2003.

P370 *Large-Scale Simulations of Hippocampal and Prefrontal Activity during a Spatial Navigation Task [no. 705]*

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The hippocampal-prefrontal loop is thought to underlie the formation, the consolidation, and the retrieval of episodic memories. Within the hippocampal system, the subiculum, and adjacent parahippocampal regions, are known to play an important role in decision making. However, extrinsic and intrinsic connectivity and

synaptic regulation among these regions remains unknown. To better understand sequential learning during spatial navigation, more detailed physiological models are needed to lead experimental studies. In a previous model, we proposed a microcircuitry that incorporated recurrent asynchronous-irregular nonlinear (RAIN) dynamics, with prefrontal executive role, hippocampal and subicular activity, as well as entorhinal grid cell regulation. During computer-simulated rodent maze navigation the model replicated the dynamics of the mammalian hippocampal-frontal loop microcircuitry. This demonstrated short-term memory during three sequential binary decisions needed to receive a reward. The original model consisted of 87,460 conductance-based leaky integrate-and-fire neurons and was simulated on the neocortical simulator (NCS). In this project, we first developed a similar size model using the four parameter Izhikevich neuron. The results of which were consistent with the previous model. This illustrated that the simple neuron could reproduce the model dynamics. We then explored how size could positively or negatively affect the dynamics of the model by systematically scaling to 1,031,520 cells. This resulted in the separate areas of the model either retaining or improving their dynamics with respect to experimental results. Although this larger model approaches more realistic cell counts the question of whether bigger is better ultimately arises. In this case the larger number of cells did improve the model with respect to stability and subthreshold dynamics.

P371 *Neuronal networks biochemical reactions discrete chaotic dynamics and brain creativity mathematical modeling [no. 661]*

Vladimir Gontar and Olga Grechko, Ben-Gurion University of the Negev, Israel

Human thinking abilities and creativity in particular represent specific properties of the living matter which still are not fully scientifically understood as it had happened with the components of non-living matter, where the main theories and dynamical laws of nature had been formulated and supported by the corresponding mathematical models. Here we consider novel theoretical approach for mathematical modeling of the living and thinking systems based on neuronal networks biochemical reactions discrete chaotic dynamics (BRDCD) and provide by this paradigm explanation of possible origin of brain cognition and creativity. BRDCD is the theory based on the expanded first physicochemical principles to include into consideration specific for living and thinking systems properties such as information processing and exchange, reproduction and memory. According to BRDCD, single neuron is considered as a "biochemical reactor" that has the ability to exchange information about its physicochemical state with all the other neurons connected to it. By "information exchange" we mean another channel of interaction in addition to mass (via chemicals, ions, etc.), charge, and energy exchange. In BRDCD, "information exchange" is taken into consideration by establishing the formal dependence of the model's parameters (rate constants) on the states of synaptically connected neurons characterized by concentrations of the chemical constituents distributed within associated network. The entire complex interconnected network operates according to some initial hypothesis about the mechanism of biochemical reactions in the individual neuron including "information exchange" between the neurons. Basic equations derived from BRDCD for any mechanism of biochemical reactions have a form of system of non-linear difference equations and describe neuronal networks evolution in discrete time and space [1],[2]. We assume that distributed on the neuronal networks neuron's internal constituents (atoms, molecules, ions, etc.) concentrations are responsible for mental activity, including cognition and creativity. According to this basic premise, an artistic images, melodies, etc. would initially emerge in the brain in a form of synchronized and selforganized chemical constituents distributions. To support proposed paradigm it will be shown that BRDCD mathematical models have regimes resulted to the creative 1D and 2D patterns (generated by BRDCD melodies and 2D artistic images will be presented). Physical meaning of "information exchange" between the neurons and meaning of discrete time and space in living systems will be disputed. Application of the proposed approach to the EEG mathematical modeling, neurotherapy and artificial brain systems will be discussed. References [1] Gontar, V. (2004), The dynamics of living and thinking systems, biological networks and the laws of physics, Discrete Dynamics in Nature and Society, 8 (1), pp. 101-111. [2] Grechko, O. and Gontar, V. (2009), Visual stimuli generated by biochemical reactions discrete chaotic dynamics as a basis for neurofeedback, Journal of Neurotherapy, 13(1), pp. 30-40.

P372 *The CARMEN Project and Neuroinformatics [no. 89]*

Leslie Smith, Jim Austin, Tom Jackson, Paul Watson and Colin Ingram, University of Stirling, United Kingdom; University of York, United Kingdom; Newcastle University, United Kingdom

CARMEN (Code Analysis, Modelling and Repository for e-Neuroscience) is an eScience based project aimed at enabling experimental and computational neuroscientists to share data and analysis tools (services), particularly for extracellular neural recordings. It aims to support sharing of data and metadata, and the techniques for analysing such data. The goal is to allow collaborators to undertake their primary analysis on a web environment and to facilitate re-use and re-analysis of this data, whether for clinical, physiological or computational applications. The portal is accessed at https://portal.carmen.org.uk/ and academic users may freely register. CARMEN has been developed as a collaboration between researchers in informatics and experimental neuroscience. The proposers believed that neuroscience was being held back because, in general, (i) experimental neuroscientists were often not sharing their data beyond their laboratories, and collaboration over a distance was constrained by the need to transfer large data files; (ii) developers of analysis techniques were not making their techniques public, making it hard to replicate the results of their analyses; and (iii) computational neuroscientists were not able to find appropriate experimental datasets for testing their theories. To overcome these issues, CARMEN provides a portal environment to enable experimentalists to upload primary data with associated metadata, and allow analysts to deploy code for their services. Security for data, metadata and services is user-specific, enabling collaboration between laboratories or broader sharing. The project has faced both technical and sociological issues. No common standards for electrophysiological data exist, so CARMEN has developed Neurophysiology Data translation Format (NDF)[1], into which datasets are translated and on which services can run. Though metadata standards do exist, requesting complete metadata descriptions from experimenters would guarantee failure, so a basic metadata set was defined [2]. Currently, CARMEN enables a variety of filtering, spike detection and sorting, and spike train analyses to be carried out: these are performed as separate processes, but workflow capability is planned for a future release to enable greater automation of complex analyses. The project is supported by data sharing initiatives, particularly by the International Neuroinformatics Coordinating Facility (INCF), and a number of user groups have developed (for example, for in vitro retinal recordings). However, many electrophysiologists have remained cautious about public access to their raw data, fearing possible misinterpretation of their data or failures to credit the data source. Many funding agencies and journals now require public disclosure of datasets and analysis tools and CARMEN provides a platform to support this initiative. CARMEN aims to be a sustainable resource with broad take-up from across the neuroscience community. Full integration of NDF and workflows will enable broader utility, both for neuroscientists and for neuroscience education. [1] B. Liang, NDF Toolbox 1.0.0.1. http://www.carmen.org.uk/software/descriptions/softwareproduct.2010-11-11.1935112106 [2] F. Gibson et al, Minimum Information about a Neuroscience Investigation (MINI): Electrophysiology, Nature Precedings : hdl:10101/npre.2008.1720.1 : Posted 25 Mar 2008.

P373 *Knife-Edge Scanning Microscopy for Connectomics Research [no. 469]*
Yoonsuck Choe, David Mayerich, Jaerock Kwon, Daniel Miller, Ji Ryang Chung, Chul Sung, John Keyser and Louise Abbott, Texas A and M University, United States; University of Illinois, Urbana-Champaign, United States; Kettering University, United States

In this paper, we will review a novel microscopy modality called Knife-Edge Scanning Microscopy (KESM) that we have developed over the past twelve years (since 1999) and discuss its relevance to connectomics and computational neuroscience research. The operational principle of KESM is to simultaneously section and image small animal brains embedded in hard polymer resin so that a near-isotropic, sub-micrometer voxel size of 0.6 um x 0.7 um x 1.0 um can be achieved over 1 cm^3 volume of tissue which is enough to hold an entire mouse brain. At this resolution, morphological details such as dendrites, dendritic spines, and axons are visible (for sparse stains like Golgi). KESM has been successfully used to scan whole mouse brains stained in Golgi (neuronal morphology), Nissl (somata), and India ink (vasculature), providing unprecedented insights into the system-level architectural layout of microstructures within the mouse brain. In this paper, we will present whole-brain-scale data sets from KESM and discuss challenges and opportunities posed to connectomics and computational neuroscience by such detailed yet system-level data.

P374 *An Optimal Construction and Training of Second Order RBF Network for Approximation and Illumination invariant Image Segmentation [no. 657]*
Xun Cai, Kanishka Tyagi and Michael Manry, Shandong University, China; The University of Texas at Arlington, United States

In this paper, we proposed an hybrid optimal radial-basis function (RBF) neural network for approximation and illumination invariant image segmentation. Unlike other RBF learning algorithms, the proposed paradigm introduces a new way to train RBF models by using optimal learning factors (OLFs) to train the network parameters, i.e. spread parameter, kernel vector and a weighted distance measure (DM) factor to calculate the activation function. An efficient second order Newton's algorithm is proposed for obtaining multiple OLF's (MOLF) for the network parameters. The weights connected to the output layer are trained by a supervised-learning algorithm based on orthogonal least square (OLS). The error obtained is then back-propagated to tune the RBF parameters. By applying RBF network for approximation on some real-life datasets and classification to reduce illumination effects of image segmentation, the results show that the proposed RBF neural network has fast convergence rates combining with low computational time cost, allowing it a good choice for real-life application such as image segmentation.

P375 *On Combination of SMOTE and Particle Swarm Optimization based Radial Basis Function for Imbalanced Problems [no. 252]*
Ming Gao, Xia Hong, Sheng Chen and Chris Harris, University of Reading, United Kingdom; University of Southampton, United Kingdom

The combination of the synthetic minority oversampling technique (SMOTE) and the radial basis function (RBF) classifier is proposed to deal with classification for imbalanced two-class data. In order to enhance the significance of the small and specific region belonging to the positive class in the decision region, the SMOTE is applied to generate synthetic instances for the positive class to balance the training data set. Based on the over-sampled training data, the RBF classifier is constructed by applying the orthogonal forward selection procedure, in which the classifier structure and the parameters of RBF kernels are determined using a particle swarm optimization algorithm based on the criterion of minimizing the leave-one-out misclassification rate. The experimental results on both simulated and real imbalanced data sets are presented to demonstrate the effectiveness of our proposed algorithm.

P376 *Some Experimental Results on Sparsely Connected Autoassociative Morphological Memories for the Reconstruction of Color Images Corrupted by Either Impulsive or Gaussian Noise [no. 79]*
Marcos Eduardo Valle and Daniela Maria Grande Vicente, University of Londrina, Brazil

Sparsely connected autoassociative morphological memories (SCAMMs) are single layer feedforward neural networks that compute either the maximum or the minimum of a finite subset of the input signals. These memories are computationally cheaper than traditional models and have a wide range of applications because they rely only on a complete lattice structure, which is obtained by imposing some ordering on a set. In particular, SCAMMs can be used for the storage and recall of color images. However, there exist several mathematical representations of color images, including the RGB, HSL, and CIELab color systems. Furthermore, the colors can be ordered in many different ways in each system. In view of these remarks, this paper aims at providing some experimental results on the performance of SCAMMs, defined on different ordered color models, for the reconstruction of color images corrupted by either Gaussian or impulsive noise.

P377 *Prosody Dependent Mandarin Speech Recognition [no. 63]*
Chong-Jia Ni, Wen-Ju Liu and Bo Xu, NLPR,CASIA, China

In this paper, we discuss how to model and train Mandarin prosody dependent acoustic model based on automatic prosody annotation corpus. Based on prosody annotation corpus, we first utilize our proposed methods to train prosody dependent and prosody independent tonal syllable model, and then use these models to get the mixed acoustic models. In this paper, we also utilize tone model to improve the correct rate of tonal syllable through revising the tone of the tonal syllable at certain significant level. When compared with the baseline system, the performance of our proposed mixed speech recognition system improves the correct rate of tonal syllable significantly.

P378 *A Spiking Neural Network for Tactile Form Based Object Recognition [no. 191]*
Sivalogeswaran Ratnasingam and Martin McGinnity, University of Ulster, United Kingdom

This paper proposes a biologically plausible system for object recognition based on tactile form perception. A spiking neural network, an encoding scheme for converting the input values into spike trains, a method for converting the output spike pattern into reliable features for object recognition and a training approach for the spiking neural network are proposed. Three separate spiking neural networks are used in this recognition system. Three features, based on the output firing pattern of the three networks, are projected onto a three dimensional space. Each class of objects forms a cluster in the three-dimensional feature space. During the training the firing threshold of the hidden layer is modified in such a way that the cluster formed by an object is small and does not overlap with neighbouring clusters. The system has been tested with a number of objects for recognition based on shape. In addition, the system has also been tested for the ability to recognise objects of the same shape but different size. The results show the proposed system gives good performance in recognising objects based on tactile form perception.

P379 *Smart Recognition and Synthesis of Emotional Speech for Embedded Systems with Natural User Interfaces [no. 189]*

Malcangi Mario, Universita' degli Studi di Milano, Italy

The importance of the emotion information in human speech has been growing in recent years due to increasing use of natural user interfacing in embedded systems. Speech-based human-machine communication has the advantage of a high degree of usability, but it need not be limited to speech-to-text and text-to-speech capabilities. Emotion recognition in uttered speech has been considered in this research to integrate a speech recognizer/synthesizer with the capacity to recognize and synthesize emotion. This paper describes a complete framework for recognizing and synthesizing emotional speech based on smart logic (fuzzy logic and artificial neural networks). Time-domain signal-processing algorithms has been applied to reduce computational complexity at the feature-extraction level. A fuzzy-logic engine was modeled to make inferences about the emotional content of the uttered speech. An artificial neural network was modeled to synthesize emotive speech. Both were designed to be integrated into an embedded handheld device that implements a speech-based natural user interface (NUI).

P380 *Temporal Nonlinear Dimensionality Reduction [no. 410]*

Michael Gashler and Tony Martinez, Brigham Young University, United States

Existing Nonlinear dimensionality reduction (NLDR) algorithms make the assumption that distances between observations are uniformly scaled. Unfortunately, with many interesting systems, this assumption does not hold. We present a new technique called Temporal NLDR (TNLDR), which is specifically designed for analyzing the high-dimensional observations obtained from random-walks with dynamical systems that have external controls. It uses the additional information implicit in ordered sequences of observations to compensate for non-uniform scaling in observation space. We demonstrate that TNLDR computes more accurate estimates of intrinsic state than regular NLDR, and we show that accurate estimates of state can be used to train accurate models of dynamical systems.

P381 *An Electrosensory Virtual Reality [no. 582]*

Todd Leen, Patrick Roberts, John Hunt, Amy Boyle, Nathaniel Sawtell and Karina Scalise, OHSU, United States; Columbia University, United States

A key challenge in neuroscience is to understand how adaptive processes allow the central nervous system to ignore predictable sensory input and focus on important new information. The cerebellum-like electrosensory lateral line lobe (ELL) of the mormyrid electric fish is a superb system to study such questions, because its architecture and physiology are beautifully-well characterized. Circuit-level models [1] that incorporate the anti-Hebbian spike-timing-dependent learning observed in slice preparations [2] successfully reproduce the observed ability of the system to predict and cancel out habitual temporal patterns of sensory input resulting from the fish electric organ discharge (EOD) [3]. Despite these significant accomplishments, understanding of the mormyrid electrosensory processing of complex spatio-temporal stimuli when engaged in hunting or navigation is limited. Unlike studies of the visual system, the weak link in electrosensory neuroscience is the crude stimulus technique. Current stimuli are generated from one or two localized dipole sources with imprecise and unreliable spatial placement. Such stimuli are inadequate to explore the response to spatio-temporal patterns used to discriminate object distance or conductive vs. dielectric bodies, and responses during exploratory behavior. Nor are they adequate to answer detailed questions about adaptation. To answer these needs, we are developing a flexible platform for presenting to the fish precise and repeatable electrical images with intricate spatial-temporal profiles while recording from the ELL. The system allows the experimenter to synthesize an electric image at the surface of the skin tailored to test specific hypotheses, or mimic the field of a natural object. The user can tailor both the electric field shape and the temporal waveform, and reference the spatial field shape to the receptive field captured by the electrophysiology probe. The desired electric images are projected onto the surface of the skin by controlling voltages sent to a transducer array of silver-chloride electrodes patterned onto a circuit board held 2-5mm from the surface of the skin. The experimenter designs a sequence of desired skin patterns and Matlab software calculates the required transducer electrode voltages (in realtime if required). Delivery of the patterns to the transducer array is controlled through user interfaces constructed in Labview. Measurements confirm the ability to control spatial position, shape, and modulation of electrical patterns on the skin. [1] Patrick D. Roberts and Curtis C. Bell (2000). Computational consequences of temporally asymmetric learning rules: II Sensory image cancellation. J. Comp. Neurosci., 9, 67--83. [2] Curtis C. Bell, Victor Han, Yoshiko Sugawara and Kirsty Grant (1997a). Synaptic plasticity in a cerebellum-like structure depends on temporal order. Nature, 387, 278--281. [3] C. C. Bell, D. Bodznick, J. Montgomery, and J. Bastian (1997b). The generation and subtractionof sensory expectations within cerebellum-like structure. Brain Beh. Evol. 50, 17--31 (suppl. 1).

P382 *Generative Mechanisms During Testing: How the Brain May Recognize Mixtures of Patterns. [no. 718]*

Tsvi Achler, Zhengping Ji and Luis Bettencourt, Los Alamos National Labs, United States

A class of generative models has been proposed for recognition processing. Generative models are related to predictive coding, top-down feedback and Independent Component Analysis (ICA) algorithms. We develop the distinction of generative-like strategies applied either during learning or testing (i.e., recognition)and study how a generative approach during testing may overcome known combinatorial problems associated with simultaneous pattern mixtures. Briefly within the generative model account of recognition, after the brain learns input patterns, it is hypothesized that recognition centers of the brain "generate" inputs that correspond to contending solutions. These generated input patterns are compared with (and subtracted from) original input patterns from the environment to determine success of recognition based on the generated internal neural representation. Learned components (patterns) are evaluated as to which set fit the data best with the least amount of pattern overlap. The least amount of overlap is determined by finding features of patterns with the least amount of mutual correlation, most sparseness, or in other words with the least amount of pattern inter-dependence. Our goals are to understand how the brain may be organized to, and whether it uses this strategy during the short timescale of recognition (without the learning) to resolve combinatorial difficulties associated with simultaneous pattern recognition of pattern mixtures. Such combinatorial problems found when processing simultaneous patterns have been described early in the study of connectionist networks using the terms "the binding problem", or "superposition catastrophe". The brain demonstrates abilities to resolve such problems common to patterns found in natural environments such as scenes. Top-down brain mechanisms that implement a generative-like algorithm during recognition may reveal how the brain solves mixture of pattern problems. We have found a neurally-plausible version of the generative model for the recognition phase, which is well suited for mixture problems. We compare it with other flavors of generative models and neurally-plausible networks.

P383 *Representing and Decoding Rank Order Codes Using Polychronization in a Network of Spiking Neurons [no. 207]*
Francesco Galluppi and Steve Furber, University of Manchester, United Kingdom

The introduction of axonal delays in networks of spiking neurons has enhanced the representational capabilities of neural networks, whilst also providing more biological realism. Approaches in neural coding such as rank order coding and polychronization have exploited the precise timing of action potential observed in real neurons. In a rank order code information is coded in the order of firing of a pool of neurons; on the other hand with polychronization it is the time of arrival of different spikes at the postsynaptic neuron which triggers different post-synaptic responses, with the axonal delays compensating for different timings in the afferents. In this paper we propose a model in which rank order coding is used to represent an arbitrary symbol, and a polychronous layer is used to decode, represent and recall that symbol. To prove that the polychronous layer is able to do this a detector neuron is trained with a supervised learning strategy and associated with a single code. According to this premise the detector neuron only fires on the appearance of the associated code, even in the presence of noise. Tests prove that rank order coding and polychronization can be coupled to code and decode information such as intensity or significance using timing information in spiking neural networks in an effective way.

P384 *A Training Algorithm for SpikeProp Improving Stability of Learning Process [no. 208]*
Toshiki Wakamatsu, Haruhiko Takase, Hiroharu Kawanaka and Shinji Tsuruoka, Mie university, Japan

In this paper, we aims to improve stability of learning processes by the SpikeProp algorithm. We proposed the method that reduce the increase of the error in learning processes. It repeats two steps: (1) original SpikeProp algorithm, and (2) use a linear search in the steepest descent direction only if the first step is failed. Some experimental results shows the improvement of learning processes.

P385 *Optimization of Spiking Neural Networks with Dynamic Synapses for Spike Sequence Generation using PSO [no. 623]*
Ammar Mohemmed, Satoshi Matsuda, Stefan Schliebs, Kshitij Dhoble and Nikola Kasabov, Auckland University of Technology, New Zealand; Nihon University, Japan

We present a method that is based on Particle Swarm Optimization (PSO) for training a Spiking Neural Network (SNN) with dynamic synapses to generate precise time spike sequences. The similarity between the desired spike sequence and the actual output sequence is measured by a simple leaky integrate and fire spiking neuron. This measurement is used as a fitness function for PSO algorithm to tune the dynamic synapses until a desired spike output sequence is obtained when certain input spike sequence is presented. Simulations are made to illustrate the performance of the proposed method.

P386 *Local learning rules for spiking neurons with dendrite. [no. 459]*
Olivier Manette, CNRS, France

We present in this article four local rules to train a network of spiking dendritic neurons. After training, every neuron of the network becomes specialized for a particular feature of the input signal. With these rules, the network acts as a features extractor where each neuron contains a TAND vector, similar to logical AND but including information about time between the two events in the input signal.

P387 *Are Probabilistic Spiking Neural Networks Suitable for Reservoir Computing? [no. 664]*
Stefan Schliebs, Mohemmed Ammar and Nikola Kasabov, Auckland University of Technology, New Zealand

This study employs networks of stochastic spiking neurons as reservoirs for liquid state machines (LSM). We experimentally investigate the separation property of these reservoirs and show their ability to generalize classes of input signals. Similar to traditional LSM, probabilistic LSM (pLSM) have the separation property enabling them to distinguish between different classes of input stimuli. Furthermore, our results indicate some potential advantages of non-deterministic LSM by improving upon the separation ability of the liquid. Three non-deterministic neural models are considered and for each of them several parameter configurations are explored. We demonstrate some of the characteristics of pLSM and compare them to their deterministic counterparts. pLSM offer more flexibility due to the probabilistic parameters resulting in a better performance for some values of these parameters.

P388 *Temporal and rate decoding in spiking neurons with dendrites [no. 43]*
Olivier Manette, CNRS, France

How could synapse number and position on a dendrite affect neuronal behavior with respect to the decoding of firing rate and temporal pattern? We developed a model of a neuron with a passive dendrite and found that dendritic length and the particular synapse positions directly determine the behavior of the neuron in response to patterns of received inputs. We revealed two distinct types of behavior by simply modifying the position and the number of synapses on the dendrite. In one setting - spatio-temporally sensitive - the neuron responds to a precise spatio-temporal pattern of spikes, but shows little change following an increase in the average frequency of the same input pattern. In the other setting - frequency sensitive - the neuron is insensitive to the precise arrival time of each spike but responds to changes in the average firing rate. This would allow this model of neurons to detect different spatio-temporal patterns.

