INTERNATIONAL NEURAL NETWORK SOCIETY

March 2021

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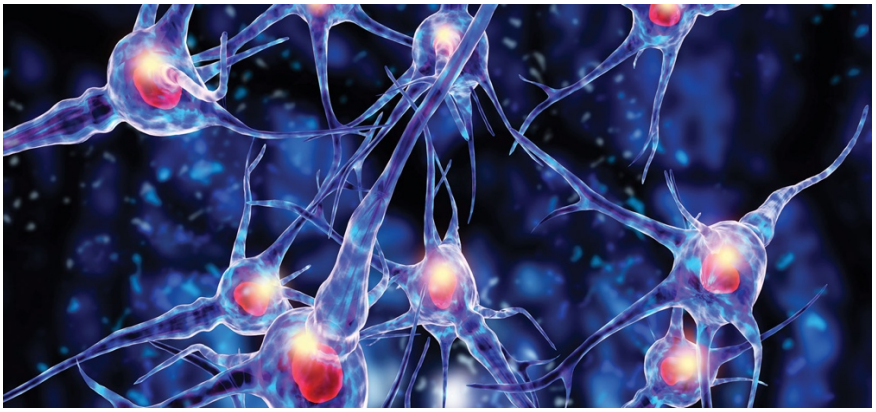
INSIDE



https://www.ijcnn.org/

XPRIZE Pandemic Response Challenge Completed

-By Risto Miikkulainen, The University of Texas at Austin

Teams from around the world competed in creating better models for predicting the course of the COVID-19 pandemic, and models to prescribe how it could be best mitigated, with interesting results.

https://www.xprize.org/challenge/pandemicresponse/articles/pandemic-response-challenge-finalists-copy

Brain-inspired reinforcement learning

-By Petia Koprinkova-Hristova

We have developed a spike timing neural network model of visual perception with reinforcement learning. It mimics all brain areas starting with photoreceptive retinal cells up to visual cortex and basal ganglia. The model was implemented using NEST simulator. A training approach using STDP plastic synapses and a teaching signal derived from test humans' eyes reactions was developed. The model allows in-silico investigations of the included brain areas.

https://www.researchgate.net/project/Modelling-of-voluntary-saccadic-eye-movements-during-decision-making

Plant Counting

-By Pascual Campoy, UPM-CVAR

I-Hawk-A is the powerful solution for automatically obtaining fully plantation reports from aerial images based on individual plants counting. The kernel of I-Hawk-A is our own innovative Deep Learning Algorithms, that are based and tested upon thousands of images of our clients. As a result of the autonomous processing the generated report contains detailed information of the terraces, number of plants in every terrace and plantation density maps, that are available for the client to be downloaded in a few minutes.

https://www.ihawk.es/

Projects Announcements

-By Plamen Angelov, Lancasetr University

Funded project: Towards explainable AI4EO: a new frontier to gain trust into the AI (XAI4EO)', awarded by the European Space Agency - http://www.research.lancs.ac.uk/portal/en/upmprojects/towards-explainable-ai4eo-a-new-frontier-to-gain-trust-into-the-ai-xai4eo(5b0bdea3-c3d7-4ef0-8614-2626227fb5df).html
An interesting initiative from Bulgaria: https://www.goethe.de/ins/bg/en/kul/ser/ppr/ethic-ai-opencall.html
Several job openings (based on several new grants):
Lancaster University, United Kingdom, has 2 postdoc openings which require neural networks and deep learning expertise:

- Senior Research Associate/ Research Associate: Prognostic modelling of electric battery ageing
- Senior Research Associate in Security (Design, Assessment, Verification/Validation, Adversarial Machine Learning/ML)
- https://hr-jobs.lancs.ac.uk/vacancies.aspx?cat=232

2020 TÜBA Academy Prize

Professor Okyay Kaynak was recently recognized and awarded the 2020 TÜBA Academy Prize in the Basic and Engineering Sciences for his works and contributions on the sliding mode control method developed by using artificial intelligence and artificial neural network techniques in his applications and studies in the fields of industrial process control, aviation, vehicle control, robotics, and automation by the Turkish Academy of Sciences.

