IEEE 17th International Symposium on Applied Computational Intelligence and Informatics (SACI 2023), May 23-26, 2023, Timisoara, Romania.

Neuroinformatics, Neural networks and Neurocomputers for Brain-inspired Computational Intelligence

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ABSTRACT.

The talk discusses briefly current challenges in artificial intelligence (AI), including: efficient learning of data (interactive, adaptive, life-long; transfer); interpretability and explainability; personalised predictive modelling and profiling; multiple modality of data (e.g. genetic, clinical, behaviour, cognitive, static, temporal, longitudinal); computational complexity; energy consumption; human-machine interaction.

Opportunities to address these challenges are presented through advancement in ***N***euroinformatics, ***N***eural networks and ***N***eurocomputers (the 3N). **Neuroinformatics** offer a tremendous amount of data and knowledge about how the human brain and the nervous system work. Many brain information processing principles can be now implemented in novel **Neural network** computational models. The latter ones have inspired the development of neuromorphic hardware chips and N**eurocomputers,** characterised by much low power consumption, massive parallelism and fast processing.

The talk presents also the main principles of evolving connections systems (ECOS) [1,2] and spiking neural networks (SNN) [3,4] along with a brain-inspired computational architecture based on SNN, **NeuCube to** address the above AI problems. NeuCube is first used for brain data modelling and then developed as a generic spatio-temporal data machine and an open source development environment for a wide scope of applied computational intelligence. Some experimental results include: modelling EEG, fMRI and other multimodal brain data; predicting AD; predicting response to treatment; early diagnosis of psychosis; personalised prediction of stroke; brain-computer interfaces; on-line learning of multisensory data for pollution and earthquake prediction; integrating financial time series and on-line news; and other.

In future, a fast development of novel **Neural network** models for the now available massively parallel and low power consuming **Neurocomputers** is expected, along with successful applications in **Neuroinformatics**, and in all areas of AI, to overcome the current challenges in AI.

[1] N.Kasabov, Evolving Connectionist Systems, Springer, 2007
[2] NeuCom: https://theneucom.com
[3] N.Kasabov, *Time-Space, Spiking Neural Networks and Brain-Inspired Artificial Intelligence*, Springer, 2019, https://www.springer.com/gp/book/9783662577134.
[4] NeuCube: https://kedri.aut.ac.nz/neucube

Biodata:

Professor Nikola K Kasabov Life Fellow of IEEE, Fellow of the Royal Society of New Zealand, Fellow of the INNS College of Fellows, DVF of the Royal Academy of Engineering UK. He has *Doctor Honoris Causa* from Obuda University, Budapest. He is the Founding Director of the Knowledge Engineering and Discovery Research Institute (KEDRI), Auckland and Professor at the School of Engineering, Computing and Mathematical Sciences at Auckland University of Technology, New Zealand. He is also George Moore Chair Professor of Data Analytics at the University of Ulster UK and a Guest Professor of IICT Bulgarian Academy of Sciences. He is also Honorary Professor at the Teesside University UK, University of Auckland NZ and Peking University in Shenzhen. Kasabov is Past President of the Asia Pacific Neural Network Society (APNNS) and the International Neural Network Society (INNS). He has been a chair and a member of several technical committees of IEEE Computational Intelligence Society and Distinguished Lecturer of IEEE (2012-2014). He is Editor of Springer Handbook of Bio-Neuroinformatics, EIC of Springer Series of Bio-and Neuro-systems and co-EIC of the Springer journal Evolving Systems. He is Associate Editor of several journals, including Neural Networks, IEEE TrNN, Tr CDS, Information Sciences, Applied Soft Computing. Kasabov holds MSc and PhD from TU Sofia, Bulgaria. His main research interests are in the areas of neural networks, intelligent information systems, soft computing, bioinformatics, neuroinformatics. He has published more than 700 publications, highly cited internationally. He has extensive academic experience at various academic and research organisations in Europe and Asia, including: TU Sofia Bulgaria; University of Essex UK; University of Otago, NZ; Shanghai Jiao Tong University and CASIA China, ETH/University of Zurich. Kasabov has received a number of awards, among them:; INNS Ada Lovelace Meritorious Service Award; NN journal Best Paper Award for 2016; APNNA 'Outstanding Achievements Award'; INNS Gabor Award for 'Outstanding contributions to engineering applications of neural networks'; EU Marie Curie Fellowship; Bayer Science Innovation Award; APNNA Excellent Service Award; RSNZ Science and Technology Medal; 2015 AUT NZ Medal; Medal "Bacho Kiro" of the SU Pavlikeni; Honorary Member of the Bulgarian, the Greek and the Scottish Societies for Computer Science, Honorary Citizen of Pavlikeni, Bulgaria. More information of Prof. Kasabov can be found from: https://academics.aut.ac.nz/nkasabov.