P389 *Foraging Behavior in a 3-D Virtual Sea Snail Having a Spiking Neural Network Brain [no. 45]*
David Olmsted, None, United States

This paper reports on a simulation study of foraging behavior in a 3-D virtual sea snail. The responsible circuit is composed of 8 spiking neurons which is part of a larger 37 neuron brain. The 3-D virtual environment has full soft body physics enabled and is completely defined in software. When no odor targets are available this brain implements a semi-random path foraging behavior and when targets are available this brain switches to a directed approach behavior. The core spiking neuron simulation equation is the Erlang function which is simulated as a cascade of leaky exponential functions. The use of this equation is justified by the new Soft State Automata Theory which describes causation in non-clocked mathematically discontinuous systems like the brain in which finite states cannot be defined by the system itself. The use of the Erlang function to propagate both the normal signal and the threshold response signal results in 9 neural control parameters, 7 of which may be changed adaptively.

P390 *Comparing Evolutionary Methods for Reservoir Computing Pre-training [no. 81]*
Aida Ferreira and Teresa Ludermir, CIN/UFPE, Brazil

Evolutionary algorithms are very efficient at finding "optimal" solutions for a variety of problems because they do not impose many limitations encountered in traditional methods. Reservoir Computing is a type of recurrent neural network that allows for the black box modeling of (nonlinear) dynamic systems. In contrast to other recurrent neural network approaches, Reservoir Computing does not train the input and internal weights of the network; only the output layer is trained. However, it is necessary to adjust parameters and topology to create a "good" reservoir for a given application. This study compares three different evolutionary methods in order to find the best reservoir applied to the task of time series forecasting. The results obtained with the methods are compared regarding the performance (prediction error) and regarding the computational complexity (time). We used three sets to compare the methods' results. The results show that it is possible to find well-adjusted networks automatically and that the weights search, without restriction of the echo state property, allows for more adequate solutions to be found for the problem with a lower computational cost.

P391 *Reference time in SpikeProp [no. 238]*
Ioana Sporea and Andre Gruning, University of Surrey, United Kingdom

Although some studies have been done on the learning algorithm for spiking neural networks SpikeProp, little has been mentioned about the required input bias neuron that sets the reference time start. This paper examines the importance of the reference time in neural networks based on temporal encoding. The findings confute previous assumptions about the reference start time.

P392 *Selecting the Hypothesis Space for Improving the Generalization Ability of Support Vector Machines [no. 257]*
Davide Anguita, Alessandro Ghio, Luca Oneto and Sandro Ridella, University of Genoa, Italy

The Structural Risk Minimization framework has been recently proposed as a practical method for model selection in Support Vector Machines (SVMs). The main idea is to effectively measure the complexity of the hypothesis space, as defined by the set of possible classifiers, and to use this quantity as a penalty term for guiding the model selection process. Unfortunately, the conventional SVM formulation defines a hypothesis space centered at the origin, which can cause undesired effects on the selection of the optimal classifier. We propose here a more flexible SVM formulation, which addresses this drawback, and describe a practical method for selecting more effective hypothesis spaces, leading to the improvement of the generalization ability of the final classifier.

P393 *Modularity-based model selection for kernel spectral clustering [no. 391]*
Rocco Langone, Carlos Alzate and Johan A. K. Suykens, ESAT-SCD-SISTA, Belgium

A proper way of choosing the tuning parameters in a kernel model has a fundamental importance in determining the success of the model for a particular task. This paper is related to model selection in the framework of community detection on weighted and unweighted networks by means of a kernel spectral clustering model. Here we propose a new method based on Modularity (a popular measure of community structure in a network) which can deal with quite general situations (i.e. overlapping communities with different sizes). Thus we use Modularity criterion for model selection and not at the training level, which is the case of all the clustering algorithms proposed so far in the literature.

P394 *Sparseness and a Reduction from Totally Nonnegative Least Squares to SVM [no. 403]*
Vamsi Potluru, Sergey Plis, Shuang Luan, Vince Calhoun and Thomas Hayes, UNM, United States; MRN, United States

Nonnegative Least Squares (NNLS) is a general form for many important problems. We consider a special case of NNLS where the input is nonnegative. It is called Totally Nonnegative Least Squares (TNNLS) in the literature. We show a reduction of TNNLS to a single class Support Vector Machine (SVM), thus relating the sparsity of a TNNLS solution to the sparsity of supports in a SVM. This allows us to apply any SVM solver to the TNNLS problem. We get an order of magnitude improvement in running time by first obtaining a smaller version of our original problem with the same solution using a fast approximate SVM solver. Second, we use an exact NNLS solver to obtain the solution. We present experimental evidence that this approach improves the performance of state-of-the-art NNLS solvers by applying it to both randomly generated problems as well as to real datasets, calculating radiation therapy dosages for cancer patients.

P395 *Handwritten Chinese Character Identification with Bagged One-Class Support Vector Machines [no. 56]*
Hong-Wei Hao, Cui-Xia Mu, Xu-Cheng Yin and Zhi-Bin Wang, University of Science and Technology Beijing, China

Today, more and more foreigners go to China and are emerged into studying Chinese. Thereinto, how to write Chinese characters is a very important and difficult task. As computers and internets develop, many teachers for Chinese Education want to use pattern recognition technologies to automatically evaluate and direct the quality of Chinese characters written by foreign students through document scanning. Actually, this is a handwritten character evaluation and identification problem. In this paper, we investigate and compare several character identification methods for Chinese Education within a classification framework. First, some two-class classification techniques with different features and classifiers (BP neural networks and SVMs) are investigated to identify each handwritten Chinese character. Moreover, in character identification, positive examples are always conjunctive, but negative examples are diffused in most cases. Consequently, we use one-class classification technique (one-class SVMs) to perform this handwritten character identification. In order to overcome the sensitivity to the SVM parameters, we propose a variant one-class SVM system - Bagged One-Class SVMs, which integrate many one-class SVMs with sample bagging. Some experiments of evaluating real handwritten Chinese characters by foreigners are performed, which show that general handwritten character identification is a big challenge and one-class classification technique is a potential researching and developing direction.

P396 *Designing Associative Memories Implemented via Recurrent Neural Networks for Pattern Recognition [no. 541]*
Jose A. Ruz-Hernandez, Maria U. Suarez-Duran, Ramon Garcia-Hernandez, Evgen Shelomov and Edgar N. Sanchez, Universidad Autonoma del Carmen, Mexico; CINVESTAV-IPN, Guadalajara Campus, Mexico

In this paper a recurrent neural network is used as associative memory for pattern recognition. The goal of associative memory is to retrieve a stored pattern when

enough information is presented in the network input. The network is training with twelve bipolar patterns to determine the corresponding weights. The weights are calculated by means of support vector machines training algorithms as the optimal hyperplane and soft margin hyperplane. Once the neural network is trained its performance is evaluated to retrieval stored patterns which correspond to characters encoded as bipolar vectors.Furthermore, a performance analysis is carried out to determine the basins of attraction and the evolution of states to each memory designed.

Poster Session Tu-PC: Poster Session C: Competitions

Tuesday, August 2, 7:30PM-9:30PM, Room: Bayshore Ballroom, Chair: Sven Crone and Isabelle Guyon

P501 *A Hybrid System Ensemble Based Time Series Signal Classification on Driver Alertness Detection [no. 435]*

Shen Xu, Ruoqian Liu, Dai Li and Yi Lu Murphey, University of Michigan-Dearborn, United States

This paper presents the methodolodies developed for solving IJCNN 2011's Ford Challenge II problem, where the driver's alertness is to be detected employing physiological, environmental and vehicular data acquired during driving. The solution is based on a thorough four-fold framework consisting of temporal processing, feature creation and extraction, and the training and ensemble of several learning systems, such as neural networks, random forest, support vector machine (SVM), trained from diverse features. The selection of input features to a learning machine has always been critique on signal classification. In our approach, the employment of bayesian network filtered out a set of features and has been proved by the ensemble to be effective. The ensemble technique enhanced the performance of individual systems dramatically. The performance acquired on 30 of the test samples reached an accuracy of 76.34. These results are significant for a real-world vehicular problem and we are quite confident this solution will become one of the top ones on the competition test data.

P502 *Exploring the relationship between degrees of self similarity and altered driving states [no. 669]*

Sekou Remy, University of Notre Dame, United States

Combating the dangers of distracted driving is currently one of the major road safety concerns for our society. There is much being done to increase awareness on the issue and also to legislate punishment for drivers shoo get caught turning their focus away from the road, but these have not proven to fully address the issue. While cars are equipped with several other systems to keep their drivers and all nearby safe, there is a void when it comes to tools which can help keep drivers alerts, or at least to help identify the driver's distraction states. This work seeks to unmask distracted driving by monitoring the statistical self similarity of physiological, environmental and vehicular channels of data, through the application of Detrended Fluctuation Analysis (DFA). Combining the self similarity property for several but not all the channels in the considered data, a viable predictor was generated. Implemented in large part as a Self Organizing Map (SOM) construct, the predictor confirms that self similarity contains useful information. More work is required to uncover why this is the case, as well as just how good a predictor can be generated through extending this approach.

P503 *Graph-based Features for Supervised Link Prediction [no. 272]*

William Cukierski, Benjamin Hamner and Bo Yang, Rutgers University, United States; Ecole Polytechnique Federale de Lausanne, Switzerland; Software developer in the Vancouver, Canada area, Canada

The growing ubiquity of social networks has spurred research in link prediction, which aims to predict new connections based on existing ones in the network. The 2011 IJCNN Social Network challenge asked participants to separate real edges from fake in a set of 8960 edges sampled from an anonymized, directed graph depicting a subset of relationships on Flickr. Our method incorporates 94 distinct graph features, used as input for classification with an ensemble of Random Forests. We present a three- problem approach to the link prediction task, along with several novel variations on established similarity metrics. We discuss the challenges of processing a graph with more than a million nodes. The performance of the strongest features is reported on the ground-truth answers from the contest. Our method achieved an area under the receiver-operator characteristic (ROC) curve of 0.9695, the 2nd best overall score in the competition and the best score which did not de-anonymize the dataset.

P504 *Link Prediction by De-anonymization: How We Won the Kaggle Social Network Challenge [no. 385]*

Arvind Narayanan, Elaine Shi and Benjamin Rubinstein, Stanford University, United States; PARC/Berkeley, United States; Microsoft Research, United States

This paper describes the winning entry to the IJCNN 2011 Social Network Challenge run by Kaggle.com. The goal of the contest was to promote research on real-world link prediction, and the dataset was a graph obtained by crawling the popular Flickr social photo sharing website, with user identities scrubbed. By de-anonymizing much of the competition test set using our own Flickr crawl, we were able to effectively game the competition. Our attack represents a new application of de-anonymization to gaming machine learning contests, suggesting changes in how future competitions should be run. We introduce a new simulated annealing-based weighted graph matching algorithm for the seeding step of de-anonymization. We also show how to combine de-anonymization with link prediction---the latter is required to achieve good performance on the portion of the test set not de-anonymized---for example by training the predictor on the de-anonymized portion of the test set, and combining probabilistic predictions from de-anonymization and link prediction.

P505 *A Support Vector Machines Network for Traffic Sign Recognition [no. 456]*

Fabio Boi and Lorenzo Gagliardini, Universita' degli studi di Genova, Italy

The objective of this paper is to describe an algorithm able to solve the traffic sign recognition problem, based on a structure composed by a cascade of competing classifiers and some computer vision pre-processing operations. Traffic sign recognition is a very complex problem, involving a multiclass analysis with unbalanced class frequencies, most of them very similar to each other. With our system, that we are going to call Traffic Sign Classifier (TSC), during the competition promoted by the Institut fuer Neuroinformatik, Ruhr Universitaet Bochum, it was possible to recognize more than 40 classes of signs with an average error close to 3%. The algorithm, realized by our development team, consists basically of two

modules: a preprocessing module, where the data are managed in order to extract some features, such as the Hue Histogram (HH) and the Histograms of Oriented Gradients (HOG); a second module, where the data coming from the first one are analyzed using a sequence of Support Vector Machines (SVM), implemented with the One Versus All (OVA) methodology. This module includes a couple of systems, composed of several SVMs; one of these systems consists of a hierarchical structure. The results coming out from both the systems are compared with each other in order to define which is the most reliable. This work is performed by the so called "Combining the Results and Assigning the Labels" procedure; calibrating the systems and the parameters employed inside the several analyses performed, it is possible to decrease the number of misclassifications and consequently increase the performance of the entire network.

P506 *Coherence Vector of Oriented Gradients for Traffic Sign Recognition using Neural Networks [no. 199]*
Rajesh R., Rajeev K., Suchithra K., Lekhesh V.P., Ragesh N.K. and Gopakumar V., NeST, India

This paper makes use of Coherence Vector of Oriented Gradients (CVOG) for traffic sign recognition. Experiments are conducted on German Traffic Sign benchmark dataset. The results on traffic sign recognition using CVOG features with neural network classifier is promising. The results based on the combination of other features gave better recognition rates.

Wednesday, August 3, 8:00AM-9:00AM

Plenary Talk We-Plen1: Plenary Session

Wednesday, August 3, 8:00AM-9:00AM, Room: Oak, Chair: David Casasent

8:00AM *Challenges for Computational Vision: From Random Dots to the Wagon Wheel Illusion*
Leon Glass, McGill University, Canada

Even understanding the way we perceive very simple images presents a major challenge for both neurophysiologists and computer scientists. In this talk I will discuss two visual effects. In one random dots are superimposed on themselves following a linear transformation (1,2). In the second, a rotating disk with radial spokes is viewed under stroboscopic illumination, where the frequency and duration of the stroboscopic flash are varied (3,4). Though these phenomena are very different, in both correlation plays a major role in defining the structure of the image. In this talk, I will give demonstrations of these phenomena and discuss related experimental and theoretical work by ourselves and others. In particular, I focus on recent analysis that uses the theory of forced nonlinear oscillations to predict the percept of rotating disks during stroboscopic illumination over a wide range of disk rotation speeds and strobe frequencies (4). Finally, I suggest that the anatomical structure of the human visual system plays a major role in enabling the amazingly rapid and accurate computation of spatial and time dependent correlation functions carried out by the visual system. 1. L. Glass. Moire effect from random dots. Nature 223, 578580 (1969). 2. L. Glass, R. Perez. Perception of random dot interference patterns. Nature 246, 360-362 (1973). 3. R.M. Shymko, L. Glass. Negative images in stroboscopy. Optical Engineering 14, 506-507 (1975). 4. P. Martineau, M. Aguilar, L. Glass. Predicting perception of the wagon wheel illusion. Physical Review Letters, 103:2 (2009).

Wednesday, August 3, 9:30AM-11:30AM

Special Session We1-1: Memristor Minds I

Wednesday, August 3, 9:30AM-11:30AM, Room: Cedar, Chair: Robert Kozma and Giovanni Pazienza

9:30AM *Neuromorphic hardware, memristive memory, and photonic interconnect [no. 683]*
Greg Snider, Hewlett-Packard Laboratories, United States

Building a brain with electronics is difficult both algorithmically and from a power/density perspective. Although many neuromorphic architectures pursue traditional subthreshold CMOS, we suggest that an all-digital approach is economically more viable and technically far less risky as two critical technologies become available in the coming years: dense, CMOS compatible memory and photonic interconnect. This talk will explore the rationale behind that statement, focusing on three key areas: (1) Math: nonlinear dynamics; tensor, lattice, and geometric algebras; bias/variance dilemma. (2) Hardware: Rent's rule for the brain; CV^2f losses; spatial vs. temporal locality; memristive memory, photonic communication; analog vs. digital. (3) Algorithms: time, space, frequency domains; steerable filter theory; FFTs; tensor convolution; examples. The talk will include demonstrations of efficiently solving some essential low- level vision processes (contrast normalization, boundary completion, learning) on our platform, Cog ex Machina.

10:10AM *Biologically-inspired schemes with memory circuit elements [no. 91]*
Massimiliano Di Ventra, UC San Diego, United States

Memory effects are ubiquitous in nature and the class of memory circuit elements - which includes memristors, memcapacitors and meminductors [1] - shows great potential to understand and simulate the associated fundamental physical processes [1]. Here, I discuss how these elements can be used in electronic schemes mimicking biological systems. I will report on memristor-based adaptive filters [2] that were suggested to model primitive learning of amoebas; biologically-inspired neuromorphic computer architectures in which memristors play the role of artificial synapses, and demonstrate experimentally an important feature of the human brain, namely associative memory, with a memristive neural network [3]; and massively-parallel maze-solving capabilities with memory elements [4]. If time permits, I will finally discuss how memcapacitors and meminductors have the potential to expand the capabilities of certain digital and quantum computation schemes [5]. [1] M. Di Ventra, Y. V. Pershin, and L. O. Chua, Proc. IEEE 97, 1717 (2009); Y.V. Pershin and M.

Di Ventra, Advances in Physics (in press). [2] Y. V. Pershin, S. La Fontaine, and M. Di Ventra, Phys. Rev. E 80, 021926 (2009). [3] Y. V. Pershin and M. Di Ventra, Neural Networks 23, 881 (2010). [4] Y. V. Pershin and M. Di Ventra, arXiv:1103.0021 [5] Y. V. Pershin and M. Di Ventra, arXiv:1009.6025

10:50AM *Brain-Inspired Computing with Memristive Technology [no. 84]*
Anatoli Gorchetchnikov and Massimiliano Versace, Boston University, United States

At this point in time and in the foreseeable future, convergent advances in neural modeling, neuroinformatics, neuromorphic engineering, materials science, and computer science will enable the study and manufacturing of novel computer architectures. These new architectures are not only promising in helping overcome Moore's law imminent failure, but will also open the door to large-scale neural modeling research and applications. This talk focuses on memristor-based bio-inspired computing devices and models scalable to biological levels (Versace and Chandler, 2010; Snider et al., 2011). These devices promise to advance our ability not only to implement adaptive whole-brain systems able to intelligently behave in simulated and robotic agents, but also to create innovative technological applications to impact general-purpose computing and mobile robotics. Versace, M., and Chandler, B. (2010). MoNETA: A Mind Made from Memristors. IEEE Spectrum, December 2011. Snider, G., Amerson, R., Carter, D. , Abdalla, H., Qureshi, S., Leveille, J., Versace, M., Ames, H., Patrick, S.,Chandler, B., Gorchetchnikov, A., and Mingolla, E. (2011). From Synapses to Circuitry: Using Memristive Memory to Explore the Electronic Brain. In press, IEEE Computer.

Special Session We1-2: From Neuroscience to Robotics and Human-Computer Interfaces

Wednesday, August 3, 9:30AM-11:30AM, Room: Pine, Chair: Hava Siegelmann

9:30AM *Fuzzy Bio-Interface: Indicating Logicality from Living Neuronal Network and Learning Control of Bio-Robot [no. 497]*
Isao Hayashi, Megumi Kiyotoki, Ai Kiyohara, Minori Tokuda and Suguru N. Kudoh, Kansai University, Japan; Kwansei Gakuin University / Osaka University, Japan; Kwansei Gakuin University, Japan

Recently, many attractive brain-computer interface and brain-machine interface have been proposed. The outer computer and machine are controlled by brain action potentials detected through a device such as near-infrared spectroscopy (NIRS) and electroencephalograph (EEG), and some discriminant model determines a control process. In this paper, we introduce a fuzzy bio-interface between a culture dish of rat hippocampal neurons and the khepera robot. We propose a model to analyze logic of signals and connectivity of electrodes in a culture dish, and show the bio- robot hybrid we developed. We believe that the framework of fuzzy system is essential for BCI and BMI, thus name this technology "fuzzy bio-interface". We show the usefulness of a fuzzy bio-interface through some examples.

9:50AM *The Effects of Neuromodulation on Human-Robot Interaction in Games of Conflict and Cooperation [no. 432]*
Derrik Asher, Andrew Zaldivar, Brian Barton, Alyssa Brewer and Jeffrey Krichmar, University of California, Irvine, United States

Game theory has been useful for understanding risk-taking, cooperation, and social behavior. However, in studies of the neural basis of decision-making during games of conflict, subjects typically play against an opponent with a predetermined strategy. The present study introduces a neurobiologically plausible model of action selection and neuromodulation, which adapts to its opponent's strategy and the environmental conditions. The neural model is based on the assumption that the dopaminergic and serotonergic systems track expected rewards and costs, respectively. The neural model controlled both simulated and robotic agents that played a series of Hawk-Dove games against human subjects. When playing against an aggressive version of the neural model having a simulated lesion of its serotonergic system, there was a significant shift in the human subject strategy from Win-Stay-Lose-Shift to Tit-For-Tat. Humans became retaliatory when confronted with an agent that tended to adopt risky behavior by fighting for resources. These results highlight the important interactions between human subjects and an agent that can adapt its behavior. Moreover, they reveal neuromodulatory mechanisms that give rise to cooperative and competitive behaviors.

10:10AM *Expanding the Go/NoGo depiction of the action of Basal Ganglia Pathways [no. 690]*
Sanjeeva Kumar, Maithreye Rengaswamy, Neelima Gupte and Srinivasa Chakravarthy, Indian Institute of Technology, Madras, India; PostDoc, Indian Institute of Technology, Madras, India; Professor, Indian Institute of Technology, Madras, India

We present a neuronal network model of Basal Ganglia that departs from the classical Go/NoGo picture of the function of its key pathways - the direct and indirect pathways (DP and IP). The model is instantiated in a simple action selection task. Striatal dopamine is assumed to switch between DP and IP activation. Simulations reveal that between the Go and NoGo regimes, exhibited at extreme values of dopamine, the system displays, at intermediate values of dopamine, a new Explore regime, which enables it to explore the space of action alternatives. The exploratory dynamics originates from the chaotic dynamics of pallido-subthalamic loop. Following the tradition of applying reinforcement learning (RL) concepts to BG function, we associate this new regime with the Explorer, a key component in Actor-Critic framework.

10:30AM *Functional and Physical Constraints for Evolving Small-World Structure in Embodied Networks [no. 486]*
Derek Harter, Texas AandM University - Commerce, United States

The human brain contains a huge number of neurons (10^{11} neurons) and a huge number of interconnections (10^{14} synapses). The ontogenetic process that forms this structure is believed to be ruled primarily by optimizing principles of resource allocation and constraint minimization. These evolutionary and developmental processes lead to brain structures that are known to have certain interesting macroscopic properties, such as small-world behavior. However, the nature of these constraints to building neural structure, and the relationship of such structure to cognitive performance remain important questions. Connectivity structure might be the result of wiring optimization; at least this appears to be a plausible assumption as wiring is expensive, thus evolution would prefer structures that minimize wiring and the cost of building it. However, this must be balanced with factors for optimizing information processing performance, as a minimally wired network may not be adequate to integrate information and support sufficient dynamics for controlling the organism. It is therefore plausible that real brain network development has

both physical constraints and functional information processing constraints that guide the development of structural elements and functional dynamics. In this paper we present an embodied model of a brain network that uses both spatial and functional constraints in its evolutionary and developmental processes. We show that small-world organization can develop in such embodied systems when both constraints are present. And we compare the performance of the embodied agent to evolutionary systems that use only functional constraints to guide the systems development.