This is a very prestigious award which he received at the Presidential Palace in Ankara from the President of the Republic.

https://iten.ieee-ies.org/featured-news/2021/prof-okyay-kaynak-receives-prestigious-2020-tuba-academy-prize/

An Explainable Neural Network for Industry 4.0

-By Luca Marchese (www.synaptics.org)

In recent times, when the Deep Learning technique has achieved great application successes, it has increasingly been highlighted that the decisions taken by a black box system very often present ethical, analytical and safety issues. There has therefore been much talk of Explainable Artificial Intelligence and also DARPA has been actively involved with the XAI (eXplainable Artificial Intelligence) project. In 2015 a new neural network model based on Hebb's rule and

called SHARP (Systolic Hebb Agnostic Resonance Perceptron) was presented at WIRN - 25th Italian Workshop on Neural Networks - Societa Italiana Reti Neuroniche (SIREN) - International Institute for Advanced Scientific Studies (IIASS) - May 20, 2015 and, subsequently published in "Advances in Neural Networks: Computational Intelligence for ICT" - CHAPTER 153-160 - (SPRINGER). This paradigm allows to learn from data by mapping them in the form of rules on the synaptic links of the neural network. Inference can be performed in black-box mode or by extracting the rules involved in the inference when it is required (explainable inference). Currently (2019-2020) this neural network model is being successfully applied in the Healthcare Sector of Industry 4.0 on projects related to the interpretation of ECG traces (Electro Cardio Gram) and the detection of anomalies on ultrasound probes through IAR (In Air Reverberation) image analysis on the field, as suggested by the FDA. Scientific publications on these two applications are not yet available. The Healthcare sector is particularly sensitive to the explainability of inference obtained with Artificial Intelligence algorithms. Furthermore, the SHARP algorithm is extremely fast both in the learning phase and in the inference phase even with BIG-DATA and is optimal for applications on CPUs with low computing power: this feature allows you not to have to send sensitive data to the Cloud. The latter is another issue to which companies operating in the Healthcare sector are very interested.

https://www.researchgate.net/publication/317003867_Systolic_Hebb_Agnostic_Resonance_Perceptron_SHARP_a_Neural_Network_Model_Inspired_By_the_Topological_Organization_of_the_Cerebral_Cortex_which_Implements_Virtual_Parallelism_on_Von_Neumann_Computers

New Book by INNS Fellow on Psychology and Society

-By Daniel S. Levine, University of Texas at Arlington

Routledge published in December, 2020 (with a 2021 copyright) a book for a general audience by Daniel S. Levine, a Fellow of INNS who served in 1998 as INNS President and was General Co-Chair of the 2013 IJCNN. The book is entitled Healing the Reason-Emotion Split, with the subtitle Scarecrows, Tin Woodmen, and the Wizard.

The main argument of the book is that the common cultural idea that emotion and reason are opposites, with reason considered superior to emotion, is not supported by science and is harmful to society. Evidence supporting this argument is presented from the findings of Antonio Damasio, Luiz Pessoa, and other neuroscientists that emotion is essential to effective decision making and that emotional regions of the brain are subject to attentional control. Evidence is also presented from various experimental psychology laboratories showing that emotion and cognition are deeply interconnected and that optimal cognitive function requires emotional stimulation rather than quiescence. The book is not primarily a book about neural networks but there is some discussion of biologically realistic neural network models by the author, Stephen Grossberg, and a few other researchers that incorporate these emotional-cognitive interactions.

The book reviews historical movements such as the Enlightenment that privileged reason over emotion, and other historical movements such as Romanticism and the 1960s counterculture that did the opposite. At the end it calls for synthesizing the best of both the Enlightenment and

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Romanticism to promote optimal brain functioning as needed to solve the societal problems caused by globalization, climate change, and pandemics. The book is 146 pages long including bibliography and index, and available in paperback, hardback, e-book, and Kindle. Ordering information, the table of contents, and endorsements are available from https://www.amazon.com/Healing-Reason-Emotion-Split-Scarecrows-Woodmen/dp/0367856840/ref=sr_1_1?dchild=1&keywords=Healing%20the%20Reason-Emotion%20Split&qid=1607268654&sr=8-1&fbclid=IwAR1UzioSDkmlCvYuxEi3vpCh6jy-D5FClzhcqUFlj7QtKyFaiLUJQbfWZOE or https://www.routledge.com/Healing-the-Reason-Emotion-Split-Scarecrows-Tin-Woodmen-and-the-Wizard/Levine/p/book/9780367856830

NeuCube - An INNS Success Story- First Published in our journal Neural Networks and now used in 30+ countries and 100+ publications

-By Nikola Kasabov, Professor of Knowledge Engineering, Auckland University of Technology, George Morre Chair of Data Analyitics, University of Ulster, Honorary Professor Teesside University and the University of Auckland

NeuCube is a brain-inspired spiking neural network architecture, initially proposed by Prof. Nikola Kasabov in 2014 for spatio-temporal brain data and later used for predictive modelling and understanding of various spatio-temporal data. The first and the most important publications related to NeuCube were published in the premier INNS society journal Neural Networks. This helped to disseminate the further developed methods and applications based on NeuCube.