10:50AM *Modeling Oxytocin Induced Neurorobotic Trust and Intent Recognition in Human-Robot Interaction [no. 700]*

Sridhar Anumandla, Laurence Jayet Bray, Corey Thibeault, Roger Hoang and Sergiu Dascalu, University of Nevada, Reno, United States

Recent human pharmacological fMRI studies suggest that oxytocin (OT) is a centrally-acting neurotransmitter important in the development and expression of trusting relationships in men and women. OT administration in humans was shown to increase trust, acceptance of social risk, memory of faces, and inference of the emotional state of others, in part by directly inhibiting the amygdala. However, the cerebral microcircuitry underlying this mechanism is still unclear. Here, we propose a spiking integrate-and-fire neuronal model of several key interacting brain regions affected by OT neurophysiology during social trust behavior. As a social behavior scenario, we embodied the brain simulator in a behaving virtual humanoid neurorobot, which interacted with a human via a camera. At the physiological level, the amygdala tonic firing was modeled using our recurrent asynchronous irregular nonlinear (RAIN) network architecture. OT cells were modeled with triple apical dendrites characteristic of their structure in the paraventricular nucleus of the hypothalamus. Our architecture demonstrated the success of our system in learning trust by discriminating concordant from discordant movements of a human actor. This led to a cooperative versus protective behavior by the neurorobot after being challenged by a new intent.

11:10AM *A Spiking Neuronal Network Model of the Dorsal Raphe Nucleus [no. 333]*

KongFatt Wong-Lin, Girijesh Prasad and T. Martin McGinnity, University of Ulster, Northern Ireland

The raphe nucleus in the brain is the main source of serotonin (5-HT), an important brain chemical in regulating mood, cognition and behavior. This paper presents a spiking neuronal network model of the dorsal region of the raphe nucleus (DRN). We solve the perplexing problem of heterogeneous spiking neuronal behavior observed in the DRN by using an adaptive quadratic integrate- and-fire neuronal model and varying only its membrane potential reset after a spike, suggesting a potential role of certain recovery ionic currents. Specifically, the model can mimic the effects of slow afterhyperpolarization current and control the production of spikes per burst as found in experiments. Our model predicts specific input-output functions of the neurons which can be experimentally tested. Phase-plane analysis confirms it spiking dynamics. By coupling the 5-HT neurons with non-5-HT inhibitory neurons, we show that the neuronal spiking activities of putative 5-HT neurons recorded in the DRN of behaving monkeys can generally be reproduced by adopting a feedforward inhibitory network architecture. Our model further predicts a low frequency network oscillation (about 8 Hz) among non-5-HT neurons around the rewarding epoch of a simulated experimental trial, which can be verified through direct recordings in behaving animals. Our computational model of the DRN accounts for the heterogeneous spiking patterns found in experiments, suggests plausible network architecture, and provides model predictions which can be directly tested in experiments. The model conveniently forms the basis for building extended network models to study complex interactions of the 5-HT system with other brain regions.

Special Session We1-3: Neural Modeling of Socio-Cultural and Linguistic Phenomena: Neural network and neural modeling fields approaches

Wednesday, August 3, 9:30AM-11:30AM, Room: Oak, Chair: José Fontanari

9:30AM *Towards the Grounding of Abstract Words: A Neural Network Model for Cognitive Robots [no. 122]*

Francesca Stramandinoli, Angelo Cangelosi and Davide Marocco, University of Plymouth, United Kingdom

In this paper, a model based on Artificial Neural Networks (ANNs) extends the symbol grounding mechanism to abstract words for cognitive robots. The aim of this work is to obtain a semantic representation of abstract concepts through the grounding in sensorimotor experiences for a humanoid robotic platform. Simulation experiments have been developed on a software environment for the iCub robot. Words that express general actions with a sensorimotor component are first taught to the simulated robot. During the training stage the robot first learns to perform a set of basic action primitives through the mechanism of direct grounding. Subsequently, the grounding of action primitives, acquired via direct sensorimotor experience, is transferred to higher-order words via linguistic descriptions. The idea is that by combining words grounded in sensorimotor experience the simulated robot can acquire more abstract concepts. The experiments aim to teach the robot the meaning of abstract words by making it experience sensorimotor actions. The iCub humanoid robot will be used for testing experiments on a real robotic architecture.

9:50AM *From Neural Activation to Symbolic Alignment: A Network-Based Approach to the Formation of Dialogue Lexica [no. 132]*

Alexander Mehler, Andy Luecking and Peter Menke, Dep. of Computer Science and Mathematics, Goethe-University Frankfurt am Main, Germany; CRC 673, Bielefeld University, Germany

We present a lexical network model, called TiTAN, that captures the formation and the structure of natural language dialogue lexica. The model creates a bridge between neural connectionist networks and symbolic architectures: On the one hand, TiTAN is driven by the neural motor of lexical alignment, namely priming. On the other hand, TiTAN accounts for observed symbolic output of interlocutors, namely uttered words. The TiTAN series update is driven by the dialogue inherent dynamics of turns and incorporates a measure of the structural similarity of graphs. This allows to apply and evaluate the model: TiTAN is tested classifying 55 experimental dialogue data according to their alignment status. The trade-off between precision and recall of the classification results in an F-score of 0.92.

10:10AM *A Low-Power Memristive Neuromorphic Circuit Utilizing a Global/ Local Training Mechanism [no. 431]*

Garrett Rose, Robinson Pino and Qing Wu, Polytechnic Institute of New York University, United States; Air Force Research Laboratory, United States

As conventional CMOS technology approaches fundamental scaling limits novel nanotechnologies offer great promise for VLSI integration at nanometer scales. The memristor, or memory resistor, is a novel nanoelectronic device that holds great promise for continued scaling for emerging applications. Memristor behavior is very similar to that of the synapses necessary for realizing a neural network. In this research, we have considered circuits that leverage memristance in the realization of an artificial synapse that can be used to implement neuromorphic computing hardware. A charge sharing based neural network is described which consists of a hybrid of conventional CMOS technology and novel memristors. Results demonstrate that the circuit can be implemented with energy consumption on the order of tens of femto-joules. Furthermore, a training circuit is presented for implementing supervised learning in hardware with low area overhead. To help offset the area overhead a technique employing both global and local training circuits is proposed. The global trainer is responsible for deciding if training is required and in what direction (i.e., exhibit or inhibit) for a large set of synapses. A local trainer at each synapse is included to allow training to occur or not occur for a particular synapse based on the global signals supplied. The major design goal is that the global trainer be much larger and complex than any local trainer.

10:30AM *Aquila: An Open-Source GPU-Accelerated Toolkit for Cognitive and Neuro-Robotics Research [no. 370]*

Martin Peniak, Anthony Morse, Christopher Larcombe, Salomon Ramirez-Contla and Angelo Cangelosi, Centre for Robotics and Neural System of the University of Plymouth, United Kingdom

This paper presents a novel open-source software application, Aquila, developed as a part of the ITALK and RobotDoC projects. The software provides many different tools and biologically-inspired models, useful for cognitive and developmental robotics research. Aquila addresses the need for high-performance robot control by adopting the latest parallel processing paradigm, based on the NVidia CUDA technology. The software philosophy, implementation, functionalities and performance are described together with three practical examples of selected modules.

10:50AM *A Neural Network model for spatial mental imagery investigation: A study with the humanoid robot platform iCub [no. 454]*

Alessandro Di Nuovo, Davide Marocco, Santo Di Nuovo and Angelo Cangelosi, University of Catania, Italy; University of Plymouth, United Kingdom

Understanding the process behind the human ability of creating mental images of events and experiences is a still crucial issue for psychologists. Mental imagery may be considered a multimodal biological simulation that activates the same, or very similar, sensorial and motor modalities that are activated when we interact with the environment in real time. Neuro-psychological studies show that neural mechanisms underlying real-time visual perception and mental visualization are the same when a task is mentally recalled. Nevertheless, the neural mechanisms involved in the active elaboration of mental images might be different from those involved in passive elaborations. The enhancement of this active and creative imagery is the aim of most psychological and educational processes, although, more empirical effort is needed in order to understand the mechanisms and the role of active mental imagery in human cognition. In this work we present some results of on ongoing investigation about mental imagery using cognitive robotics. Here we focus on the capability to estimate, from proprioceptive and visual information, the position into a soccer field when the robot acquires the goal. Results of simulation with the iCub platform are given to show that the computational model is able to efficiently estimate the robot's position. The final objective of our work is to replicate with a cognitive robotics model the mental imagery when it is used during the training phase of athletes that are allowed to imaginary practice to score a goal.

11:10AM *Emotions of Cognitive Dissonance [no. 46]*

Jose Fontanari, Leonid Perlovsky, Marie-Claude Bonniot-Cabanac and Michel Cabanac, Universidade de Sao Paulo, Brazil; The Air Force Research Laboratory, RY, Hanscom, United States; Laval University, Canada

Basic emotions correspond to bodily signals. Many psychologists think that there are only a few basic emotions, and that most emotions are combinations of these few. Here we advance a hypothesis that the number of principally different emotions is near infinite. We consider emotions as mental states with hedonic content, indicating satisfaction and dissatisfaction. Our hypothesis is that a large number of emotions are related to the knowledge instinct (KI, or a need for knowledge). Contradictions between knowledge and bodily motivations, between various elements of knowledge are known as cognitive dissonances. We suggest that specific emotions are involved with cognitive dissonances. The number of cognitive dissonances is combinatorial in terms of elements of knowledge. Correspondingly, the number of these knowledge-related emotions is very large. We report experimental results indicating that emotions of cognitive dissonance exist. We propose that these emotions are different from basic emotions in principle, and outline future research directions toward showing that their number is large.

Session We1-4: Unsupervised Learning I

Wednesday, August 3, 9:30AM-11:30AM, Room: Monterey, Chair: Georgios Anagnostopoulos

9:30AM *Sparse Kernelized Vector Quantization with Local Dependencies [no. 325]*

Frank-Michael Schleif, University of Bielefeld, Germany

Clustering approaches are very important methods to analyze data sets in an initial unsupervised setting. Traditionally many clustering approaches assume data points to be independent. Here we present a method to make use of local dependencies to improve clustering under guaranteed distortions. Such local dependencies are very common for data generated by imaging technologies with an underlying topographic support of the measured data. We provide experimental results on artificial and real world data of clustering tasks.

9:50AM *Network-Based Learning Through Particle Competition for Data Clustering [no. 37]*

Thiago Silva and Liang Zhao, University of Sao Paulo, Brazil

Complex network provides a general scheme for machine learning. In this paper, we propose a competitive learning mechanism realized on large scale networks, where several particles walk in the network and compete with each other to occupy as many nodes as possible. Each particle can perform a random walk by choosing any neighbor to visit, a deterministic walk by choosing to visit the node with the highest domination, or a combination of them. Computer simulations show attractive results when the model is applied for data clustering problems.

10:10AM *Observed Stent's anti-Hebbian Postulate on Dynamic Stochastic Computational Synapses [no. 290]*

Subha Danushika Fernando, Koichi Yamada and Ashu Marasinghe, Nagaoka University of Technology, Japan

Unconstrained growth of synaptic connectivity and the lack of references to synaptic depression in Hebb's postulate has diminished its value as a learning algorithm. While spike timing dependent plasticity and other synaptic scaling mechanisms have been studying the possibility of regulating synaptic activity on neuronal level, we studied the possibility of regulating the synaptic activity of Hebb's neurons on dynamic stochastic computational synapses. The study was conducted on fully connected network with four artificial neurons where each neuron consisted of thousands of artificial stochastic synapses that are modeled with transmitters and receptors. The synapses updated their stochastic states dynamically according to the spike arrival time to that synapses. The activity of these synapses was regulated by a new stability promoting mechanism. Results support the following findings: (i) the synchronous activity between presynaptic (cell A) and postsynaptic (cell B) neuron increases the activity of A. (ii) Asynchronous activation of these two neurons decreases A's activity if one of the following conditions are satisfied (a). if activity of the other presynaptic neurons of the postsynaptic neuron B is asynchronous with the A's activity or (b) if B is in a depressed state when activity of presynaptic neuron A is increased. (iii) the introduced stability promoting mechanism exhibited similar to the Homeostatic synaptic plasticity process and encouraged the emergence of Hebb's postulate and its anti-Hebbian mechanisms. Further, we demonstrated the metabolic changes that could occur inside Hebb's neurons when such an activity takes place on a dynamic stochastic neural network.

10:30AM *Expectation-Maximization Approach to Boolean Factor Analysis [no. 139]*

Alexander Frolov, Dusan Husek and Pavel Polyakov, IHNA RAS, Russia; ICS AS CR, Czech Republic; VSB -Technical university Ostrava, Czech Republic

Methods for hidden structure of high-dimensional binary data discovery are one of the most important challenges facing machine learning community researchers. There are many approaches in literature that try to solve this hitherto rather ill-defined task. In the present study, we propose a most general generative model of binary data for Boolean factor analysis and introduce new Expectation- Maximization Boolean Factor Analysis algorithm which maximizes likelihood of Boolean Factor Analysis solution. Using the so-called bars problem benchmark, we compare efficiencies of Expectation-Maximization Boolean Factor Analysis algorithm with Dendritic Inhibition neural network. Then we discuss advantages and disadvantages of both approaches as regards results quality and methods efficiency.

10:50AM *Non-Gaussian Component Analysis using Density Gradient Covariance Matrix [no. 210]*

Nima Reyhani and Erkki Oja, Aalto University, Finland

High dimensional data are often modeled by signal plus noise where the signal belongs to a low dimensional manifold contaminated with high dimensional noise. Estimating the signal subspace when the noise is Gaussian and the signal is non-Gaussian is the main focus of this paper. We assume that the Gaussian noise variance can be high, so standard denoising approaches like Principal Component Analysis fail. The approach also differs from standard Independent Component Analysis in that no independent signal factors are assumed. This model is called non-Gaussian subspace/component analysis (NGCA). The previous approaches proposed for this subspace analysis use the fourth cumulant matrix or the Hessian of the logarithm of characteristic functions, which both have some practical and theoretical issues. We propose to use sample Density Gradient Covariances, which are similar to the Fisher information matrix for estimating the non-Gaussian subspace. Here, we use nonparametric kernel density estimator to estimate the gradients of density functions. Moreover, we extend the notion of non-Gaussian subspace analysis to a supervised version where the label or response information is present. For the supervised non-Gaussian subspace analysis, we propose to use conditional density gradient covariances which are computed by conditioning on the discretized response variable. A non-asymptotic analysis of density gradient covariance is also provided which relates the error of estimating the population DGC matrix using sample DGC to the number of dimensions and the number of samples.

11:10AM *Finding Dependent and Independent Components from Two Related Data Sets [no. 121]*

Juha Karhunen and Tele Hao, Aalto University, School of Science, Dept. of Information and Computer Science, Finland

Independent component analysis (ICA) and blind source separation (BSS) are usually applied to a single data set. Both these techniques are nowadays well understood, and several good methods based on somewhat varying assumptions on the data are available. In this paper, we consider an extension of ICA and BSS for separating mutually dependent and independent components from two different

but related data sets. This problem is important in practice, because such data sets are common in real-world applications. We propose a new method which first uses canonical correlation analysis (CCA) for detecting subspaces of independent and dependent components. Standard ICA and BSS methods can after this be used for final separation of these components. The proposed method performs excellently for synthetic data sets for which the assumed data model holds exactly, and provides meaningful results for real-world robot grasping data. The method has a sound theoretical basis, and it is straightforward to implement and computationally not too demanding. Moreover, the proposed method has a very important by-product: its improves clearly the separation results provided by the FastICA and UniBSS methods that we have used in our experiments. Not only are the signal-to-noise ratios of the separated sources often clearly higher, but CCA preprocessing also helps FastICA to separate sources that it alone is not able to separate.

Session We1-5: Applications II

Wednesday, August 3, 9:30AM-11:30AM, Room: Carmel, Chair: Anya Getman

9:30AM *A Hardware Suitable Integrated Neural System for Autonomous Vehicles - Road Structuring and Path Tracking [no. 423]*

Udhay Ravishankar and Milos Manic, University of Idaho, United States

Current developments in autonomous vehicle systems typically consider solutions to single problems like road detection, road following and object recognition individually. The integration of these individual systems into a single package becomes difficult because they are less compatible. This paper introduces a generic Integrated Neural System for Autonomous Vehicles (INSAV) package solution with processing blocks that are compatible with each other and are also suitable for hardware implementation. The generic INSAV is designed to account for important problems such as road detection, road structure learning, path tracking and obstacle detection. The paper begins the design of the generic INSAV by building its two most important blocks: the Road Structuring and Path Tracking Blocks. The obtained results from implementing the two blocks demonstrate an average of 92% accuracy of segmenting the road from a given image frame and path tracking of straight roads for stable motion and obstacle detection.

9:50AM *Real Time Vehicle Speed Prediction using a Neural Network Traffic Model [no. 627]*

Jungme Park, Dai Li, Yi L Murphey, Johannes Kristinsson and Ryan McGee, University of Michigan-Dearborn, United States; Ford Motor Company, United States

Prediction of the traffic information such as flow, density, speed, and travel time is important for traffic control systems, optimizing vehicle operations, and the individual driver. Prediction of future traffic information is a challenging problem due to many dynamic contributing factors. In this paper, various methodologies for traffic information prediction are investigated. We present a speed prediction algorithm, NNTM-SP(Neural Network Traffic Modeling-Speed Prediction) that trained with the historical traffic data and is capable of predicting the vehicle speed profile with the current traffic information. Experimental results show that the proposed algorithm gave good prediction results on real traffic data and the predicted speed profile shows that NNTM-SP correctly predicts the dynamic traffic changes.

10:10AM *Forecasting tropospheric ozone concentrations with adaptive neural networks [no. 392]*

Eros Pasero, Luca Mesin, Fiammetta Orione and Riccardo Taormina, Politecnico di Torino, Italy; Hong Kong Polytechnic University, China

This work concerns the description of a method for local prediction of air pollutants concentration. Pollutants are elements that threaten ecosystems leading to adverse consequences on human health. In this paper, we present an application of artificial neural networks (ANN) to perform local predictions of daily maximum tropospheric ozone concentration in the London area. Air pollution and meteorological data provided by London Air Quality Network (LAQN) have been employed for model development. Our analysis is based on previous work carried out within the NeMeFo (Neural Meteo Forecasting) research project for meteorological data short-term forecasting. The results of the optimal ANN on the different data sets were tested in terms of linear correlation coefficient (R2), root mean square error (RMSE) and ratio between the RMSE and the data set standard deviation. It emerges that the performances on the training and validation data set are generally good; the RMSE is below half the standard deviation of the output variable, with R2 of around 0.90. Performing the adaptive prediction by changing the ANN weights slightly improves the network performances. The optimal number of iterations and the adaptive step were respectively found to be 14 and 0.0019, low enough to prevent instabilities due to overtraining.

10:30AM *Wiener Systems for Reconstruction of Missing Seismic Traces [no. 231]*

Gonzalo Safont, Addisson Salazar, Luis Vergara, Raul Llinares and Jorge Igual, Universidad Politecnica de Valencia, Spain

This paper presents a new method for the reconstruction of missing data in seismic signals. The method is based on Wiener systems considering non-Gaussian statistics in the probability density function of the seismic data. Wiener structures are proposed combining different techniques for the linear and non- linear stages. The linearity in the data is recovered using kriging and cross correlation, and the data non-linearity is reconstructed using direct sample estimation and a third order polynomial approximation. The results by linear and Wiener structures are compared with the results of Multi-Layer Perceptron and Radial Basis Function networks. Several examples with real data demonstrate the efficiency of the method for seismic trace reconstruction. The accuracy of the recovered data is evaluated by the error of the estimates and statistics of the data density for the recovered data.

10:50AM *Discrete Synapse Recurrent Neural Network with Time-Varying Delays for Nonlinear System Modeling and Its Application on Seismic Signal Classification [no. 489]*

Hyung O. Park, Alireza A. Dibazar and Theodore W. Berger, University of Southern California, United States

Discrete Synapse Recurrent Neural Network (DSRNN) using fully Recurrent Neural Network (RNN) structure and Extended Kalman Filter (EKF) algorithm for its training is improved with time-varying delay in its recurrent connection. An additional

shadowing network is employed and learned to choose appropriate time delays at the right time in order to increase the memory depth inside the recurrent connection efficiently. As a lumped nonlinear model in capturing temporal dynamics related between input and output sequences, DSRNN with time-varying delay is applied to a task of seismic signal classification to discriminate footsteps and vehicles from background which are recorded in the deserts of Joshua Tree, CA. Even though the smaller sized network was trained from a smaller set of training data due to slow convergence in training, the proposed classifier showed 0.6% false recognition rate for the recognition of human footsteps, 0.8% for vehicle, and 0.0% for background. The models were able to reject quadrupedal animal's footsteps (in this study a trained dog). The system rejected the dog's footsteps with 0.1% false recognition rate.

11:10AM *Application of SOM to Analysis of Minnesota Soil Survey Data. [no. 151]*

Sauptik Dhar and Vladimir Cherkassky, University of Minnesota, United States

This paper describes data-analytic modeling of the Minnesota soil chemical data produced by the 2001 metro soil survey. The chemical composition of the soil is characterized by the concentration of many metal and non-metal constituents, resulting in high-dimensional data. This high dimensionality and possible unknown (nonlinear) correlations in the data make it difficult to analyze and interpret using standard statistical techniques. This paper applies Self Organizing Map (SOM), to present the high-dimensional soil data in a 2D format suitable for human understanding and interpretation. This SOM representation enables analysis of the soil chemical concentration trends within the Twin Cities Metropolitan area of Minnesota. These trends are important for various Minnesota regulatory agencies concerned with the concentration of polluting chemical elements due to human activities.

Session We1-6: Time Series Modeling and Prediction

Wednesday, August 3, 9:30AM-11:30AM, Room: Santa Clara, Chair: Sven Crone

9:30AM *Prediction of Electric Power Consumption for Commercial Buildings [no. 156]*

Vladimir Cherkassky, Sohini Roy Chowdhury, Volker Landenberger, Saurabh Tewari and Paul Bursch, University of Minnesota, United States; NorthWrite, United States

Currently, many commercial buildings are not continuously monitored for energy consumption, especially small buildings which constitute 90% of all such buildings. However, readily available data from the electric meters can be used for monitoring and analyzing energy consumption. Efficient utilization of available historical data (from these meters) can potentially improve energy efficiency, help to identify common energy wasting problems, and, in the future, enable various Smart Grid programs, such as demand response, real-time pricing etc. This paper describes application of computational intelligence techniques for prediction of electric power consumption. The proposed approach combines regression and clustering methods, in order to improve the prediction accuracy of power consumption, as a function of time (of the day) and temperature, using real- life data from several commercial and government buildings. Empirical comparisons show that the proposed approach provides an improvement over the currently used bin-based method for modeling power consumption.

9:50AM *GA-PAT-KNN: Framework for Time Series Forecasting [no. 487]*

Armando Goncalves, Igor Alencar, Ing-Ren Tsang and George Cavalcanti, UFPE, Brazil

A novel framework for time series prediction that integrates Genetic Algorithm (GA), Partial Axis Search Tree (PAT) and K-Nearest Neighbors (KNN) is proposed. This methodology is based on the information obtained from Technical analysis of a stock. Experiments have shown that GAs can capture the most relevant variables and improve the accuracy of predicting the direction of daily change in a stock price index. A comparison with other models shows the advantage of the proposed framework.

10:10AM *Hybrid Model Incorporating Multiple Scale dynamics for Time Series Forecasting [no. 708]*

Vishal Sharma and Dipti Srinivasan, National University of Singapore, Singapore

Most of the real world physical systems have critical thresholds, also known as tipping points, at which the system abruptly shifts its state from one to another. From dynamical system's perspective, bifurcation is the phenomenon responsible for these critical transitions in the system. There are various directions which can be adopted to study this bifurcation problem in an attempt to predict this phenomenon. The focus of this paper is classical bifurcation theory based approach incorporating multiple scale dynamics which is able to give analysis of bifurcations responsible for critical transitions in electricity price time series system. Fitz-Hugh Nagumo (FHN), which is a classical example exhibiting slow-fast scale dynamics is studied and later on hybridized with nonlinear neural networks to model this time series in various markets. Encouraging results allow us to look into this approach in future.

10:30AM *Predictions Tasks with Words and Sequences: Comparing a Novel Recurrent Architecture with the Elman Network [no. 262]*

David Gil, Jose Garcia, Miguel Cazorla and Magnus Johnsson, University of Alicante, Spain; Lund University Cognitive Science, Sweden

The classical connectionist models are not well suited to working with data varying over time. According to this, temporal connectionist models have emerged and constitute a continuously growing research field. In this paper we present a novel supervised recurrent neural network architecture (SARASOM) based on the Associative Self-Organizing Map (A-SOM). The A-SOM is a variant of the Self-Organizing Map (SOM) that develops a representation of its input space as well as learns to associate its activity with an arbitrary number of additional inputs. In this context the A-SOM learns to associate its previous activity with a delay of one iteration. The performance of the SARASOM was evaluated and compared with the Elman network in a number of prediction tasks using sequences of letters (including some experiments with a reduced lexicon of 10 words). The results are very encouraging with SARASOM learning slightly better than the Elman network.

10:50AM *Designing Dilation-Erosion Perceptrons with Differential Evolutionary Learning for Air Pressure Forecasting [no. 144]*
Ricardo Araujo, Adriano Oliveira, Sergio Soares and Silvio Meira, Informatics Center - Federal University of Pernambuco, Brazil

The dilation-erosion perceptron (DEP) is a class of hybrid artificial neurons based on framework of mathematical morphology (MM) with algebraic foundations in the complete lattice theory (CLT). A drawback arises from the gradient estimation of dilation and erosion operators into classical gradient-based learning process of the DEP model, since they are not differentiable of usual way. In this sense, we present a differential evolutionary learning process, called DEP(MDE), using a modified differential evolution (MDE) to design the DEP model for air pressure forecasting. Also, we have included an additional step into learning process, called automatic phase fix procedure (APFP), to eliminate time phase distortions observed in some forecasting problems. Furthermore, an experimental analysis is presented using two complex time series, where five well-known performance metrics and an evaluation function are used to assess forecasting performance.

11:10AM *Semi-supervised monitoring of electric load time series for unusual patterns [no. 588]*
Nikolaos Kourentzes and Sven Crone, Lancaster University Management School, United Kingdom

In this paper we propose a semi-supervised neural network algorithm to identify unusual load patterns in hourly electricity demand time series. In spite of several modeling and forecasting methodologies that have been proposed, there have been limited advancements in monitoring and automatically identifying outlying patterns in such series. This becomes more important considering the difficulty and the cost associated with manual exploration of such data, due to the vast number of observations. The proposed network learns from both labeled and unlabeled patterns, adapting automatically as more data become available. This drastically limits the cost and effort associated with exploring and labeling such data. We compare the proposed method with conventional supervised and unsupervised approaches, demonstrating higher accuracy, robustness and efficacy on empirical electricity load data.

Wednesday, August 3, 11:40AM-12:40PM

Special Session We2-1: Memristor Minds II

Wednesday, August 3, 11:40AM-12:40PM, Room: Cedar, Chair: Robert Kozma and Giovanni Pazienza

11:40AM *Computational Intelligence and Neuromorphic Computing Architectures [no. 668]*
Robinson Pino, Air Force Research Laboratory/RITC, United States

Nanoscale computing architectures offer exciting possibilities for reaching higher levels of computing systems performance and capacity. However, as amazing as the technological possibilities are, at the nanoscale, so are the challenges for its practical integration within complex computing systems. For example, neuromorphic computing promises to allow for the development of intelligent systems able to imitate natural neuro-biological processes. This is achieved by artificially re-creating the highly parallelized computing architecture of the mammalian brain. In particular, neuromorphic computers are suitable for applications in pattern recognition, i.e. image, voice, etc. In order to achieve high levels of intelligence within systems, neuromorphic computing must exploit novel complex materials and structures to achieve very large scale integration with highly parallel and dense neural architectures. Our recent research efforts at the Air Force Research Laboratory (AFRL), Information Directorate, focus on the development of neuromorphic computational devices, mathematical models, novel materials, and computational applications to develop neuromorphic computing processors. However, in order to achieve nanoscale device powered technologies, we must develop design methodologies that take advantage of the highly non-linear and environment sensitive physical behavior of such novel devices. Therefore, as we work to develop next generation nanotechnologies, we must address technological challenges such as modeling, characterization, integration, manufacturability, ecological impact, and resources. This talk will focus on the technology challenges that we are seeking to overcome to enable nanoscale parallel computing architectures. DISTRIBUTION A. Unlimited Distribution, 88ABW-2009-4021.

12:00PM *Memristor Crossbar for System Architecture [no. 711]*
Chris Yakopcic, Tarek Taha, Guru Subramanyam, Stanley Rogers and Robinson Pino, University of Dayton, United States; Air Force Research Lab, United States

The recently discovered memristor has the potential to be the building block of a high-density memory system. A memristor based crossbar memory system was analyzed in terms of timing and switching energy using SPICE. The memristor model in the simulations was designed to match the I-V characteristics of three different published devices. The simulation results for each device were compared to demonstrate the performance of a one transistor one memristor (1T1M) memristor crossbar.

12:20PM *Phase Change Memory for Synaptic Plasticity Application in Neuromorphic Systems [no. 149]*
Manan Suri, Veronique Sousa, Luca Perniola, Dominique Vuillaume and Barbara DeSalvo, CEA - LETI - MINATEC, France; IEMN - CNRS, France

In this paper, we show that Phase Change Memory (PCM) can be used to emulate specific functions of a biological synapse similar to Long Term Potentiation (LTP) and Long Term Depression (LTD) plasticity effects. The dependence of synaptic weight on programming pulse width and pulse amplitude is shown experimentally for the PCM devices. Different combinations of consecutive LTD and LTP events have been experimentally demonstrated and analyzed for the PCM synapse.

Special Session We2-2: Mining the Brain: Better Neural Networks Inspired by Neurobiology

Wednesday, August 3, 11:40AM-12:40PM, Room: Pine, Chair: Fred Harris

11:40AM *Bio-inspired Models of Memory Capacity, Recall Performance and Theta Phase Precession in the Hippocampus [no. 662]*

Vassilis Cutsuridis, Bruce P. Graham, Stuart Cobb and Michael E. Hasselmo, Boston University, United States; University of Stirling, United Kingdom; University of Glasgow, United Kingdom

The hippocampus plays an important role in the encoding and retrieval of spatial and non-spatial memories. Much is known about the anatomical, physiological and molecular characteristics as well as the connectivity and synaptic properties of various cell types in the hippocampal circuits [1], but how these detailed properties of individual neurons give rise to the encoding and retrieval of memories remains unclear. Computational models play an instrumental role in providing clues on how these processes may take place. Here, we present three computational models of the region CA1 of the hippocampus at various levels of detail. Issues such as retrieval of memories as a function of cue loading, presentation frequency and learning paradigm, memory capacity, recall performance, and theta phase precession in the presence of dopamine neuromodulation and various types of inhibitory interneurons are addressed. The models lead to a number of experimentally testable predictions that may lead to a better understanding of the biophysical computations in the hippocampus.

12:00PM *Evolving Recurrent Neural Networks are Super-Turing [no. 681]*

Jeremie Cabessa and Hava Siegelmann, University of Massachusetts Amherst, United States

The computational power of recurrent neural networks is intimately related to the nature of their synaptic weights. In particular, neural networks with static rational weights are known to be Turing equivalent, and recurrent networks with static real weights were proved to be super-Turing. Here, we study the computational power of a more biologically-oriented model where the synaptic weights can evolve rather than stay static. We prove that such evolving networks gain a super-Turing computational power, equivalent to that of static real-weighted networks, regardless of whether their synaptic weights are rational or real. These results suggest that evolution might play a crucial role in the computational capabilities of neural networks.

12:20PM *A forecast-based biologically-plausible STDP learning rule [no. 383]*

Sergio Davies, Alexander Rast, Francesco Galluppi and Steve Furber, School of Computer Science, The university of Manchester, United Kingdom

Spike Timing Dependent Plasticity (STDP) is a well known paradigm for learning in neural networks. In this paper we propose a new approach to this problem based on the standard STDP algorithm, with modifications and approximations, that relate the membrane potential with the LTP (Long Term Potentiation) part of the basic STDP rule. On the other side we use the standard STDP rule for the LTD (Long Term Depression) part of the algorithm. We show that on the basis of the membrane potential it is possible to make a statistical prediction of the time needed by the neuron to reach the threshold, and therefore the LTP part of the STDP algorithm can be triggered when the neuron receives a spike. We present results that show the efficacy of this algorithm using one or more input patterns repeated over the whole time of the simulation. Through the approximations we suggest in this paper we introduce a learning rule that is easy to implement in simulators and reduces the execution time if compared with the standard STDP rule.

Special Session We2-3: Autonomous Social Learning and Knowledge Representation

Wednesday, August 3, 11:40AM-12:40PM, Room: Oak, Chair: Yan Meng and Angelo Cangelosi

11:40AM *Embodied Cognition, Language, and Mirror Neuron System [no. 141]*

Leonid Perlovsky, Harvard University and AFRL, United States

Language and cognition seems to be very different, they are studied in different university departments, they are located in different parts of the brain, still nature gives us no separate examples of these abilities. What exactly is similar and different among language and cognition? What are functions of language in cognition, and vice versa? How are these abilities embodied? The paper develops mathematical model of interacting cognition and language based on existing cognitive data and closely related to mirror neuron system. Dynamic logic modeling fundamental mechanisms of the mind leads to a hypothesis answering above questions. Future research and verifiable experimental predictions are discussed.

12:00PM *Creative Brain and Abstract Art: a quantitative study on Kandinskij paintings [no. 493]*

Francesco Carlo Morabito, Matteo Cacciola and Gianluigi Occhiuto, University Mediterranea of Reggio Calabria, DIMET, Italy

In this paper, we speculate that abstract art can become an useful paradigm for both studying the relationship between neuroscience and art, and as a benchmark problem for the researches on Autonomous Machine Learning (AML) in brain-like computation. In particular, we are considering the case of some Kandinskij's oeuvres. There, it seems to see a deliberate willingness of introducing some effects today's hugely studied in the neuroscience, namely, for the retrieval of mental visual images or the neural correlates underlying visual tasks. The genial use of colours, geometry and vague forms generates very complex pictures that, we claim, excite preferentially mid-hierarchic levels of the bottom-up/top-down architecture of the brain, widely recognized as a possible framework for implementing AML. We introduce a quantitative metric for confirming the intuitive and psychological ranking of complexity given to paintings and pictures, the Artistic Complexity. The paintings of the artist are analysed, by selecting appropriately the oeuvres in order to point out different aspects of the topic. The concept of non-extensive Tsallis

entropy is also introduced in an information-theoretic perspective, to cope with long-range interactions, as is done in spectral analysis of the human brain EEG. fMRI experimentations are sought to justify our speculations.

12:20PM *Self-Reorganizing Knowledge Representation for Autonomous Learning in Social Agents [no. 397]*

Matthew Conforth and Yan Meng, Stevens Institute of Technology, United States

The CIVS (Civilization-Inspired Vying Societies) system is a novel evolutionary learning multi-agent system loosely inspired by the history of human civilization. CIVS uses artificial life (Alife) methods to produce highly- capable artificial intelligence (AI) agents proficient in one or more complex tasks as well as more general adaptability, reasoning, and survivability in dynamic, unpredictable environments. A new cognitive architecture called CHARISMA is proposed as a brain for the social agents within the CIVS system. In this paper, we will develop a self-growing, self-reorganizing semantic network named SHYNE (Semantic HYper NEtwork) as the basic knowledge representation data structure for the CHARISMA cognitive architecture. SHYNE builds on ideas from semantic networks, slipnets, and hypergraphs to create a very powerful and flexible data structure. We believe SHYNE will solve the problem of brittle reliance on predefined rules/relations/concepts with its extensive self-reorganizing capabilities. Experimental results demonstrate that the proposed SHYNE is efficient as the knowledge representation for social agents.

Special Session We2-5: Concept Drift and Learning in Dynamic Environments

Wednesday, August 3, 11:40AM-12:40PM, Room: Carmel, Chair: Robi Polikar

11:40AM *A Supervised Approach for Change Detection in Data Streams [no. 131]*

Alexis Bondu and Marc Boulle, Edf r and d, France; Orange Labs, France

In recent years, the amount of data to process has increased in many application areas such as network monitoring, web click and sensor data analysis. Data stream mining answers to the challenge of massive data processing, this paradigm allows for treating pieces of data on the fly and overcomes exhaustive data storage. The detection of changes in a data stream distribution is an important issue which application area is wide. In this article, change detection problem is turned into a supervised learning task. We chose to exploit the supervised discretization method "MODL" given its interesting properties. Our approach is favorably compared with an alternative method on artificial data streams, and is applied on real data streams.

12:00PM *An effective just-in-time adaptive classifier for gradual concept drifts [no. 355]*

Cesare Alippi, Giacomo Boracchi and Manuel Roveri, Politecnico di Milano, Italy

Classification systems designed to work in nonstationary conditions rely on the ability to track the monitored process by detecting possible changes and adapting their knowledge-base accordingly. Adaptive classifiers present in the literature are effective in handling abrupt concept drifts (i.e., sudden variations), but, unfortunately, they are not able to adapt to gradual concept drifts (i.e., smooth variations) as these are, in the best case, detected as a sequence of abrupt concept drifts. To address this issue we introduce a novel adaptive classifier that is able to track and adapt its knowledge base to gradual concept drifts (modeled as polynomial trends in the expectations of the conditional probability density functions of input samples), while maintaining its effectiveness in dealing with abrupt ones. Experimental results show that the proposed classifier provides high classification accuracy both on synthetically generated datasets and measurements from real sensors.

12:20PM *Semi-supervised Learning in Nonstationary Environments [no. 563]*

Gregory Ditzler and Robi Polikar, Rowan University, United States

Learning in nonstationary environments, also called learning concept drift, has been receiving increasing attention due to increasingly large number of applications that generate data with drifting distributions. These applications are usually associated with streaming data, either online or in batches, and concept drift algorithms are trained to detect and track the drifting concepts. While concept drift itself is a significantly more complex problem than the traditional machine learning paradigm of data coming from a fixed distribution, the problem is further complicated when obtaining labeled data is expensive, and training must rely, in part, on unlabelled data. Independently from concept drift research, semi-supervised approaches have been developed for learning from (limited) labeled and (abundant) unlabeled data; however, such approaches have been largely absent in concept drift literature. In this contribution, we describe an ensemble of classifiers based approach that takes advantage of both labeled and unlabeled data in addressing concept drift: available labeled data are used to generate classifiers, whose voting weights are determined based on the distances between Gaussian mixture model components trained on both labeled and unlabeled data in a drifting environment.

Session We2-4: Unsupervised Learning II

Wednesday, August 3, 11:40AM-12:40PM, Room: Monterey, Chair: Carlos Alzate

11:40AM *Evolutionary Spectral Co-Clustering [no. 235]*

Nathan Green, Manjeet Rege, Xumin Liu and Reynold Bailey, Rochester Institute of Technology, United States

Co-clustering is the problem of deriving submatrices from the larger data matrix by simultaneously clustering rows and columns of the data matrix. Traditional co-clustering techniques are inapplicable to problems where the relationship between the instances (rows) and features (columns) evolve over time. Not only is it important for the clustering algorithm to adapt to the recent changes in the evolving data, but it also needs to take the historical relationship between the instances and features into consideration. We present ESCC, a general framework for evolutionary spectral co-clustering. We are able to efficiently co-cluster evolving data by incorporation of historical clustering results. Under the proposed framework, we present two approaches, Respect To the Current (RTC), and Respect To Historical (RTH). The two approaches differ in the way the historical cost is computed. In RTC, the present clustering quality is of most importance and historical cost is calculated with only one previous timestep. RTH, on the other hand, attempts to keep instances and features tied to the same clusters between time-steps. Extensive experiments performed on synthetic and real world data, demonstrate the effectiveness of the approach.

12:00PM *Independent Component Analysis with Graphical Correlation: Applications to Multi-Vision Coding [no. 162]*

Ryota Yokote, Toshikazu Nakamura and Yasuo Matsuyama, Waseda University, Japan

New algorithms for joint learning of independent component analysis and graphical high-order correlation (GC-ICA: Graphically Correlated ICA) are presented. The presented method has a fixed point style or of the FastICA, however, it comprises independent but correlated subparts. Correlations by teacher signals are also allowed. In spite of such inclusion of the dependency, the presented algorithm shows fast convergence. The converged set of bases has reduced indeterminacy on the ordering. This is equivalent to a self-organization of bases. This method can be used to analyze multiple images simultaneously. Examples are given on images from 3D- stereo videos shots. The correlation of bases on left and right eye views is shown for the first time here. Further speedup using the strategy of the RapidICA is possible.

12:20PM *Discriminative Hat Matrix : a new tool for outlier identification and linear regression [no. 175]*

Franck Dufrenois and Jean charles Noyer, Lasl, France

The hat matrix is an important auxiliary quantity in linear regression theory for detecting errors in predictors. Traditionally, the comparison of the diagonal elements with a calibration point serves as decision rule for separating a dominant linear population from outliers. However, several problems exist : first, the calibration point is not well defined because no exact statistical distribution (asymptotic form) of the hat matrix diagonal exists [cha]. Secondly, being based on the standard covariance matrix, this outlying measure looses its efficiency when the rate of "atypical" observations becomes large [Dufre1][rou1]. In this paper, we present a discriminative version of the hat matrix (DHM) which transposes this classification problem into a subspace clustering problem. We propose a LDA-type criterion directly built on the properties of the hat matrix and which its maximization comes down to search an optimal projection subspace and an optimal indicator matrix. We will show that the statistic of the hat matrix diagonal "projected" on this optimal subspace has an exact \chi^{2} behaviour and thus makes it possible to identify outliers by way of hyptothesis testing. Synthetic data sets are used to study the performance both in terms of regression and classification of the proposed approach. We also illustrate its potential application to motion segmentation in image sequences.

Session We2-6: Financial Applications

Wednesday, August 3, 11:40AM-12:40PM, Room: Santa Clara, Chair: Li-Wei Ko

11:40AM *Forecasting Exchange Rate with Deep Belief Networks [no. 276]*

Jing Chao, Furao Shen and Jinxi Zhao, Nanjing University, China

Forecasting exchange rates is an important financial problem which has received much attention. Nowadays, neural network has become one of the effective tools in this research field. In this paper, we propose the use of a deep belief network (DBN) to tackle the exchange rate forecasting problem. A DBN is applied to predict both British Pound/US dollar and Indian rupee/US dollar exchange rates in our experiments. We use six evaluation criteria to evaluate its performance. We also compare our method to a feedforward neural network (FFNN), which is the state-of-the-art method for forecasting exchange rate with neural networks. Experiments indicate that deep belief networks (DBNs) are applicable to the prediction of foreign exchange rate, since they achieve better performance than feedforward neural networks (FFNNs).

12:00PM *A Simulation Environment for Volatility Analysis of Developed and in Development Markets [no. 505]*

Paulo Mattos Neto, Tiago Ferreira and George Cavalcanti, Federal University of Pernambuco, Brazil; Federal Rural University of Pernambuco, Brazil

In this paper, a simulation of intelligent agents is developed to recreate the environment of negotiation of stock markets. The focus is analyze the behavior of movement/fluctuation of stock markets. This movement can be captured by a measure called volatility, which is the difference between two stock prices in distinct periods. It characterizes the sensibility of a market change in the world economy. The contributions of this work are three-fold: (i)a simulation of dynamics of stock markets based in intelligent agents; (ii)based in this simulation an analysis of the volatility dynamic of the simulated time series; (iii)after that, a investigation about the relationship between the volatility of the markets, distribution of gain/loss money of agents and the coefficient of the exponential function based on the ideal gas theory of Maxwell-Boltzmann. This information can be used, for example, to predict the future behavior of the markets.

12:20PM *Graph Weighted Subspace Learning Models in Bankruptcy [no. 427]*
Bernardete Ribeiro and Ning Chen, University of Coimbra, Portugal; Polytechnic Institute of Porto, Portugal

Many dimensionality reduction algorithms have been proposed easing both tasks of visualization and classification in high dimension problems. Despite the different motivations they can be cast in a graph embedding framework. In this paper we address weighted graph subspace learning methods for bankruptcy analysis. The rationale behind re-embedding the data in a lower dimensional space that would be better filled is twofold: to get the most compact representation (visualization) and to make subsequent processing of data more easy (classification). The approaches used, Graph regularized Non-Negative Matrix Factorization (GNMF) and Spatially Smooth Subspace Learning (SSSL), construct an affinity weight graph matrix to encode geometrical information and to learn in the training set the subspace models that enhance visualization and are able to easy the task of bankruptcy prediction. The experimental results on a real problem of French companies show that from the perspective of financial problem analysis the methodology is quite effective.