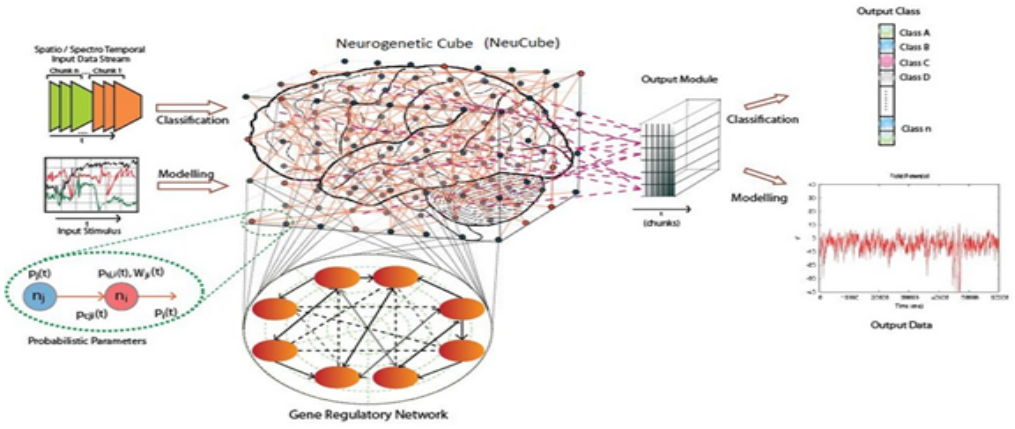

Figure 1: NeuCube functional diagram (from Kasabov, NN, 2014)

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Applications spanned across several areas:

1. Brain data modelling: - EEG: peri-perceptual modelling; mindfulness; Depression; AD; response to treatment; BCI - fMRI: cognitive data modelling -fMRI+ DTI: response to treatment -EEG + MRI data: epilepsy -Neurogenetic, integrated data
2. Gene expression over time
3. Audio/Visual data processing - Speech, sound and music recognition - Moving object recognition - Language processing
4. Multisensory streaming data - Health risk event prediction from temporal climate data (stroke) - Hazardous environmental event prediction (e.g. risk of earthquakes in NZ; flooding in - Malaysia; - pollution in London area; extreme weather from satellite images)
5. Brain-Computer Interfaces and knowledge transfer between humans and machines Robot control
6. Neuro-rehabilitation robots (with China Academy of Sciences)

Now more than 30 countries are using NeuCube and 100+ related publications published. Researchers from the following countries are currently using NeuCube: New Zealand, Australia, Indonesia, Malaysia, Thailand, China, Taiwan, Japan, Iran, Lebanon, Saudi Arabia, Turkey, Greece, Bulgaria, Italy, Switzerland, The Netherlands, the UK, the USA, Brazil, Mexico, Spain, France, Ireland, Poland, Hungary, Pakistan, Sri Lanka, India, Germany, Canada.
Thirty researchers from the EU were funded through a 1.8mln NZD EU Erasmus Mundus Project PANTHER to visit KEDRI/AUT in New Zealand and to work with NeuCube, resulted in a large number of publications in international journals, including Neural Networks.

Figure 2: A map of some of the countries which are using and further developing NeuCube (March 2021)

For more information see: https://kedri.aut.ac.nz/neucube and https://neucube.io. Main references:

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1. Kasabov, N. NeuCube: A Spiking Neural Network Architecture for Mapping, Learning and Understanding of Spatio-Temporal Brain Data, Neural Networks vol.52 (2014), pp. 62-76, http://dx.doi.org/10.1016/j.neunet.2014.01.006
2. N. Kasabov, N. Scott, E.Tu, S. Marks, N.Sengupta, E.Capecci, M.Othman,M. Doborjeh, N.Murli,R.Hartono, J.Espinosa-Ramos, L.Zhou, F.Alvi, G.Wang, D.Taylor, V. Feigin,S. Gulyaev, M.Mahmoudh, Z-G.Hou, J.Yang, Evolving spatio-temporal data machines based on the NeuCube neuromorphic framework: Design methodology and selected applications, Neural Networks, v.78, 1-14, 2016. http://dx.doi.org/10.1016/j.neunet.2015.09.011.
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5. K.Kumarasinghe, N.Kasabov, D.Taylor, Deep Learning and Deep Knowledge Representation in Spiking Neural Networks for Brain-Computer Interfaces, Neural Networks, vol.121, Jan 2020, 169-185, doi: https://doi.org/10.1016/j.neunet.2019.08.029.
6. Kasabov, N., Time-Space, Spiking Neural Networks and Brain-Inspired Artificial Intelligence, Springer (2018) 750p., https://www.springer.com/gp/book/9783662577134

New Book “Data Analytics on Graphs”