Wednesday, August 3, 1:50PM-2:50PM

Plenary Talk We-Plen2: Plenary Session

Wednesday, August 3, 1:50PM-2:50PM, Room: Oak, Chair: Risto Miikkulainen

1:50PM *Deep Learning and Unsupervised Feature Learning*
Andrew Ng, Stanford University, United States

Machine learning often works very well, but can be a lot of work to apply because it requires spending a long time engineering the input representation (or "features") for each specific problem. This is true for machine learning applications in vision, audio, text/NLP and other problems. To address this, researchers have recently developed "unsupervised feature learning" and "deep learning" algorithms that can automatically learn feature representations from unlabeled data, thus bypassing much of this time-consuming engineering. Many of these algorithms are developed using simple simulations of cortical (brain) computations, and build on such ideas as sparse coding, self-taught learning, and deep belief networks. By doing so, they exploit large amounts of unlabeled data (which is cheap and easy to obtain) to learn a good feature representation. These methods have also surpassed the previous state-of-the-art on a number of problems in vision, audio, and text. In this talk, I describe some of the key ideas behind unsupervised feature learning and deep learning, and present a few algorithms.

Wednesday, August 3, 3:20PM-4:20PM

Special Session We3-1.1: Memristor Minds III

Wednesday, August 3, 3:20PM-4:20PM, Room: Cedar, Chair: Robert Kozma and Giovanni Pazienza

3:20PM *Simulation of a Memristor-Based Spiking Neural Network Immune to Device Variations [no. 376]*
Damien Querlioz, Olivier Bichler and Christian Gamrat, Univ. Paris-Sud, CNRS, France; CEA, LIST, France

We propose a design methodology to exploit adaptive nanodevices (memristors), virtually immune to their variability. Memristors are used as synapses in a spiking neural network performing unsupervised learning. The memristors learn through an adaptation of spike timing dependent plasticity. Neurons' threshold is adjusted following a homeostasis-type rule. System level simulations on a textbook case show that performance can compare with traditional supervised networks of similar complexity. They also show the system can retain functionality with extreme variations of various memristors' parameters, thanks to the robustness of the scheme, its unsupervised nature, and the power of homeostasis. Additionally the network can adjust to stimuli presented with different coding schemes.

3:40PM *An Implementation of a Chalcogenide based, Ion-Conducting Field Programmable Memristor Array (FPMA) [no. 119]*
Terry Gafron, Jennifer Regner and Kristy Campbell, Bio Inspired Technologies, LLC, United States; Boise State University, United States

An Implementation of a Chalcogenide based, Ion-Conducting Field Programmable Memristor Array (FPMA) We have designed, and are currently implementing a functional field programmable memristor array (FPMA), based on ion-conducting memristor technology. The realization of the FPMA is accomplished by utilizing a standard, commercially available 0.5um CMOS fabrication process, a proprietary BEOL memristor deposition process currently used by the Boise State University Advanced Memory and Reconfigurable Logic Group, and an FPGA front end application designed by Bio Inspired Technologies LLC. The result is a memristor based FPGA platform demonstrating the use of the ion-conducting technology as a reconfigurable logic element, memory element, and reconfigurable interconnect topology. Our design extends the use of the conventional FPGA by coupling the capabilities of the memristor based FPMA as an effective reprogrammable architecture with applications in neuromorphic systems and advanced computing architectures. The proposed FPMA consists of sixteen lookup table based Boolean

logic blocks, implemented in ion-conducting memristor technology, capable of being defined through external connections to an Altera Stratix V FPGA. Additionally, a fabric of interlocking memristors are also placed strategically as programmable interconnect points (PIP's) and can be reconfigured to allow access to each memristor logic block. The programming of the PIP's enables combinations of single block logic to be structured, forming the simple compound combinational logic architecture. Additional memristor cells, located within each programmable logic block may be configured as a non-volatile memory element, enabling the flexible reallocation of logic space and memory space on a single substrate. Defining the programming path for the FPMA system is achieved by the use of conventional VHDL code and standard industry tools (Quartus II and Modelsim), providing the pathways and front-end logic to build the lookup-tables, PIP routing, and memory cells built into the FPMA. Pulses defining the look-up table logic are generated off chip by a National Instruments PXI based buffered analog output card and routed to the FPMA by the Stratix V FPGA. The finalized implementation is a single printed circuit board containing the Stratix V FPGA, the CMOS test die with the BEOL processed memristor arrays, peripheral support circuitry, and I/O ports for programming/erasing and verifying functional performance. Subsequent pending designs include on-board pulse circuitry and leverage the FPGA clock circuitry to provide integrated programming or erasing of the memristor elements. The final demonstration of this work is to facilitate the implementation of an independent, reconfigurable FPMA that may be substituted for a conventional FPGA using established industry design tools, methodologies, and standards.

4:00PM *Class of all i-v dynamics for memristive elements in Pattern Recognition Systems [no. 474]*
Fernando Corinto, Alon Ascoi and Marco Gilli, Politecnico di Torino, Italy

The design of pattern recognition systems based on memristive oscillatory networks need to include a detailed study of the dynamics of the networks and their basic components. A simple two-cell network of this kind, where each cell is made up of a linear circuitry in parallel with a nonlinear memristive element, was found to experience a rich gamut of nonlinear behaviors. In particular, for a synchronization scenario with almost-sinusoidal oscillations, the memristive elements used in the cells exhibited an unusual current-voltage characteristic. This work focuses on the dynamics of the single cell under this synchronization scenario, and, modeling the linear circuitry with a sinusoidal voltage source, analytically derives a rigorous classification of all possible current-voltage characteristics of the periodically-driven memristive element on the basis of amplitude-angular frequency ratio and time hystory of the input source.

Wednesday, August 3, 4:20PM-6:00PM

Panel Session We3-1.2: Is the Memristor the Future of AI?

Wednesday, August 3, 4:20PM-6:00PM, Room: Cedar, Chairs: Robert Kozma and Giovanni Pazienza

Panelists: Leon Chua, Kristy Campbell, Max DiVentra, Anatoli Gorchetchnikov, Carlo Morabito, Steven Kang, Robinson Pino, Greg Snider, Tarek Taha, Paul Werbos and Don Wunsch

Wednesday, August 3, 3:20PM-6:00PM

Special Session We3-2: Advances towards Natural Human-Computer Interfaces

Wednesday, August 3, 3:20PM-6:00PM, Room: Pine, Chair: Jeff Krichmar

3:20PM *A Comparative Study of Classification Methods for Gesture Recognition using a 3-axis Accelerometer [no. 510]*
Fahad Moiz, Prasad Natoo, Reza Derakhshani and Walter Leon-Salas, University of Missouri - Kansas City, United States

We used Fisher linear discriminant analysis (LDA), static neural networks (NN), and focused time delay neural networks (TDNN) for gesture recognition. Gestures were collected in form of acceleration signals along three axes from six participants. A sports watch containing a 3-axis accelerometer, was worn by the users, who performed four gestures. Each gesture was performed for ten seconds, at the speed of one gesture per second. User-dependent and userindependent k-fold cross validations were carried out to measure the classifier performance. Using first and second order statistical descriptors of acceleration signals from validation datasets, LDA and NN classifiers were able to recognize the gestures at an average rate of 86% and 97% (user-dependent) and 89% and 85% (user-independent), respectively. TDNNs proved to be the best, achieving near perfect classification rates both for user-dependent and userindependent scenarios, while operating directly on the acceleration signals alleviating the need for explicit feature extraction.

3:40PM *Gaze Tracking Based On Pupil Estimation Using Multilayer Perception [no. 551]*
Kim Sangwook, Hwang Byunghun and Lee Minho, Kyungpook National University, Republic of Korea

Most accurate gaze trackers commonly use near IR (infrared ray) illuminators to detect a pupil rather than an iris because the pupil detection provides higher accuracy for implementing a gaze tracker and it is easier to detect the pupil under IR illumination. However, the active IR illuminating methods directly emit energies to human eyes and also generate heats to an embedded mobile device. Thus, it may be uncomfortable and unstable to utilize an active IR illuminating method in an embedded mobile device as a gaze tracker for a long time. In this paper, we propose a new gaze tracking method using a common USB camera, in which a multilayer

perceptron is applied to estimate the pupil's location using iris area information localized in a face area detected from a captured image. The pupil location information as teaching target signals for the neural network is obtained from off-line experiments using an IR camera with an illuminator. And localized iris area information obtained from on-line experiments using a common USB camera is used as input signals of the neural network. Experimental results show that the proposed method plausibly performs the pupil estimation by the multilayer perceptron and successfully generates gaze tracking by an additional calibration process.

4:00PM *Recognition of Human Physical Activity based on a novel Hierarchical Weighted Classification scheme [no. 455]*
Oresti Banos, Miguel Damas, Hector Pomares and Ignacio Rojas, University of Granada, Spain

The automatic recognition of postures, movements and physical exercises has being recently applied to several healthcare related fields, with a special interest in chronic disease management and prevention. In this work we describe a complete method to define an accurate activity recognition system, stressing on the classification stage. As binary classifiers can be, in general, considered more efficient than direct multiclass classifiers, and looking for an appropriate multiclass extension schema, a hierarchical weighted classification model with a special application for multi-sensed problems is presented. Remarkable accuracy results are obtained for a particular activity recognition problem in contrast to a traditional multiclass majority voting algorithm.

4:20PM *Emotional State Recognition from Speech via Soft-Competition on Different Acoustic Representations [no. 401]*
Arslan Shaukat and Ke Chen, National University of Sciences and Technology, Pakistan; The University of Manchester, United Kingdom

This paper presents our investigations on automatic emotional state recognition from speech signals using ensemble based methods based on different acoustic representations/feature measures. In our work, we employ various types of acoustic feature measures where none of the feature measures is optimal for emotional state classification. It is observed that different feature measures may be complementary and used simultaneously to yield a robust classification performance. Therefore, we employ a probabilistic method of combining classifiers based on different feature measures. The combination method that uses different feature measures simultaneously yields high recognition rates on various emotional speech corpora for both full feature set and language-independent feature subset. The ensemble method also outperforms a composite-feature representation and two other methods reported in literature. In addition, the classification accuracies achieved by our combination method are competitive with those mentioned in literature for different emotional speech corpora.

4:40PM *Study on Gesture Recognition System Using Posture Classifier and Jordan Recurrent Neural Network [no. 108]*
Hiroomi Hikawa and Araga Yusuke, Kansai University, Japan

This paper proposes a Jordan recurrent neural network (JRNN) based dynamic hand gesture recognition system. A set of allowed gestures is modeled by a sequence of representative static images, i.e., postures. The proposed system first classifies the input postures contained in the input video frames, and the resulting posture indexes are fed to the JRNN that can detect dynamic temporal behavior. The feasibility of the proposed system and its characteristics are examined by experiments. Especially the effects of the posture classification performance and the gesture speed are studied. Experimental results show that the system recognize 10 gestures with the accuracy of 95%.

5:00PM *Communicated Somatic Markers Benefit Both the Individual and the Species [no. 719]*
Kyle Harrington, Megan Olsen and Hava Siegelmann, Brandeis University, United States; University of Massachusetts, Amherst, United States

We use emotional communication within a predator-prey game to evaluate the tradeoff between socio-emotional behavior at individual- and species- scales. In this predator-prey game, individual predators and prey use emotion in their decision making, and communicate their emotional state with neighboring conspecifics. The model of emotion is based upon the somatic marker hypothesis. In comparing individual utility and population dynamics we find emotion is capable of both supporting species and individual gain. We suggest this type of dynamic may provide a mechanism for the emergence of altruistic behavior within a species under individual and/or group selection.

5:20PM *Spiking Neural Networks based Cortex-Like Mechanism: A Case Study for Facial Expression Recognition [no. 348]*
Siyao Fu, Guosheng Yang and Zengguang Hou, Central University of Nationalities, China; Institute of Automation, Chinese Academy of Sciences, China

Ongoing efforts within neuroscience and intelligent system have been directed toward the building of artificial computational models using simulated neuron units as basic building blocks. Such efforts, inspired in the standard design of traditional neural networks, are limited by the difficulties arising from single functional performance and computational inconvenience, especially when modeling large scale, complex and dynamic processes such as cognitive recognition. Here, we show that there is a different form of implementing cortex-like mechanism, the motivation comes directly from recent pioneering works on detailed functional decomposition analysis of the visual cortex and developments on spiking neural networks (SNNs), a promising direction for neural networks, as they utilize information representation as trains of spikes, embedded with spatiotemporal characteristics. A practical implementation is presented, which can be simply described as cortical-like feedforward hierarchy using biologically plausible neural system. As a proof of principle, a prototype model has been testified on the platform of a large scale facial expression dataset. Of note, small structure modifications and different learning schemes allow for implementing more complicated decision system, showing great potential for discovering implicit pattern of interest and further analysis. Our results support the approach of using such hierarchical consortia as an efficient way of complex pattern analysis task not easily solvable using traditional, single functional way of implementations.

5:40PM *A New Efficient SVM and Its Application to Real-time Accurate Eye Localization [no. 518]*
Shuo Chen and Chengjun Liu, New Jersey Institute of Technology, United States

For complicated classification problems, the standard Support Vector Machine (SVM) is likely to be complex and thus the classification efficiency is low. In this paper, we propose a new efficient SVM (eSVM), which is based on the idea of minimizing the margin of misclassified samples. Compared with the conventional SVM, the eSVM

is defined on fewer support vectors and thus can achieve much faster classification speed and comparable or even higher classification accuracy. We then present a real-time accurate eye localization system using the eSVM together with color information and 2D Haar wavelet features. Experiments on some public data sets show that (i) the eSVM significantly improves the efficiency of the standard SVM without sacrificing its accuracy and (ii) the eye localization system has real-time speed and higher detection accuracy than some state-of-the-art approaches.

Special Session We3-3: Neural Network Models and Human Nature

Wednesday, August 3, 3:20PM-6:00PM, Room: Oak, Chair: Dan Levine

3:20PM *Creativity and Thinking according to Cognition-Language-Music Model [no. 112]*

Leonid Perlovsky, Harvard University and AFRL, United States

Functions of conceptual cognition, emotions, language, and music in creativity and thinking are analyzed. Much of interactions between these abilities and functions are unconscious. Consciousness keeps us under illusion of continuous conscious presence in the world, in which we mostly understand causes and consequences in everyday life. Only scientific analysis could reveal most fundamental aspects of self. The paper analyses several mechanisms of the mind, which suggest that thinking is not always as autonomous and thoughtful as might be felt subjectively. A significant part of thinking processes might run on autopilot guided by language without much cognition. Creative roles of emotions are considered. Mathematical models and cognitive experiments are analyzed and experimentally verifiable hypotheses formulated.

3:40PM *Connectivity and Creativity in Semantic Neural Networks [no. 659]*

Nagendra Marupaka and Ali Minai, University of Cincinnati, United States

Creativity and insight are distinctive attributes of human cognition, but their neural basis remains poorly understood due to the difficulty experimental study. As such, computational modeling can play an important role in understanding these phenomena. Some researchers have proposed that creative individuals have a "deeper" organization of knowledge, allowing them to connect remote associates and form novel ideas. It is reasonable to assume that the depth and richness of semantic organization in individual minds is related to the connectivity of neural networks involved in semantic representation. In this paper, we use a simple and plausible neurodynamical model of semantic networks to study how the connectivity structure of these networks relates to the richness of the semantic constructs, or ideas, thay can generate. This work is motivated, in part, by research showing that experimentally obtained semantic networks have a specific connectivity pattern that is both small-world and scale-free. We show that neural semantic networks reflecting this structure have richer semantic dynamics than those with other connectivity structures. Though simple, this model may provide insight into the important issue of how the physical structure of the brain determines one of the most profound features of the human mind -- its capacity for creative thought.

4:00PM *A stochastic model of the role of semantic networks in individual and group idea generation [no. 717]*

Simona Doboli and Vincent Brown, Hofstra University, United States

Brainstorming is the process of generating a variety of alternative ideas on a topic or solutions to a problem. Brainstorming can take place individually or in groups. The factors facilitating the generation of novel, creative ideas in both settings are still not clearly understood. Experimental results show that brainstormers generate fewer ideas in a group than an equal number of individuals working alone. Yet groups are thought to be capable of producing more original ideas because the interactions between individuals' unique semantic networks create the potential for priming concepts that an individual would not be as likely to activate alone. But since groups are also affected negatively by social factors such as free-riders, fear of evaluation by others, or interference from what others are saying, the development of appropriate models can assist in determining the conditions under which both individuals and groups can generate both more ideas and more novel ideas. The probabilistic associative category model by Brown et al. (1998) represents semantic knowledge as a network of categories and the retrieval of ideas from it as a stochastic process. The model can simulate attention and short-term memory effects, and divergent and convergent thinking. It was used to replicate successfully several results from group and individual brainstorming experiments. However, the model does not account for unique individual ideas, and thus cannot be used to study the quality of ideas. More recently, neural cognitive models (Doboli and Brown (2010), Iyer et al. (2009)) represent the idea generation process as a dynamical system with ideas as emergent itinerant activity in a network of concepts and features. These models replicated several experimental results on how providing hints affects brainstorming. The current model extends the probabilistic associative model of Brown et al. (1998) by explicitly incorporating individual ideas. The model has N concept units (xi) connected among each other by conditional probabilistic links. Units in the same category have more and stronger connections among themselves than with other units. Ideas are represented as the active unit(s) at each time step. The sequence of ideas is denoted as Si(t)= {I(t), I(t-1), ..., I(0)}. The probability of a unit becoming active is updated after each time step as a discounted and normalized sum of pij(t-k), with k = 1 to M, where M is working memory capacity and j the index of units active at (t-k) steps in the past. After a unit becomes active, its probability of activation is multiplied by a small term that temporarily shuts down the unit, but maintains its influence on the other units it is connected to. The "value" of an idea can be estimated by the number of units whose pi(t) becomes larger than a threshold after the idea becomes active, representing the intuition that in brainstorming, the most valuable ideas are those that facilitate the generation of the largest number of additional ideas. We will simulate the effect of different semantic network structures and different interaction protocols on the sequence of ideas generated in individuals and in groups.

4:20PM *Neurodynamics and the mind [no. 704]*

Wlodzislaw Duch, Nicolaus Copernicus University, Poland

Is science of human experience, aimed at explaining phenomenology of mental events accessible through introspection, possible? What do we really known about ourselves and how do we know it? Psychology and neural sciences have turned away from such questions and experimentally oriented philosophers discovered formidable obstacles in attempts to answer even simple questions about the nature of conscious experience. To talk in a meaningful way about subjective mental processes a new level of description is needed, resulting from neurodynamics but connected to inner experience. Visualization of neurodynamics may lead to

geometrical, continuous models of mental events. It should allow to view brains and artificial cognitive systems form mental perspective.

4:40PM *Neural Networks As a Path to Self-Awareness [no. 716]*
Paul Werbos, NSF, CLION, IntControl, United States

There has been important new cross-disciplinary work using neural network mathematics to unify key issues in engineering, technology, psychology and neuroscience - and many opportunities to create a discrete revolution in science by pushing this further. That particular strain of research has a natural link to clinical and subjective human experience - "first person science" of the mind. This paper discusses why and how, and gives several examples of links between neural network models and key phenomena in human experience, such as Freud's "psychic energy," the role of traumatic experience, the interpretation of dreams and creativity and the cultivation of human potential and sanity in general, and the biological foundations of language.

5:00PM *The Pitfalls of Doing the Right Thing for the Wrong Reason [no. 193]*
Daniel Levine, University of Texas at Arlington, United States

In a previous model of the Wisconsin Card Sorting task, the correct sorting rule shifted several times from one sorting criterion (e.g., color matching) to another criterion (e.g., shape matching). Yet a few of the cards matched a template simultaneously on the old and the new criterion. It was found that correct answers on those cards slowed the change from the old to the new rule. An analogy can be drawn to real-life situations involving changes of prevailing rules, such as a change from a neurotic to an adaptive pattern in psychotherapy or a change from an incorrect to a correct method for solving algebra problems. Actions that fit both the old and the new rules can adventitiously prolong the survival of the maladaptive old rule.

5:20PM *Mental Disorders within a Cognitive Architecture [no. 101]*
Ron Sun, Nick Wilson and Robert Mathews, RPI, United States; LSU, United States

This paper explores how mental disorders of certain types might be explained based on mechanisms and processes of human motivation (including drives and goals) and action selection (as well as other related mechanisms and processes), within a generic, comprehensive computational cognitive architecture model. Several simulation tests have been conducted that demonstrate that the model is reasonable and captures some characteristics of certain mental disorders. The work is a first step in showing the feasibility of integrating mental disorders modeling/simulation into a cognitive architecture model.

Special Session We3-5: Complex-Valued Neural Networks

Wednesday, August 3, 3:20PM-6:00PM, Room: Carmel, Chair: Igor Aizenberg, Danilo Mandic, Akira Hirose and Jacek Zurada

3:20PM *On Retrieval Performance of Associative Memory by Complex-valued Synergetic Computer [no. 296]*
Kimura Masaaki, Isokawa Teijiro, Nishimura Haruhiko and Matsui Nobuyuki, University of Hyogo, Japan

Properties and performances of associative memories, based on Complex-valued Synergetic Computer (CVSC), are explored in this paper. All the parameters of CVSC are encoded by complex values. CVSC is extended from the conventional Synergetic Computer (RVSC) in which the parameters are real values. Performances of associative memories in CVSC are investigated through a problem of image retrievals where the input images are partially occluded or noise-affected. From the experimental results concerning the retrieval performances related to various sizes of images and different levels of defectiveness of input images, we found that CVSC outperforms RVSC.

3:40PM *Fully Complex-valued ELM Classifiers for Human Action Recognition [no. 577]*
Venkatesh Babu Radhakrishnan and Suresh Sundaram, Indian Institute of Science, India; Nanyang Technological University, Singapore

In this paper, we present a fast learning neural network classifier for human action recognition. The proposed classifier is a fully complex-valued neural network with a single hidden layer. The neurons in the hidden layer employ the fully complex-valued hyperbolic secant as the activation function. The parameters of the hidden layer are chosen randomly and the output weights are estimated as the minimum norm least square solution to a set of linear equations. The fast leaning neural classifier is used for recognizing human actions accurately. Optical flow-based features extracted from the video sequences are utilized to recognize 10 different human actions. The feature vectors are computationally simple first order statistics of the optical flow vectors, obtained from coarse to fine rectangular patches centered around the object. The results indicate the superior performance of the complex-valued neural classifier for action recognition. The superior performance of the complex neural network for action recognition stems from the fact that motion, by nature, consists of two components, one along each of the axes.

4:00PM *A Class of Fast Quaternion Valued Variable Stepsize Stochastic Gradient Learning Algorithms for Vector Sensor Processes [no. 574]*
Mingxuan Wang, Clive Cheong Took and Danilo Mandic, Imperial College London, United Kingdom

We introduce a class of gradient adaptive stepsize algorithms for quaternion valued adaptive filtering based on three- and four-dimensional vector sensors. This equips the recently introduced quaternion least mean square (QLMS) algorithm with enhanced tracking ability and enables it to be more responsive to dynamically changing environments, while maintaining its desired characteristics of catering for large dynamical differences and coupling between signal components. For generality, the analysis is performed for the widely linear signal model, which by virtue of accounting for signal noncircularity, is optimal in the mean squared error (MSE) sense for both second order circular (proper) and noncircular (improper) processes. The widely linear QLMS (WL-QLMS) employing the proposed adaptive stepsize modifications is shown to provide enhanced performance for both synthetic and real world quaternion valued signals. Simulations include signals with drastically different component dynamics, such as four dimensional quaternion comprising three dimensional turbulent wind and air temperature for renewable energy applications.

4:20PM *Classification of Blurred Textures using Multilayer Neural Network Based on Multi-Valued Neurons [no. 289]*
Igor Aizenberg, Jacob Jackson and Shane Alexander, Texas A and M University-Texarkana, United States

In this paper, we consider the problem of blurred texture classification using a multilayer neural network based on multi-valued neurons (MLMVN). We use the frequency domain as a feature space. The low frequency part of the Fourier phase spectrum of a blurred image remains almost unaffected by blur. This means that phases corresponding to the lowest frequencies can be used as features for classification. MLMVN is the most suitable machine learning tool for solving the problem, since it uses phases as inputs. MLMVN is based on multi-valued neurons whose inputs and output are located on the unit circle and therefore they are determined exactly by phases. This determines a very important ability of MLMVN and MVN to treat phases properly We employ in this paper a slightly modified learning MLMVN rule and a modified learning strategy, which extends margins between classes' representatives used for the learning and the borders of classes. This approach makes it possible to classify with 100% accuracy even such heavily blurred textures where visual analysis and classification are not possible at all.

4:40PM *Complex-Valued Functional Link Network Design by Orthogonal Least Squares Method for Function Approximation Problems [no. 318]*
Md. Faijul Amin, Ramasamy Savitha, Muhammad Ilias Amin and Kazuyuki Murase, University of Fukui, Japan; Nanyang Technological University, Singapore; United International University, Bangladesh

This paper presents a fully complex-valued functional link network (CFLN). The CFLN is a single-layered neural network, which introduces nonlinearity in the input layer using nonlinear functions of the original input variables. In this study, we consider multivariate polynomials as the nonlinear functions. Unlike multilayer neural networks, the CFLN is free from local minima problem, and it offers very fast learning in parameters because of its linear structure. In the complex domain, polynomial based CFLN has an additional advantage of not requiring activation functions, which is a major concern in the complex-valued neural networks. However, it is important to select a smaller subset of polynomial terms (monomials) for faster and better performance, since the number of all possible monomials may be quite large. In this paper, we use the orthogonal least squares method in a constructive fashion (starting from lower degree to higher) for the selection of a parsimonious subset of monomials. Simulation results demonstrate that computing CFLN in purely complex domain is advantageous than in double-dimensional real domain, in terms of number of connection parameters, faster design, and possibly generalization performance. Moreover, our proposed CFLN compares favorably with several other multilayer networks in the complex domain.

5:00PM *A Fast Learning Fully Complex-valued Relaxation Network (FCRN) [no. 297]*
Suresh Sundaram, Savitha Ramasamy and Sundararajan Narasimhan, School of Computer Engineering, Nanyang Technological University, Singapore; School of Electrical and Electronics Engineering, Nanyang Technological University, Singapore

This paper presents a fast learning algorithm for a single hidden layer complex-valued neural network named as the "Fully Complex-valued Relaxation Network"(FCRN). FCRN employs a fully complex-valued Gaussian like activation function (sech) in the hidden layer and an exponential activation function in the output layer. FCRN estimates the minimum energy state of a logarithmic error function which represents both the magnitude and phase errors explicitly to compute the optimum output weights for randomly chosen hidden layer parameters. As the weights are computed by the inversion of a nonsingular matrix, FCRN requires lesser computational effort during training. Performance studies using a synthetic function approximation problem and a QAM equalization problem show improved approximation ability of the proposed FCRN network.

5:20PM *Models of Clifford Recurrent Neural Networks and Their Dynamics [no. 228]*
Yasuaki Kuroe, Kyoto Institute of Technology, Japan

Recently, models of neural networks in the real domain have been extended into the high dimensional domain such as the complex and quaternion domain, and several high-dimensional models have been proposed. These extensions are generalized by introducing Clifford algebra (geometric algebra). In this paper we extend conventional real-valued models of recurrent neural networks into the domain defined by Clifford algebra and discuss their dynamics. Since geometric product is non-commutative, some different models can be considered. We propose three models of fully connected recurrent neural networks, which are extensions of the real- valued Hopfield type neural networks to the domain defined by Clifford algebra. We also study dynamics of the proposed models from the point view of existence conditions of an energy function. We discuss existence conditions of an energy function for two classes of the Hopfield type Clifford neural networks.

5:40PM *A Fast Learning Complex-valued Neural Classifier for Real-valued Classification Problems [no. 467]*
Savitha Ramasamy, Suresh Sundaram and Sundararajan Narasimhan, School of Electrical and Electronics Engineering, Nanyang Technological University, Singapore; School of Computer Engineering, Nayang Technological University, Singapore

This paper presents a fast learning fully complex-valued classifier to solve real-valued classification problems, called the 'Fast Learning Complex-valued Neural Classifier' (FLCNC). The FLCNC is a single hidden layer network with a non-linear, real to complex transformed input layer, a hidden layer with a fully complex activation function and a linear output layer. The neurons in the input layer convert the real-valued input features to the Complex domain using an unique non-linear transformation. At the hidden layer, the complex-valued transformed input features are mapped onto a higher dimensional Complex plane using a fully complex-valued activation function of the type of 'sech'. The parameters of the input and hidden neurons of the FLCNC are chosen randomly and the output parameters are estimated analytically which makes the FLCNC to perform fast classification. Moreover, the unique nonlinear input transformation and the orthogonal decision boundaries of the complex-valued neural network help the FLCNC to perform accurate classification. Performance of the FLCNC is demonstrated using a set of multi-category and binary real valued classification problems with both balanced and unbalanced data sets from the UCI machine learning repository. Performance comparison with existing complex-valued and real-valued classifiers show the superior classification performance of the FLCNC.

Session We3-4: Optimization

Wednesday, August 3, 3:20PM-6:00PM, Room: Monterey, Chair: Robi Polikar

3:20PM *Ant Colony Optimization Changing the Rate of Dull Ants and its Application to QAP [no. 581]*

Sho Shimomura, Haruna Matsushita and Yoshifumi Nishio, Tokushima University, Japan; Kagawa University, Japan

In our previous study, we have proposed an Ant Colony Optimization with Intelligent and Dull Ants (IDACO) which contains two kinds of ants. We have applied IDACO to various Traveling Salesman Problems (TSPs) and confirmed its effectiveness. This study proposes an Ant Colony Optimization Changing the Rate of Dull Ants (IDACO-CR) and its Application to Quadratic Assignment Problems (QAPs). In addition to the existence of the dull ants which cannot trail the pheromone, the rate of dull ants in IDACO-CR is changed flexibly and automatically in the simulation, depending on the problem. We investigate the behavior of IDACO-CR in detail and the effect of changing the rate of dull ants. Simulation results show that IDACO-CR gets out from the local optima by changing the rate of dull ants, and we confirm that IDACO-CR obtains the effective results in solving complex optimization problems.

3:40PM *Solving a Real Large Scale Mid-term Scheduling for Power Plants via Hybrid Intelligent Neural Networks Systems [no. 176]*

Ronaldo Aquino, Otoni Nobrega Neto, Milde Lira and Manoel Carvalho Jr., UFPE, Brazil

This paper deals with an application of Artificial Neural Network (ANN) and a Hybrid Intelligent System (HIS) to solve a large scale real world optimization problem, which is an operation planning of generation system in the mid-term operation. This problem is related to economic power dispatch that minimizes the overall production cost while satisfying the load demand. These kinds of problem are large scale optimization problems in which the complexity increases with the planning horizon and the accuracy of the system to be modeled. This work considers the two-phase optimization neural network, which solves dynamically linear and quadratic programming problems with guaranteed optimal convergence and HIS, which combines ANN and Heuristics Rules (HRs) to boost the convergence speed. This network also provides the corresponding Lagrange multiplier associated with each constraint (marginal price). The results pointed out that the applications of the HIS have turned the implementation of ANN models in software more attractive.

4:00PM *Water Quantity Prediction Based on Particle Swarm Optimization and Evolutionary Algorithm Using Recurrent Neural Networks [no. 450]*

Nian Zhang and Shuhua Lai, University of the District of Columbia, United States; Virginia State University, United States

Stormwater pollution is one of most important issues that the District of Columbia faces. Urban stormwater pollution can be a large contributor to the water quality problems of many receiving waters, as runoff transports a wide spectrum of pollutants to local receiving waters and their cumulative magnitude is large. Therefore, evaluations of stormwater runoff quantity are necessary to enhance the performance of an assessment operation and develop better water resources management and plan. However, some computational intelligence methods that have most successful applications on time series prediction have not yet been investigated on water quantity prediction. Only a limited number of neural networks models were applied to the water quantity monitoring. Therefore, we proposed an Elman style based recurrent neural network on the water quantity prediction. A hybrid learning algorithm incorporating particle swarm optimization and evolutional algorithm was presented, which takes the complementary advantages of the two global optimization algorithms. The neural networks model was trained by particle swarm optimization and evolutional algorithm to forecast the stormwater runoff discharge. The USGS real-time water data at Four Mile Run station at Alexandria, VA were used as time series input. The excellent experimental results demonstrated that the proposed method provides a suitable prediction tool for the stormwater runoff monitoring.

4:20PM *Chaotic Routing Strategy with Load-Balanced Effects for Communication Networks [no. 349]*

Takayuki Kimura and Tohru Ikeguchi, Nagasaki University, Japan; Saitama University, Japan

To establish reliable communicate between end users, alleviation of the congestion of packets in the communication networks is the most important problem. As one of the effective routing strategies for reliable communication, we have also proposed a routing strategy with chaotic neurodynamics. By a refractory effect which is the most important effect of chaotic neuron, the routing strategy shows high performance for communication networks as compared to the shortest path approach. In addition, we improved the routing strategy by combining information of the shortest paths and waiting times at adjacent nodes. However, in the previous works, the chaotic routing strategy was evaluated for ideal communication networks; each node has same transmission capability for routing the packets and same size of buffer for storing the packets. From a view point of realistic application of the chaotic routing strategy, it is important to evaluate the performance of the routing strategy under realistic conditions. Thus, in this paper, we evaluate the chaotic routing strategy for the realistic communication networks. Results show that the chaotic routing strategy keeps the highest arrival rate of the packets as compared to the conventional routing strategies by avoiding the congestion of the packets effectively. Also, we confirmed that the chaotic routing strategy has much possibility for application in the real communication networks.

4:40PM *Computational Intelligence Methods for Helicopter Loads Estimation [no. 395]*

Julio J. Valdes, Catherine Cheung and Weichao Wang, National Research Council Canada, Institute for Information Technology, Canada; National Research Council Canada, Institute for Aerospace Research, Canada

Accurately determining component loads on a helicopter is an important goal in the helicopter structural integrity field. While measuring dynamic component loads directly is possible, these measurement methods are not reliable and are difficult to maintain. This paper explores the potential of using computational intelligence methods to estimate some of these helicopter dynamic loads. Thirty standard time-dependent flight state and control system parameters were used to construct a set of 180 input variables to estimate the main rotor blade normal bending during forward level flight at full speed. Unsupervised nonlinear mapping was used to study the structure of the multidimensional time series from the predictor and target variables. Based on these criteria, black and white box modeling techniques (including ensemble models) for main rotor blade normal bending prediction were

applied. They include neural networks, local linear regression and model trees, in combination with genetic algorithms based on residual variance (gamma test) for predictor variables selection. The results from this initial work demonstrate that accurate models for predicting component loads can be obtained using the entire set of predictor variables, as well as with smaller subsets found by computational intelligence based approaches.

5:00PM *Optimization of Wavelet Neural Networks for Nonlinear System Identification [no. 630]*
Juan Cordova and Wen Yu, CINVESTAV-IPN, Mexico

In the construction of a Wavelet Neural Network, the number of neurons is determined by the traslation coefficient and by the dilations coefficient. Exists two ways to set the value of the traslation coefficients and dilation, one is considering the coefficients like a hidden layer of the network and the other way is establishing fixed values to those coefficients, where there remains the problem of establishing the number of fixed values to be taken, in this paper we present an algorithm to determine the number of fixed values, that they minimize a rate that depends on the approximation error and the number of neurons that are used.

5:20PM *Solving Traveling Salesman Problem by a Hybrid Combination of PSO and Extremal Optimization [no. 320]*
Saeed Khakmardan, Hanieh Poostchi and Mohammad -R Akbarzadeh -T, Department of Artificial Intelligence, Mashhad Branch, Islamic Azad University, Iran; Ferdowsi University of Mashhad, Iran

Particle Swarm Optimization (PSO) has received great attention in recent years as a successful global search algorithm, due to its simple implementation and inexpensive computation overhead. However, PSO still suffers from the problem of early convergence to locally optimal solutions. Extremal Optimization (EO) is a local search algorithm that has been able to solve NP hard optimization problems. The combination of PSO with EO benefits from the exploration ability of PSO and the exploitation ability of EO, and reduces the probability of early trapping in the local optima. In other words, due to the EO's strong local search capability, the PSO focuses on its global search by a new mutation operator that prevents loss of variety among the particles. This is done when the particle's parameters exceed the problem conditions. The resulting hybrid algorithm Mutated PSO-EO (MPSO-EO) is then applied to the Traveling Salesman Problem (TSP) as a NP hard multimodal optimization problem. The performance of the proposed approach is compared with several other meta-heuristic methods on 3 well known TSP databases and 10 unimodal and multimodal benchmark functions.

5:40PM *Multi-Objective Evolutionary Optimization of Exemplar-Based Classifiers: A PNN Test Case [no. 365]*
Talitha Rubio, Tiantian Zhang, Michael Georgiopoulos and Assem Kaylani, University of Central Florida, United States; InCube, United Arab Emirates

In this paper the major principles to effectively design a parameter-less, multi-objective evolutionary algorithm that optimizes a population of probabilistic neural network (PNN) classifier models are articulated; PNN is an example of an exemplar-based classifier. These design principles are extracted from experiences, discussed in this paper, which guided the creation of the parameter-less multi-objective evolutionary algorithm, named MO-EPNN (multi- objective evolutionary probabilistic neural network). Furthermore, these design principles are also corroborated by similar principles used for an earlier design of a parameter-less, multi-objective genetic algorithm used to optimize a population of ART (adaptive resonance theory) models, named MO-GART (multi- objective genetically optimized ART); the ART classifier model is another example of an exemplar-based classifier model. MO-EPNN's performance is compared to other popular classifier models, such as SVM (Support Vector Machines) and CART (Classification and Regression Trees), as well as to an alternate competitive method to genetically optimize the PNN. These comparisons indicate that MO-EPNN's performance (generalization on unseen data and size) compares favorably to the aforementioned classifier models and to the alternate genetically optimized PNN approach. MO-EPPN's good performance, and MO-GART's earlier reported good performance, both of whose design relies on the same principles, gives credence to these design principles, delineated in this paper.

Session We3-6: Learning and Neural Dynamics

Wednesday, August 3, 3:20PM-6:00PM, Room: Santa Clara, Chair: Emilio Del Moral Hernandez

3:20PM *The effects of feedback and lateral connections on perceptual processing: a study using oscillatory networks [no. 258]*
A. Ravishankar Rao and Guillermo Cecchi, IBM Research, United States

We model neural dynamical behavior during object perception using the principle of sparse coding in multi-layer oscillatory networks. The network model consists of units with amplitude and phase variables, and allows the propagation of higher-level information to lower levels via feedback connections. We show that this model can replicate findings in the neuroscience literature, where measurements have shown that neurons in lower level visual areas respond in a delayed fashion to missing contours of whole objects. We contrast the behavior of feedback connections with that of lateral connections by selectively disabling these in our model to examine their contributions to object perception. This paper successfully extends the previously reported capabilities of oscillatory networks by applying them to model perceptual tasks.

3:40PM *Perturbation Theory for Stochastic Learning Dynamics [no. 424]*
Todd Leen and Robert Friel, OHSU, United States

On-line machine learning and biological spike-timing-dependent plasticity (STDP) rules both generate Markov chains for the synaptic weights. We give a perturbation expansion (in powers of the learning rate) for the dynamics that, unlike the usual approximation by a Fokker-Planck equation (FPE), is rigorous. Our approach extends the related system size expansion by giving an expansion for the probability density as well as its moments. Applied to two observed STDP learning rules, our approach provides better agreement with Monte-Carlo simulations than either the FPE or a simple linearized theory. The approach is also applicable to stochastic neural dynamics.

4:00PM *An Echo State Network Architecture Based on Volterra Filtering and PCA with Application to the Channel Equalization Problem [no. 142]*
Levy Boccato, Amauri Lopes, Romis Attux and Fernando Jose Von Zuben, School of Electrical and Computer Engineering / University of Campinas, Brazil

Echo state networks represent a promising alternative to the classical approaches involving recurrent neural networks, as they ally processing capability, due to the existence of feedback loops within the dynamical reservoir, with a simplified training process. However, the existing networks cannot fully explore the potential of the underlying structure, since the outputs are computed via linear combinations of the internal states. In this work, we propose a novel architecture for an echo state network that employs the Volterra filter structure in the output layer together with the Principal Component Analysis technique. This idea not only improves the processing capability of the network, but also preserves the simplicity of the training process. The proposed architecture has been analyzed in the context of the channel equalization problem, and the obtained results highlight the adequacy and the advantages of the novel network, which achieved a convincing performance, overcoming the other echo state networks, especially in the most challenging scenarios.

4:20PM *Sparse Analog Associative Memory via L1-Regularization and Thresholding [no. 416]*
Rakesh Chalasani and Jose Principe, Computational NeuroEngineering lab, University of Florida, United States; Computational NeuroEngineering Lab, University of Florida, United States

The CA3 region of the hippocampus acts as an auto-associative memory and is responsible for the consolidation of episodic memory. Two important characteristics of such a network is the sparsity of the stored patterns and the non-saturating firing rate dynamics. To construct such a network, here we use a maximum a posteriori based cost function, regularized with L1-norm, to change the internal state of the neurons. Then a linear thresholding function is used to obtain the desired output firing rate. We show how such a model leads to a more biologically reasonable dynamic model which can produce a sparse output and recalls with good accuracy when the network is presented with a corrupted input.

4:40PM *Latent Learning - What your net also learned [no. 287]*
Steven Gutstein, Olac Fuentes and Eric Freudenthal, University of Texas at El Paso, United States

A neural net can learn to discriminate among a set of classes without explicitly training to do so. It does not even need exposure to any instances of those classes. The learning occurs while the net is being trained to discriminate among a set of related classes. This form of transfer learning is referred to as `Latent Learning' by psychologists, because the acquired knowledge remains latent until specifically elicited. Evidence that latent learning has occurred lies in the existence of consistent, unique responses to the unseen classes. Standard supervised learning can improve the accuracy of those responses with exceedingly small sets of labeled images. In this paper, we use a convolutional neural net (CNN) to demonstrate not only a method of determining a net's latent responses, but also simple ways to optimize latent learning. Additionally, we take advantage of the fact that CNN's are deep nets in order to show how the latently learned accuracy of the CNN may be greatly improved by allowing only its output layer to train. We compare our results both to those obtained with standard backpropagation training of the CNN on small datasets without any transfer learning and to a related set of current published results.

5:00PM *Preliminary Studies on Parameter Aided EKF-CRTRL Equalizer Training for Fast Fading Channels [no. 504]*
Pedro Gouvea Coelho and Luiz Biondi Neto, State University of Rio de Janeiro, Brazil

This paper shows an enhanced training for the EKF-RTRL (Extended Kalman Filter - Real Time Recurrent Learning) single neuron Equalizer using heuristic mechanisms on the training algorithms enabling them to make the training process initial conditions set-up more automatic. The method uses a parameter which evolves accordingly in the training period. The equalizer is used for fast fading selective frequency channels using the WSS_US (Wide Sense Stationary - Uncorrelated Scattering) model. The EKF-RTRL is a symbol by symbol neural equalizer. The performance results here presented depicts several scenarios regarding the channel variation speed. The performance considered in this paper is the symbol error rate (SER).

5:20PM *Stability Analysis of Layered Digital Dynamic Networks Using Dissipativity Theory [no. 357]*
Nam Nguyen and Martin Hagan, Oklahoma State University, United States

The purpose of this paper is to describe how dissipativity theory can be used for the analysis of discrete- time recurrent neural networks. Using dissipativity theory, we have found conditions for the asymptotic stability of equilibrium points of Layered Digital Dynamic Networks (LDDNs), a very general class of recurrent neural networks. We assume that the weights and biases of the LDDN are fixed, the inputs to the LDDN are constant, and there exists an equilibrium point. The LDDNs are then transformed into a standard interconnected system structure. Finally, a fundamental theorem describing the stability of interconnected dissipative systems is applied. The theorem leads to several new sufficient conditions for the stability of equilibrium points for LDDNs. These conditions are demonstrated on several test problems and compared to previously proposed stability conditions. The techniques described here can be applied to the design of neural network controllers and can also be used to provide constraints for recurrent network training.

5:40PM *A Neurodynamical Model of Context-Dependent Category Learning [no. 625]*
Laxmi Iyer and Ali Minai, University of Cincinnati, United States

The abstraction of patterns from data and the formation of categories is a hallmark of human cognitive ability. As such, it has been studied from many different perspectives by researchers, and these studies have led to several explanatory models. In this paper, we consider the inference of categorical representations for the purpose of producing task-specific responses. Task-relevant responses require a knowledge repertoire that is organized to allow efficient access to useful information. We present a neurodynamical system that infers functionally coherent categories from semantic inputs (or concepts) presented sequentially in different contexts, and encodes them as attractors in a two-dimensional topological feature space. The resulting category representations can then act as pointers in a larger system for semantic cognition. The system allows controlled hierarchical organization and functional segregation of the inferred categories.

Wednesday, August 3, 6:15PM-7:30PM

Plenary Talk We-DR: David Rumelhart Memorial Plenary Session

Wednesday, August 3, 6:15PM-7:30PM, Room: Bayshore Ballroom, Chair: Hava Siegelmann

6:15PM *Learning Natural Language Semantics*
Michael Jordan, University of California at Berkeley, United States

What is the total population of the ten largest capitals in the US? Answering free-form questions such as this requires modeling the deep semantics of language. But is it possible for a learner to acquire these deep semantics from only surface-level supervision, e.g., question/answer pairs? We answer affirmatively, by developing a new tree-based semantic representation with favorable linguistic and computational properties, along with an algorithm that induces this hidden representation. Using our approach, we obtain significantly higher accuracy on the task of question answering compared to existing state-of-the-art methods, despite using less supervision (Joint work with Percy Liang and Dan Klein).