-By Danilo Mandic

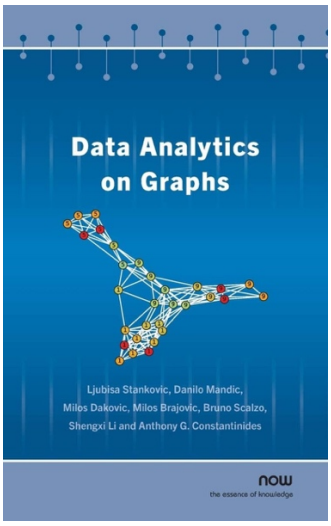
L. Stankovic, D. P. Mandic, M. Dakovic, M. Brakovic, B. Scalzo Dees, S. Li, and A. G. Constantinides, "Data Analytics on Graphs", Now Publishers, ISBN: 978-1-68083-982-1, 2021.

Summary: The current availability of powerful computers and huge data sets is creating new opportunities in computational mathematics to bring together concepts and tools from graph theory, machine learning and signal processing, creating Data Analytics on Graphs.

In discrete mathematics, a graph is merely a collection of points (nodes) and lines connecting some or all of them. The power of such graphs lies in the fact that the nodes can represent entities as diverse as the users of social networks or financial market data, and that these can be transformed into signals which can be analyzed using data analytics tools. Data Analytics on Graphs is a comprehensive introduction to generating advanced data analytics on graphs that allows us to move beyond the standard regular sampling in time and space to facilitate modelling in many important areas, including communication networks, computer science, linguistics, social sciences, biology, physics, chemistry, transport, town planning, financial systems, personal health and many others.

The authors revisit graph topologies from a modern data analytics point of view, and proceed to establish a taxonomy of graph networks. With this as a basis, the authors show how the spectral analysis of graphs leads to even the most challenging machine learning tasks, such as clustering, being performed in an intuitive and physically meaningful way. The authors detail unique aspects of graph data analytics, such as their benefits for processing data acquired on irregular domains, their ability to finely-tune statistical learning procedures through local information processing, the concepts of random signals on graphs and graph shifts, learning of graph topology from data observed on graphs, and confluence with deep neural networks, multi-way tensor networks and Big Data. Extensive examples are included to render the concepts more concrete and to facilitate a greater understanding of the underlying principles.

Aimed at readers with a good grasp of the fundamentals of data analytics, this book sets out the fundamentals of graph theory and the emerging mathematical techniques for the analysis of a wide range of data acquired on graph environments. Data Analytics on Graphs will be a useful friend and a helpful companion to all involved in data gathering and analysis irrespective of area of application.



Amazon link: https://www.amazon.com/Data-Analytics-Graphs-Ljubisa-Stankovic/dp/1680839829/ref=sr_1_2?dchild=1&keywords=Data+Analytics+on+Graphs&qid=1617027982&sr=8-2

Generalized Visual Information Analysis Over A Semisimple Commutative Algebra

-By Liang Liao, Zhongyuan University of Technology

Image analysis widely employees matrix algorithms and non-Euclidean geometrical models, most of them being built over the field of real numbers or complex numbers with the related definitions and notions being described by classical algebra and geometry. We research a novel paradigm of matrices and non-Euclidean geometrical models over a commutative algebra with its image analysis applications. The elements of the novel algebra are generalized scalars, which are backwardly compatible with complex numbers. Generalized matrices with those generalized scalars as matrix entries are backwardly compatible with canonical matrices. Compared with the linear subspace model, models of an algebraic module over our semisimple algebra can characterize higher-order visual information more effectively. Under the generalized-matrix framework's roof, we generalize the notion of orthogonality to higher-order and research image

analysis and manifold-learning algorithms with the generalized orthogonality notion. This research can extend a vast collection of canonical matrix and manifold algorithms to higher-order. Compared with canonical algorithms, generalized matrix algorithms and generalized geometrical models usually yield better results.
https://github.com/liaoliang2020/talgebra

Activity and location prediction in construction processes

-By Ivan Donadello, Free University of Bozen-Bolzano

Activity prediction in construction processes allows a better scheduling of the whole project with an overall saving of time and resources. However, this prediction is challenging due to the multidimensionality of the domain: an activity can be decomposed into actions, resources, locations, etc. Our aim is to inject into state-of-the-art sequence-2-sequence prediction models to produce better predictions. Neural-symbolic models will be developed and compared with numerical-only models.

Improving Student Learning and Retention with Neural Networks

-By Dr. Nabeel Murshed, University of Dubai

This study describes a Neuro Control Teaching and Learning (T&L) framework to improve student learning and retention. It is based on control system with NNs-based closed feedback loops. We argue that Teaching and Learning (T&L) in an outcome-based education, can be modeled by an input, Controller, Process, outputs (y1(t) and y(t)), Feedback Loops, and a Knowledge Reservoir.