Thursday, August 4, 8:00AM-9:30AM

Plenary Talks Th-Plen1: Featured Plenary Session: The Emergence of Mind

Thursday, August 4, 8:00AM-9:30AM, Room: Oak, Chair: Steven Bressler

8:00AM *The Making of Mind through the Action-Perception Cycle*
Walter Freeman, University of California at Berkeley, United States

Phylogenetically speaking, mind emerged through the need for food. Primitive vertebrates flourished using their abilities to experience the need, predict odorant chemicals in the environment that signified acceptable foods, search through the environment with tactile, visual and auditory guidance, categorize multiple modality-specific sensory inputs, synthesize a multisensory gestalt, create a cognitive map with which to label each sample giving the time and place of each acquisition, and store and recall significant memories for personal use in future searches. Vertebrates invented cognitive codes with which to make, store and recall their memories as categories of what foods to look for, where, and when. The code for memories is a landscape of chaotic attractors in each cortex. The sensory code is microscopic. Samples are taken by search (sniffing, looking, whisking), conveyed by spatial patterns of action potentials, and mapped in each cortex by topographically organized axons. The perceptual code is macroscopic. Each cortex creates a burst of amplitude-modulated gamma oscillation by a phase transition that resembles the condensation of a gas to a liquid. Every cortical neuron participates in every percept by time multiplexing in a feature vector. The vectors combine in the entorhinal cortex in a multisensory gamma burst. Recursion of the high-dimensional vector through the hippocampal loop incorporates time and place. The entorhinal cortex broadcasts each new vector in a global burst of beta oscillation, as demonstrated in 64-channel EEGs (Ruiz et al., 2011). The neural-mental search image closes the action-perception cycle and is integrated into the personal memory bank. Ruiz Y, Pockett S, Freeman WJ, Gonzales E, Li Guang (2010) A method to study global spatial patterns related to sensory perception in scalp EEG. J Neuroscience Methods 191: 110-118. Freeman WJ, Kozma R [2010] Freeman's mass action. Scholarpedia, 5(1): 8040. http://www.scholarpedia.org/article/Freeman%27s_mass_action

8:30AM *Conscious Experience and the Observing Ego: A Dynamic Global Workspace Hypothesis*
Bernard Baars, The Neuroscience Institute, United States

Global Workspace (GW) theory aims to explain the differences between conscious and unconscious brain activities, such as the striking limited capacity of conscious contents vs. the vast capacities of unconscious memory storage, automatic skills, implicit knowledge and subcortical computations. Like any theory, this one must explain its own observable indices. The most widely used behavioral index of consciousness is accurate reportability of brain events attributed to a stable executive perceiver. A global workspace is a domain of signal integration and propagation in a set of parallel-interacting processors that combine to resolve ambiguous or unpredictable signals. In nature, animals encounter such signals very often, and the ability to resolve them in a timely way can be a matter of life or death. The contents of consciousness are supported by reentrant cortical and thalamic signaling, regulated by waking state modulation. Anatomically the cortico-thalamic (C-T) system is by far the largest parallel-interactive structure in the brain. Major C-T hubs are well suited for global signal integration and dissemination. Dynamic signals in the C-T core are interpreted in the egocentric/allocentric maps of the parietal and medial temporal lobes. MTL-parietal maps enable a stable egocentric platform for visual conscious input and voluntary control (Milner and Goodale, 2004). In the case of conscious vision, a dynamic Global Workspace (dGW) integrates occipital, temporal and parietal oscillations into a single gestalt, emerging as a preconscious P3 waveform in the visual event-related potential (ERP). After achieving equilibrium, the P3 propagates a burst of phase-locked gamma/theta oscillations to multiple receiving populations in frontoparietal regions, appearing in the ERP as a conscious vs. unconscious difference wave between 400-600 ms (Del Cul et al, 2004; Revonsuo et al 2006). Receiving populations resonate to match the global signal. When a widespread match is achieved the global event fades from consciousness. A second integrative wave of dGW activity combines in the frontal lobes for voluntary control of the vocal tract and cranioskeletal muscles. This second wave enables voluntary actions with respect to conscious visual events with very high accuracy. Recurrence of the posterior dGW may be triggered by a control cycle using a frontal-basal ganglia-thalamic loop. Conscious experiences also evoke longterm coding of novel gestalts by way of MTL-neocortical theta oscillations.

9:00AM *Social Cognition: Learning Gaze Following, Joint Attention, Imitation, and Tool Use*
Stephen Grossberg, Boston University, United States

The emergence of a mind depends upon many factors, notably the ability to learn from teachers who see the world through a different perspective. How can an infant, or robot, incrementally learn through visual experience to imitate actions of adult teachers, despite the fact that the infant and adult view one another and the world from different perspectives? To accomplish this, an infant needs to learn how to share joint attention with adult teachers and to follow their gaze towards valued goal objects. The infant also needs to be capable of view-invariant object learning and recognition whereby it can carry out goal-directed behaviors, such as the use of tools, using different object views than the ones that its teachers use. Such capabilities are often attributed to ''mirror neurons''. This attribution does not, however, explain the brain processes whereby these competences arise. The CRIB (Circular Reactions for Imitative Behavior) model suggests how a child's brain may achieve these goals through inter-personal circular reactions. Inter-personal circular reactions generalize the intra-personal circular reactions of Piaget, which clarify how infants learn from their own babbled arm movements and reactive eye movements how to carry out volitional reaches, with or without tools, towards valued goal objects. The CRIB model proposes how intra-personal circular reactions create a foundation for inter-personal circular reactions when infants and other learners interact with external teachers in space. Both types of circular reactions involve learned coordinate transformations between body-centered arm movement commands and retinotopic visual feedback, and coordination of processes within and between the What and Where cortical processing streams. Specific breakdowns of model processes generate formal symptoms similar to clinical symptoms of autism. Supported in part by the DARPA SyNAPSE program and the NSF Science of Learning program. References: Cao, Y., Grossberg, S., and Markowitz, J. (2011). How does the brain rapidly learn and reorganize view- and positionally-invariant object representations in inferior temporal cortex? Neural Networks, in press. Fazl, A., Grossberg, S., and Mingolla, E. (2009). View-invariant object category learning, recognition, and search: How spatial and object attention are coordinated using surface-based attentional shrouds. Cognitive Psychology, 58, 1-48. Grossberg, S. and Seidman, D. (2006). Neural dynamics of autistic behaviors: Cognitive, emotional, and timing substrates. Psychological Review, 113, 483-525. Grossberg, S., and Vladusich, T. (2010). How do children learn to follow gaze, share joint attention, imitate their teachers, and use tools during social interactions? Neural Networks, 23, 940-965. Grossberg, S., Markowitz, J., and Cao, Y. (2011). On the road to invariant recognition: Explaining tradeoff and morph properties of cells in inferotemporal cortex using multiple-scale task-sensitive attentive learning. Neural Networks, in press. Huang, T.-R., and Grossberg, S. (2010). Cortical dynamics of contextually cued attentive visual learning and search: Spatial and object evidence accumulation. Psychological Review, 117, 1080-1112.

Thursday, August 4, 10:00AM-12:20PM

Session Th1-1: Bioinformatics and Biomedical Applications

Thursday, August 4, 10:00AM-12:20PM, Room: Cedar, Chair: Li-Wei Ko

10:00AM *Sparse Bayesian Prediction of Disordered Residues and Disordered Regions Based on Amino-Acid Composition [no. 341]*
Gavin Cawley, Steven Hayward, Gareth Janacek and Geoff Moore, University of East Anglia, United Kingdom

This paper presents some initial results of an investigation into the use of machine learning methods to detect natively disordered regions in proteins from sequence information. A committee of Relevance Vector Machines is used to select the optimal window size for residue-by-residue prediction of disordered regions, based on local amino-acid composition. The minimal error rate of approx 15% is achieved using very long (205 residue) window lengths, with the classifier making little use of more local sequence information. This suggests that disorder arises principally due to large scale diffuse changes in mean hydropathy and to a lesser extent mean charge. We also demonstrate that the proportion of proteins having long disordered regions in operational conditions cannot be reliably estimated using a classifier trained on a balanced dataset.

10:20AM *Inferring method of the Gene Regulatory Networks using Neural Networks Adopting a Majority Rule [no. 618]*
Yasuki Hirai, Masahiro Kikuchi and Hiroaki Kurokawa, Tokyo University of Technology, Japan

The regulatory interaction between gene expressions is considered as a universal mechanism in biological systems and such a mechanism of interactions has been modeled as gene regulatory networks. The gene regulatory networks show a correlation among gene expressions. A lot of methods to describe the gene regulatory network have been developed. Especially, owing to the technologies such as DNA microarrays that provide a number of time course data of gene expressions, the gene regulatory network models described by differential equations have been proposed and developed in recently. To infer such a gene regulatory network using differential equations, it is necessary to approximate many unknown functions from the time course data of gene expressions that is obtained experimentally. One of the successful inference methods of the gene regulatory networks is the method using the neural network. In this study, to improve a performance of the inference, we propose the inferring method of the gene regulatory networks using neural networks adopting a kind of majority rule. Simulation results show the validity of the proposed method.

10:40AM *Chaos of Protein Folding [no. 408]*
Jacques Bahi, Nathalie Cote and Christophe Guyeux, Computer Science Laboratory LIFC, University of Franche-Comte, France; University of Franche-Comte, France

As protein folding is a NP-complete problem, artificial intelligence tools like neural networks and genetic algorithms are used to attempt to predict the 3D shape of an amino acids sequence. Underlying these attempts, it is supposed that this folding process is predictable. However, to the best of our knowledge, this important assumption has been neither proven, nor studied. In this paper the topological dynamic of protein folding is evaluated. It is mathematically established that protein folding in 2D hydrophobic-hydrophilic (HP) square lattice model is chaotic as defined by Devaney. Consequences for both structure prediction and biology are then outlined.

11:00AM *Optimistic bias in the assessment of high dimensional classifiers with a limited dataset [no. 554]*

Weijie Chen and David Brown, Food and Drug Administration, United States

It is commonly recognized that using the same dataset for training and testing the classifier introduces optimistic bias in estimating classifier performance. However, bias of the same kind may still exist even when independent datasets are used for training and testing a classifier. This problem is especially important in the setting of high dimensional feature space and limited data. Bioinformatics data is typically characterized by a tremendous amount of data per patient but from a limited number of patients. Often the entire data set is utilized in a "pre-training" stage during which the feature set is winnowed to a manageable number, and the parameters of the training algorithm are established. Subsequently the data is bifurcated into training and test sets; however, bias has already been introduced into the classifier development process. We investigate the significance of this bias by performing simulated gene expression experiments. We find that, for data with moderate intrinsic separability and modest sample size, any observed separation is due to selection bias introduced in the aforementioned pre-training process. For greater intrinsic separability, correct data hygiene, i.e., complete separation of development and validation data yields a positive result, but one far less impressive than that mistakenly obtained using incomplete data separation.

11:20AM *Fetal Electrocardiogram Extraction and R-Peak Detection for Fetal Heart Rate Monitoring using Artificial Neural Network and Correlation [no. 24]*

M. A. Hasan, M. B. I. Reaz and M. I. Ibrahimy, International Islamic University Malaysia, Malaysia; Universiti Kebangsaan Malaysia, Malaysia

Conventional techniques are often unable to achieve the Fetal Electrocardiogram FECG extraction and R-peak detection in FECG from the abdominal ECG (AECG) in satisfactorily level for Fetal Heart Rate (FHR) monitoring. A new methodology by combining the Artificial Neural Network (ANN) and Correlation approach has been proposed in this paper. Artificial Neural Network is chosen primarily since it is adaptive to the nonlinear and time-varying features of the ECG signal. The supervised multilayer perception (MLP) network has been used because it requires a desired output in order to learn. Similarly, the Correlation method has been chosen as the correlation factor can be used to scale the MECG when subtracting it from the AECG, in order to get the FECG. By combining these two approaches the proposed methodology gives better and efficient result in terms of accuracy for FECG extraction and R-peak detection in the AECG signal due to its above characteristics. The proposed approach involves the FECG extraction from the AECG signal with the accuracy of 100% and R-peak detection performance is 93.75%, even though the overlapping situation of MECG and FECG signal in the AECG signal. Therefore the physician and clinician can make the correct decision for the well-being status of the fetus and mother during the pregnancy period.

11:40AM *An Innovative Positional Pattern Detection Tool Applied to GAL4 Binding Sites in Yeast [no. 506]*

Heike Sichtig and Alberto Riva, University of Florida, United States

The computational identification of regulatory elements in genomic DNA is key to understanding the regulatory infrastructure of a cell. We present an innovative tool to identify Transcription Factor Binding Sites (TFBSs) in genomic sequences. We show that our Positional Pattern Detection tool is able to attain high sensitivity and specificity of TFBS detection by capturing dependencies between nucleotide positions within the TFBS, thereby elucidating complex interactions that may be critical for the TFBS activity. Further, we unveil a combination of two biologically realistic information-processing methods that underlie our tool: spiking neural networks are used to represent the structure of TFBSs, and a genetic algorithm is used for optimization of network parameters. Initially, the networks are trained to distinguish known TFBS binding sites from negative examples in the learning phase. Then, the evolved network is used to detect novel TFBSs in genomic sequences. Moreover, we show an application of our method to GAL4 binding sites in yeast. A two-neuron network topology is trained with real data from TRANSFAC and SCPD and evaluated through simulation. We show how neuron and synapse parameters can be evolved to improve classification results. Furthermore, the networks' predictions were compared against MAPPER, TFBIND and TFSEARCH. Our results reveal that our innovative tool has the potential to attain very high classification accuracy, with a very small number of false positives. These results show that information-processing methods are able to capture important positional information in TFBSs and should be explored further to look at complex relationships underlying transcriptional and epigenetic regulation.

12:00PM *Magnetic Resonance Imaging Estimation of Longitudinal Relaxation Rate Change in Dual Gradient Echo Sequences Using an Adaptive Model [no. 515]*

Hassan Bagher-Ebadian, Siamak Nejad-Davarani, Meser Ali, Stephen Brown, Malek Makki, Quan Jiang, Douglas Noll and James Ewing, Henry Ford Hospital, United States; University Children Hospital of Zurich, Switzerland

Magnetic Resonance Imaging (MRI) estimation of contrast agent concentration in fast pulse sequences such as Dual Gradient Echo (DGE) imaging is challenging. An Adaptive Neural Network (ANN) was trained with a map of contrast agent concentration estimated by Look-Locker technique (modified version of inversion recovery imaging) as a gold standard. Using a set of features extracted from DGE MRI data, an ANN was trained to create a voxel based estimator of the time trace of CA concentration. The ANN was trained and tested with the DGE and LL information of six Fisher rats using a K-Folding Cross-Validation (KFCV) method with 60 folds and 10500 samples. The Area Under the Receiver Operator Characteristic Curve (AUROC) for 60 folds was used for training, testing and optimization of the ANN. After training and optimization, the optimal ANN (4:7:5:1) produced maps of CA concentration which were highly correlated ($r=0.89$, $P < 0.0001$) with the CA concentration estimated from by the LL technique. The estimation made by the ANN had an excellent overall performance (AUROC = 0.870).

Session Th1-2: Spiking Neural Networks

Thursday, August 4, 10:00AM-12:20PM, Room: Pine, Chair: Nikola Kasabov

10:00AM *Neuronal Avalanche Induced by Multiplicative Spike-Timing-Dependent Plasticity [no. 323]*

Shuhei Ohno, Hideyuki Kato and Tohro Ikeguchi, Graduate school of Science and Engineering, Saitama University, Japan

Recent studies in the field of neuroscience have reported that neuronal avalanches are observed in the cortical areas of the brain. The neuronal avalanches are considered as one of the mechanisms of memory functions in the brain. However, it still remains elusive what is a key factor to produce neuronal avalanches. To clarify this issue, we considered spike-timing-dependent plasticity (STDP) as a candidate for the mechanism to induce the neuronal avalanches because STDP constructs functional cortical circuits. In this paper, based on this idea, we analyzed neuronal activities in networks constructed through STDP from viewpoints of neuronal avalanche.

10:20AM *Simulation of Large Neuronal Networks with Biophysically Accurate Models on Graphics Processors [no. 672]*

Mingchao Wang, Boyuan Yan, Jingzhen Hu and Peng Li, Texas A M University, United States

Efficient simulation of large-scale mammalian brain models provides a crucial computational means for understanding complex brain functions and neuronal dynamics. However, such tasks are hindered by significant computational complexities. In this work, we attempt to address the significant computational challenge in simulating large-scale neural networks based on the most biophysically accurate Hodgkin-Huxley (HH) neuron models. Unlike simpler phenomenological spiking models, the use of HH models allows one to directly associate the observed network dynamics with the underlying biological and physiological causes, but at a significantly higher computational cost. We exploit recent commodity massively parallel graphics processors (GPUs) to alleviate the significant computational cost in HH model based neural network simulation. We develop look-up table based HH model evaluation and efficient parallel implementation strategies geared towards higher arithmetic intensity and minimum thread divergence. Furthermore, we adopt and develop advanced multi-level numerical integration techniques well suited for intricate dynamical and stability characteristics of HH models. On a commodity GPU card with 240 streaming processors, for a neural network with one million neurons and 200 million synaptic connections, the presented GPU neural network simulator is about 600X faster than a basic serial CPU based simulator, 28X faster than the CPU implementation of the proposed techniques, and only two to three times slower than the GPU based simulation using simpler phenomenological spiking models.

10:40AM *An Extended Evolving Spiking Neural Network Model for Spatio-Temporal Pattern Classification [no. 544]*

Haza Nuzly Abdull Hamed, Nikola Kasabov, Siti Mariyam Shamsuddin, Harya Widiputra and Kshitij Dhoble, Auckland University of Technology, New Zealand; Universiti Teknologi Malaysia, Malaysia

This paper proposes a new model of an Evolving Spiking Neural Network (ESNN) for spatio-temporal data (STD) classification problems. The proposed ESNN model incorporates an additional layer for capturing both spatial and temporal components of the STD and then transforms them into high dimensional spiking patterns. These patterns are learned and classified in the evolving classification layer of the ESNN. A fast time-to-first-spike learning algorithm is used that enables the new model to be more suitable for learning from the STD streams in an adaptive and incremental manner. The proposed method is evaluated on a benchmark sign language video that is spatio-temporal in nature. The results show that the proposed method is able to capture important spatio-temporal information from the STD stream. This results in significantly higher classification accuracy than the traditional time-delay MLP neural network model. Future directions for the development of ESNN models for STD are discussed.

11:00AM *A Novel Asynchronous Digital Spiking Neuron Model and its Various Neuron-like Bifurcations and Responses [no. 169]*

Takashi Matsubara and Hiroyuki Torikai, Osaka University, Japan

A novel spiking neuron model whose nonlinear dynamics is described by an asynchronous cellular automaton is presented. The model can be implemented by a simple digital sequential logic circuit but can exhibit various neuron-like bifurcations and responses. Using the Poincare mapping technique, it is clarified that the model can reproduce major bifurcation mechanisms of excitabilities and spikings of biological and model neurons. It is also clarified that the model can reproduce major excitatory responses of the neurons.

11:20AM *A Novel Piece-Wise Constant Analog Spiking Neuron Model and its Neuron-like Excitabilities [no. 166]*

Yutaro Yamashita and Hiroyuki Torikai, Osaka University, Japan

A novel analog spiking neuron model which has a piece-wise constant (ab. PWC) vector field and can be implemented by a simple electronic circuit is proposed. Using theories on discontinuous ODEs, the dynamics of the proposed model can be reduced into a one-dimensional return map analytically. Using the return map, it is shown that the proposed model can exhibit various neuron-like behaviors and bifurcations. It is also shown that the model can reproduce not only the individual neuron-like behaviors and bifurcations but also relations among them that are typically observed in biological and model neurons.

11:40AM *Lateral Inhibitory Networks: Synchrony, Edge Enhancement, and Noise Reduction [no. 218]*

Cornelius Glackin, Liam Maguire, Liam McDaid and John Wade, University of Ulster, Intelligent Systems Research Centre, United Kingdom

This paper investigates how layers of spiking neurons can be connected using lateral inhibition in different ways to bring about synchrony, reduce noise, and extract or enhance features. To illustrate the effects of the various connectivity regimes spectro-temporal speech data in the form of isolated digits is employed. The speech samples are pre-processed using the Lyon's Passive Ear cochlear model, and then encoded into tonotopically arranged spike arrays using the BSA spiker algorithm. The spike arrays are then subjected to various lateral inhibitory connectivity regimes configured by two connectivity parameters, namely connection length and neighbourhood size. The combination of these parameters are demonstrated to produce various effects such as transient synchrony, reduction of noisy spikes, and sharpening of spectro-temporal features.

12:00PM *Unsupervised Features Extraction from Asynchronous Silicon Retina through Spike-Timing-Dependent Plasticity [no. 188]*
Olivier Bichler, Damien Querlioz, Simon J. Thorpe, Jean-Philippe Bourgoin and Christian Gamrat, CEA, LIST, France; Univ. Paris-Sud, CNRS, France; CNRS Univ. Toulouse 3, France; CEA, IRAMIS, France

In this paper, we present a novel approach to extract complex and overlapping temporally correlated features directly from spike-based dynamic vision sensors. A spiking neural network capable of performing multilayer unsupervised learning through Spike-Timing-Dependent Plasticity is introduced. It shows exceptional performances at detecting cars passing on a freeway recorded with a dynamic vision sensor, after only 10 minutes of fully unsupervised learning. Our methodology is thoroughly explained and first applied to a simpler example of ball trajectory learning. Two unsupervised learning strategies are investigated for advanced features learning. Robustness of our network to synaptic and neuron variability is assessed and virtual immunity to noise and jitter is demonstrated.

Thursday, August 4, 10:00AM-11:20AM

Panel Session Th1-3.1: Autonomous Machine Learning Panel I

Thursday, August 4, 10:00AM-11:20AM, Room: Oak, Chairs: John Weng and Asim Roy

Panelists: Bruno Apolloni, Wlodek Duch, Walter Freeman, Ali Minai, Carlo Francesco Morabito, Leonid Perlovsky, Juyang Weng and Asim Roy

Thursday, August 4, 11:20AM-12:20PM

Panel Session Th1-3.2: Autonomous Machine Learning Panel II

Thursday, August 4, 11:20AM-12:20PM, Room: Oak, Chairs: Asim Roy and John Weng

Panelists: Janusz Starzyk, Ron Sun, Bernard Widrow, Asim Roy, and Juyang Weng

Thursday, August 4, 10:00AM-12:20PM

Session Th1-4: Brain Computer Interface & EEG

Thursday, August 4, 10:00AM-12:20PM, Room: Monterey, Chair: Jose Principe

10:00AM *A Two-fold classification for composite decision about localized arm movement from EEG by SVM and QDA techniques [no. 291]*
Anwesha Khasnobish, Saugat Bhattacharyya, Amit Konar, Dewakinandan Tibarewala and Atulya Nagar, Jadavpur University, India; Liverpool Hope University, United Kingdom

Disabled people now expect better quality of life with the development of brain computer interfaces (BCIs) and neuroprosthetics. EEG (electroencephalograph) based BCI research for robot arm control mainly concentrates on distinguishing the left/right arm movement. But for controlling artificial arm in real life scenario with greater degrees of freedom, it is essential to classify the left/right arm movement further into different joint movements. In this paper we have classified the raw EEG signal for left and right hand movement, followed by further classification of each hand movement into elbow, finger and shoulder movements. From the two electrodes of interest, namely, C3 and C4, wavelet coefficients, power spectral density (PSD) estimates for the alpha and beta bands and their corresponding powers were selected as the features for this study. These features are further fed into the quadratic discriminant analysis (QDA), linear support vector machine (LSVM) and radial basis function kernelized support vector machine (RSVM) to classify into the intended classes. For left- right hand movement, the maximum classification accuracy of 87.50% is obtained using wavelet coefficient for RSVM classifier. For the multi-class classification, i.e., Finger-Elbow-Shoulder classification the maximum classification accuracy of 80.11% for elbow, 93.26% for finger and 81.12% for shoulder is obtained using the features obtained from power spectral density for RSVM classifier. The results presented in this paper indicates that elbow- finger-shoulder movement can be successfully classified using the given set of features.

10:20AM *Classification of EEG During Imagined Mental Tasks by Forecasting with Elman Recurrent Neural Networks [no. 564]*
Elliott Forney and Charles Anderson, Colorado State University, United States

The ability to classify EEG recorded while a subject performs varying imagined mental tasks may lay the foundation for building usable Brain-Computer Interfaces as well as improve the performance of EEG analysis software used in clinical settings. Although a number of research groups have produced EEG classifiers, these methods have not yet reached a level of performance that is acceptable for use in many practical applications. We assert that current approaches are limited by their ability to capture the temporal and spatial patterns contained within EEG. In order to address these problems, we propose a new generative technique for EEG classification that uses Elman Recurrent Neural Networks. EEG recorded while a subject performs one of several imagined mental tasks is first modeled by training

a network to forecast the signal a single step ahead in time. We show that these models are able to forecast EEG well with an RMSE as low as 0.110. A separate model is then trained over EEG belonging to each class. Classification of previously unseen data is performed by applying each model and assigning the class label associated with the network that produced the lowest forecasting error. This approach is tested on EEG collected from two able-bodied subjects and one subject with a high-level spinal cord injury. Classification rates as high as 93.3% are achieved for a two-task problem with decisions made every second yielding a bitrate of 38.7 bits per minute.

10:40AM *Analysis of absence seizure EEG via Permutation Entropy spatio-temporal clustering [no. 306]*

Nadia Mammone and Francesco C. Morabito, DIMET, Mediterranean University of Reggio Calabria, Italy

The genesis of epileptic seizures is nowadays still mostly unknown. The hypothesis that most of scientist share is that an abnormal synchronization of different groups of neurons seems to trigger a recruitment mechanism that leads the brain to the seizure in order to reset this abnormal condition. If this is the case, a gradual transformation of the characteristics of the EEG can be hypothesized. It is therefore necessary to find a parameter that is able to measure the synchronization level in the EEG and, since the spatial dimension has to be taken into account if we aim to find out how the different areas in the brain recruit each other to develop the seizure, a spatio-temporal analysis of this parameter has to be carried out. In the present paper, a spatio-temporal analysis of EEG synchronization in 24 patients affected by absence seizure is proposed and the results are hereby reported and compared to the results obtained with a group of 40 healthy subjects. The spatio-temporal analysis is based on Permutation Entropy (PE). We found out that, ever since the interictal stages, fronto-temporal areas appear constantly associated to PE levels that are higher compared to the rest of the brain, whereas the parietal/occipital areas appear associated to low-PE. The brain of healthy subjects seems to behave in a different way because we could not see a recurrent behaviour of PE topography.

11:00AM *A Brain-Computer Interface for classifying EEG correlates of chronic mental stress [no. 171]*

Reza Khosrowabadi, Chai Quek, Kai Keng Ang, Sau Wai Tung and Michel Heijnen, Center for Computational Intelligence, Division of Computer Science, School of Computer Engineering, Nanyang Technological University, Singapore; Institute for Infocomm Research, A*STAR, Singapore; School of Medical Technology, Zuyd University, Netherlands

In this paper, a Brain-Computer Interface (BCI) for classifying EEG correlates of chronic mental stress is proposed. Data from 8 EEG channels are collected from 26 healthy right-handed students during university examination period and after the examination whereby the former is considered to be relatively more stressful to students than the latter. The mental stress level are measured using the Perceived Stress Scale 14 (PSS-14) and categorized into stressed and stress-free groups. The proposed BCI is then used to classify the subjects' mental stress level on EEG features extracted using the Higuchi's fractal dimension of EEG, Gaussian mixtures of EEG spectrogram, and Magnitude Square Coherence Estimation (MSCE) between the EEG channels. Classification on the EEG features is then performed using the K-Nearest Neighbor (K-NN) and Support Vector Machine (SVM). The performance of the proposed BCI is then evaluated from the inter-subject classification accuracy using leave-one-out validation. The results showed that the proposed BCI using features extracted by MSCE yielded a promising inter-subject validation accuracy of over 90% in classifying the EEG correlates of chronic mental stress.

11:20AM *EEG denoising with a Recurrent Quantum Neural Network for a Brain-Computer Interface [no. 331]*

Vaibhav Gandhi, Vipul Arora, Laxmidhar Behera, Girijesh Prasad, Damien Coyle and Martin McGinnity, Intelligent Systems Research Centre, University of Ulster, United Kingdom; Indian Institute of Technology Kanpur, India

Brain-computer interface (BCI) technology is a means of communication that allows individuals with severe movement disability to communicate with external assistive devices using the electroencephalogram (EEG) or other brain signals. This paper presents an alternative neural information processing architecture using the Schrodinger wave equation SWE) for enhancement of the raw EEG signal. The raw EEG signal obtained during the motor imagery (MI) of a BCI user is intrinsically embedded with non-Gaussian noise while the actual signal is still a mystery. The proposed work in the field of recurrent quantum neural network (RQNN) is designed to filter such non-Gaussian noise using an unsupervised learning scheme without making any assumption about the signal type. The proposed learning architecture has been modified to do away with the Hebbian learning associated with the existing RQNN architecture as this learning scheme was found to be unstable for complex signals such as EEG. Besides this, the soliton behaviour of the non-linear SWE was not properly preserved in the existing scheme. The unsupervised learning algorithm proposed in this paper is able to efficiently capture the statistical behaviour of the input signal while making the algorithm robust to parametric sensitivity. This denoised EEG signal is then fed as an input to the feature extractor to obtain features which are then used to train a Linear Discriminant Analysis (LDA) classifier. It is shown that the classification accuracy (CA) over the training and the evaluation datasets using the filtered EEG is much higher compared to that using the raw EEG. The improvement in CA computed over the nine subjects is found to be statistically significant.

11:40AM *Filter Bank Feature Combination (FBFC) approach for Brain-Computer Interface [no. 294]*

Zheng Yang Chin, Kai Keng Ang, Cuntai Guan, Chuanchu Wang and Haihong Zhang, Institute for Infocomm Research, A*STAR, Singapore

The Filter Bank Common Spatial Pattern (FBCSP) algorithm constructs and selects subject-specific discriminative CSP features from a filter bank of spatial-temporal filters in a motor imagery brain-computer interface (MI-BCI). However, information from other types of features could be extracted and combined with CSP features to enhance the classification performance. Hence this paper proposes a Filter Bank Feature Combination (FBFC) approach and investigates the use of CSP and Phase Lock Value (PLV) features, where the latter measures the phase synchronization between the EEG electrodes. The performance of the FBFC using CSP and PLV features is evaluated on four-class motor imageries from the publicly available BCI Competition IV Dataset IIa. The experimental results showed that the proposed FBFC using CSP and PLV features yielded a significant improvement in cross-validation accuracies on the training data ($p=0.008$) and better session-to-session transfer accuracies to the evaluation data compared to the use of CSP features using the FBCSP algorithm. This motivates the research of FBFC using a battery of other features that could possibly benefit EEG-based BCIs and multi-modal BCI systems.

12:00PM *Filter Bank Common Spatial Pattern (FBCSP) algorithm using online adaptive and semi-supervised learning [no. 105]*

Kai Keng Ang, Zheng Yang Chin, Haihong Zhang and Cuntai Guan, Institute for Infocomm Research, A*STAR, Singapore

The Filter Bank Common Spatial Pattern (FBCSP) algorithm employs multiple spatial filters to automatically select key temporal-spatial discriminative EEG characteristics and the Naive Bayesian Parzen Window (NBPW) classifier using offline learning in EEG-based Brain-Computer Interfaces (BCI). However, it has yet to address the non-stationarity inherent in the EEG between the initial calibration session and subsequent online sessions. This paper presents the FBCSP that employs the NBPW classifier using online adaptive learning that augments the training data with available labeled data during online sessions. However, employing semi-supervised learning that simply augments the training data with available data using predicted labels can be detrimental to the classification accuracy. Hence, this paper presents the FBCSP using online semi-supervised learning that augments the training data with available data that matches the probabilistic model captured by the NBPW classifier using predicted labels. The performances of FBCSP using online adaptive and semi-supervised learning are evaluated on the BCI Competition IV datasets IIa and IIb and compared to the FBCSP using offline learning. The results showed that the FBCSP using online semi-supervised learning yielded relatively better session-to-session classification results compared against the FBCSP using offline learning. The FBCSP using online adaptive learning on true labels yielded the best results in both datasets, but the FBCSP using online semi-supervised learning on predicted labels is more practical in BCI applications where the true labels are not available.

Session Th1-5: Pattern Analysis: Biology and Engineering

Thursday, August 4, 10:00AM-12:20PM, Room: Carmel, Chair: Hiroomi Hikawa

10:00AM *Computational Intelligence Methods for Underwater Magnetic-based Protection Systems [no. 74]*

Decherchi Sergio, Leoncini Davide, Gastaldo Paolo, Zunino Rodolfo and Faggioni Osvaldo, DIBE - Univ. of Genoa, Italy; National Institute of Geophysics and Volcanology, Italy

Magnetic-based detection technologies for undersea protection systems are very effective in monitoring critical areas where weak signal sources are difficult to identify (e.g. diver intrusion in proximity of the seafloor). The complexity of the involved geomagnetic phenomena and the nature of the target detection strategy require the use of adaptive methods for signal processing. The paper shows that Computational Intelligence (CI) models can be integrated with those magnetic-based technologies, and presents an effective, reliable system for adaptive undersea protection. Two different CI paradigms are successfully tested for the specific application task: Circular BackPropagation (CBP) and Support Vector Machines (SVMs). Experimental results on real data prove the advantage of the integrated approach over existing conventional methods. Individual CI components and the overall detection system have been verified in real experiments.

10:20AM *Perfect Recall from Noisy Input Patterns with a Dendritic Lattice Associative Memory [no. 127]*

Gerhard X. Ritter and Gonzalo Urcid, University of Florida, United States; INAOE, Mexico

We introduce a methodology for constructing an associative memory that is highly robust in the presence of noisy inputs. The memory is based on dendritic computing employing lattice algebraic operations. A major consequence of this approach is the avoidance of convergence problems during the training phase and rapid association of perfect and non-perfect input patterns with stored associated patterns.

10:40AM *Finding Patterns in Labeled Graphs Using Spectrum Feature Vectors in a SOM Network [no. 259]*

Rigoberto Fonseca, Pilar Gomez-Gil, Jesus Gonzalez and Ivan Olmos, National Institute of Astrophysics, Optics and Electronics, Mexico; Benemerita Universidad Autonoma de Puebla, Mexico

Knowledge discovery in structured databases is very important nowadays. In the last years, graph-based data mining algorithms have used artificial neural networks as tools to support clustering. Several of these algorithms have obtained promising results, but they show expensive computational costs. In this work we introduce an algorithm for clustering graphs based on a SOM network, which is part of a process for discovering useful frequent patterns in large graph databases. Our algorithm is able to handle non-directed, cyclic graphs with labels in vertices and edges. An important characteristic is that it presents polynomial computational complexity, because it uses as input a feature vector built with the spectra of the Laplacian of an adjacent matrix. Such matrix contains codes representing the labels in the graph, which preserves the semantic information included in the graphs to be grouped. We tested our algorithm in a small set of graphs and in a large structured database, finding that it creates meaningful groups of graphs.

11:00AM *Improving Classification Accuracy by Identifying and Removing Instances that Should Be Misclassified [no. 553]*

Michael Smith and Tony Martinez, Brigham Young University, United States

Appropriately handling noise and outliers is an important issue in data mining. In this paper we examine how noise and outliers are handled by learning algorithms. We introduce a filtering method called PRISM that identifies and removes instances that should be misclassified. We refer to the set of removed instances as ISMs (instances that should be misclassified). We examine PRISM and compare it against 3 existing outlier detection methods and 1 noise reduction technique on 48 data sets using 9 learning algorithms. Using PRISM, the classification accuracy increases from 78.5% to 79.8% on a set of 53 data sets and is statistically significant. In addition, the accuracy on the non-outlier instances increases from 82.8% to 84.7%. PRISM achieves a higher classification accuracy than the outlier detection methods and compares favorably with the noise reduction method.

11:20AM *A New Evaluation Measure for Learning from Imbalanced Data [no. 134]*

Nguyen Thai-Nghe, Zeno Gantner and Lars Schmidt-Thieme, University of Hildesheim, Germany

Recently, researchers have shown that the Area Under the ROC Curve (AUC) has a serious deficiency since it implicitly uses different misclassification cost distributions for different classifiers. Thus, using the AUC can be compared to using different metrics to evaluate different classifiers (Hand, 2009). To overcome this incoherence, the H measure was proposed, which uses a symmetric Beta distribution to replace the implicit cost weight distribution in the AUC. When learning from imbalanced data, misclassifying a minority class example is much more serious than misclassifying a majority class example. To take different misclassification costs into account, we propose using an asymmetric Beta distribution (B42) instead of a symmetric one. Experimental results on 36 imbalanced data sets using SVMs and logistic regression show that B42 is a good choice for evaluating on imbalanced data sets because it puts more weight on the minority class. We also show that balanced random undersampling does not work for large and highly imbalanced data sets, although it has been reported to be effective for small data sets.

11:40AM *Discriminant Kernels derived from the Optimum Nonlinear Discriminant Analysis [no. 83]*

Takio Kurita, Hiroshima University, Japan

Linear discriminant analysis (LDA) is one of the well known methods to extract the best features for multi-class classification. Recently Kernel discriminant analysis (KDA) has been successfully applied in many applications. KDA is one of the nonlinear extensions of LDA and construct nonlinear discriminant mapping by using kernel functions. But the kernel function is usually defined a priori and it is not known what the optimum kernel function for nonlinear discriminant analysis is. In this paper the optimum kernel function in terms of the discriminant criterion is derived by investigating the optimum discriminant mapping constructed by the optimum nonlinear discriminant analysis (ONDA). Otsu derived the optimum nonlinear discriminant analysis (ONDA) by assuming the underlying probabilities similar with the Bayesian decision theory. He showed that the optimum nonlinear discriminant mapping was obtained by using Variational Calculus. The optimum nonlinear discriminant mapping can be defined as a linear combination of the Bayesian a posterior probabilities and the coefficients of the linear combination are obtained by solving the eigenvalue problem of the matrices defined by using the Bayesian a posterior probabilities. Also Otsu showed that LDA could be interpreted as a linear approximation of the ONDA through the linear approximation of the Bayesian a posterior probabilities. In this paper, the optimum kernel function is derived by investigating the dual problem of the eigenvalue problem of ONDA. The derived kernel function is also given by using the Bayesian a posterior probabilities. This means that the class information is naturally introduced in the kernel function.

12:00PM *Fast pattern matching with time-delay neural networks [no. 498]*

Heiko Hoffmann, Michael Howard and Michael Daily, HRL Laboratories, LLC, United States

We present a novel paradigm for pattern matching. Our method provides a means to search a continuous data stream for exact matches with a priori stored data sequences. At heart, we use a neural network with input and output layers and variable connections in between. The input layer has one neuron for each possible character or number in the data stream, and the output layer has one neuron for each stored pattern. The novelty of the network is that the delays of the connections from input to output layer are optimized to match the temporal occurrence of an input character within a stored sequence. Thus, the polychronous activation of input neurons results in activating an output neuron that indicates detection of a stored pattern. For data streams that have a large alphabet, the connectivity in our network is very sparse and the number of computational steps small: in this case, our method outperforms by a factor 2 deterministic finite state machines, which been the state of the art for pattern matching for more than 30 years.

Session Th1-6: Robotics and Control

Thursday, August 4, 10:00AM-12:20PM, Room: Santa Clara, Chair: Zeng Guang Hou

10:00AM *A Neuromorphic Architecture From Single Transistor Neurons With Organic Bistable Devices For Weights [no. 115]*

Robert Nawrocki, Sean Shaheen and Richard Voyles, University of Denver, United States

Artificial Intelligence (AI) has made tremendous progress since it was first postulated in the 1950s. However, AI systems are primarily emulated on serial machine hardware that result in high power consumption, especially when compared to their biological counterparts. Recent interest in neuromorphic architectures aims to more directly emulate biological information processing to achieve substantially lower power consumption for appropriate information processing tasks. We propose a novel way of realizing a neuromorphic architecture, termed Synthetic Neural Network (SNN), that is modeled after conventional artificial neural networks and incorporates organic bistable devices as circuit elements that resemble the basic operation of a binary synapse. Via computer simulation we demonstrate how a single synthetic neuron, created with only a single transistor, a single-bistable-device-per-input, and two resistors, exhibits a behavior of an artificial neuron and approximates the sigmoidal activation function. We also show that, by increasing the number of bistable devices per input, a single neuron can be trained to behave like a Boolean logic AND or OR gate. To validate the efficacy of our design, we show two simulations where SNN is used as a pattern classifier of complicated, non-linear relationships based on real-world problems. In the first example, our SNN is shown to perform the trained task of directional propulsion due to water hammer effect with an average error of about 7.2%. The second task, a robotic wall following, resulted in SNN error of approximately 9.6%. Our simulations and analysis are based on the performance of organic electronic elements created in our laboratory.

10:20AM *Two-phase GA parameter tunning method of CPGs for quadruped gaits [no. 372]*

Jose Hugo Barron-Zambrano and Cesar Torres-Huitzil, Laboratory of Information Technology-CINVESTAV, Mexico; Information Technology-CINVESTAV, Mexico

Nowadays, the locomotion control research field has been pretty active and has produced different approaches for legged robots. From biological studies, it is known that fundamental rhythmic periodical signals for locomotion are produced

by Central Pattern Generator (CPG) and the main part of the coordination takes place in the central nervous system. In spite of the CPG-utility, there are few training methodologies to generate the rhythmic signals based in CPG models. In this paper, an automatic method to find the synaptic weights to generate three basic gaits using Genetic Algorithms (GA) is presented. The method is based on the analysis of the oscillator behavior and its interactions with other oscillators, in a network. The oscillator model used in this work is the proposed by Van Der Pol (VDP). A two-phase GA is adapted: (i) to find the parameter values to produce oscillations and (ii) to generate the weight values of the interconnections between oscillators. The results show the feasibility of the presented method to find the parameters to generate different gaits. The implementation takes advantage that the fitness function works directly with the oscillator and the network. So, knowledge about the robot dynamic is not necessary. The GA based approach uses small population and limited numbers of generations, ideal to be processed on either computers with reduced resources or hardware implementations.

10:40AM *A Neural Network Classifier for Notch Filter Classification of Sound-Source Elevation in a Mobile Robot [no. 172]*
John Murray and Harry Erwin, University of Lincoln, United Kingdom; University of Sunderland, United Kingdom

An important aspect of all robotic systems is sensing and there are many sensing modalities used including vision, tactile, olfactory and acoustics to name a few. This paper presents a robotic system for sensing in acoustics, specifically in elevation localization. The model presented is a two-stage model incorporating spectral analysis using artificial pinna and an artificial neural network for classification and elevation estimation. The spectral classifier uses notch filters to analyze changes in attenuation of certain frequencies with elevation. This paper shows how using the spectral output of a signal generated by an artificial pinna can be classified by a feedforward backpropagation neural network to estimate the elevation of a sound-source.

11:00AM *Evolution of Robotic Neurocontrollers with Intrinsic Noise and their Behavior in Noisy Environments [no. 413]*
Helmut Mayer, University of Salzburg, Austria

We report on experiments with robotic neurocontrollers with intrinsic noise evolved for a peg pushing task. The specific controller of the simulated robot is a feed-forward network with noisy weights, i.e, the weight values are perturbed by additive, normal noise. The neurocontrollers are evolved in a noise-free environment, and the best-performing networks are then tested in noisy environments, where peg movement and sensor signals are afflicted by noise. We find that the internal (robotic brain) noise is beneficial in coping with external noise, especially, in the case of noisy sensors.

11:20AM *Unsupervised Feature Selection and Category Formation for Mobile Robot Vision [no. 88]*
Hirokazu Madokoro, Masahiro Tsukada and Kazuhito Sato, Akita Prefectural University, Japan

This paper presents an unsupervised learning-based method for selection of feature points and object category formation without previous setting of the number of categories. For unsupervised object category formation, this method has the following features: detection of feature points and description of features using a Scale-Invariant Feature Transform (SIFT), selection of target feature points using One Class-SVMs (OC-SVMs), generation of visual words using SOMs, formation of labels using ART-2, and creation and classification of categories on a category map of CPNs for visualizing spatial relations between categories. Classification results of static images using a Caltech-256 object category dataset and dynamic images using time-series images obtained using a robot according to movements respectively demonstrate that our method can visualize spatial relations of categories while maintaining time-series characteristics. Moreover, we emphasize the effectiveness of our method for category formation of appearance changes of objects.

11:40AM *Neural PD control with second-order sliding mode compensation for robot manipulators [no. 494]*
Debbie Hernandez, Yu Wen and Marco Moreno-Armendariz, CINVESTAV-IPN, Mexico; CIC-IPN, Mexico

Both neural network and sliding mode technique can compensate the steady-state error of proportional-derivative (PD) control. The tracking error of PD control with sliding mode is asymptotically stable, but the chattering is big. PD control with neural networks is smooth, but it is not asymptotically stable. PD control combining both neural networks and sliding mode cannot reduce chattering, because the sliding mode control (SMC) is always applied. In this paper, neural control and SMC are connected serially: first a dead-zone neural PD control assures that the tracking error is bounded, then super-twisting second-order sliding-mode is used to guarantee finite time convergence of the sliding mode PD control.

12:00PM *Robot Control with a Fully Tuned Growing Radial Basis Function Neural Network [no. 94]*
Yi Luo, Yoo Hsiu Yeh and Abraham Ishihara, Deptartment of Mechanical Engineering, Carnegie Mellon University, United States; Carnegie Mellon University, Silicon Valley, United States

A fully tuned Growing Radial Basis Function (GRBF) neural network controller for the control of robot manipulators is proposed. In addition to the weights, the centers and the standard variations are adapted online. Furthermore, we present an algorithm in which nodes of the network are appended based on sliding window performance criteria. Lyapunov analysis is used to show uniform ultimate boundedness and a discretization method is used to derive the growing algorithm. Simulations on a 2-DOF planar robot arm are presented to illustrate the method

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