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PLENARY TALK

Neuromorphic Predictive AI: Methods, Systems, Applications

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Abstract:

Brain-inspired AI (BIAI), based on spiking neural networks (SNN) and neuromorphic systems, have proofed already their efficiency not only in their minimal power consumption and massive parallelism, but in predictive modelling as well, due to their spike-based/event-based information processing [1, 2]. They can learn from data both time and space in their dynamic interaction and provide explainability and adaptability to new data. They are by far superior for spatio/spectro-temporal data processing [1, 2]. *Predictive BIAI* are complementary to the current *generative AI*, such as LLM and their integration is on the way. Recently, new methods and systems of BIAI have emerged, such as evolving spatio-temporal associative memories, spike-transformers, neuromorphic agentic AI, hybrid SNN-quantum systems [3] and more.

The talk presents first computational principles of BIAI and then presents briefly compelling examples of their current application for predictive modelling in health, such as: modelling of neuroimaging data; early prediction of individual stroke, psychosis, dementia, depression, epilepsy; brain-machine interfaces for paralysed people; mental state diagnosis using voice; discovering spatio-temporal brain patterns during treatment with sound; brain-state detection, such as emotion, using audio- and audio-visual information; understanding and modelling conscious perception in humans and machines.

[1] N. K. Kasabov, N., Time-Space, Spiking Neural Networks and Brain-Inspired Artificial Intelligence, Springer-Nature (2019) 750p., https://doi.org/10.1007/978-3-662-57715-8

[2] N. K. Kasabov, "NeuCube: A spiking neural network architecture for mapping, learning and understanding of spatio-temporal brain data," Neural Networks, vol. 52, pp. 62–76, 2014, https://doi.org/10.1016/j.neunet.2014.01.006.

[3] R K Jha, N Kasabov, S Bhattacharyya, D Coyle and G Prasad, A hybrid spiking neural network - quantum framework for spatio-temporal data classification: a case study on EEG data, EPJ Quantum Technologies, (2025) 12:130, 1-23, https://doi.org/10.1140/epjqt/s40507-025-00443-1
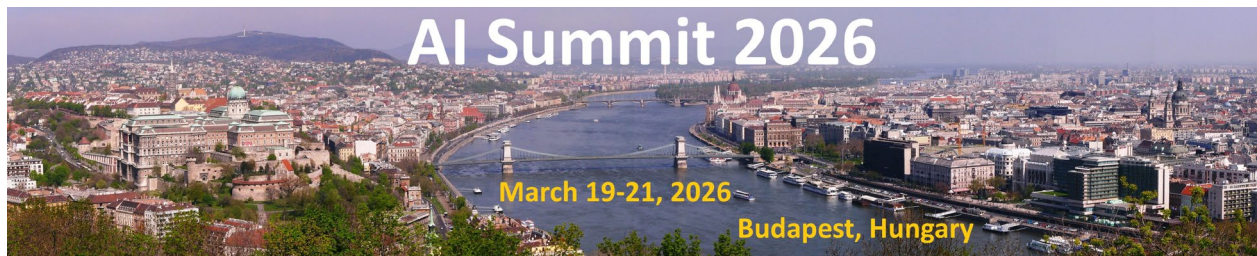
Biodata:

Professor Nikola K Kasabov **is a** 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 KEDRI and Professor Emeritus at the School of Engineering, Computing and Mathematical Sciences at Auckland University of Technology, New Zealand. He is also Visiting Professor at the Institute for Information and Communication Technologies of the Bulgarian Academy of Sciences and Dalian University, China. Kasabov is Director of Knowledgeengineering.ai and member of the advisory board of Conscium.com. 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 other journals. Kasabov holds MSc in computer engineering and PhD in mathematics from TU Sofia. His main research interests are in the areas of neural networks, intelligent information systems, soft computing, neuroinformatics, spiking neural networks. 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 Beijing; ETH/University of Zurich. Kasabov has received a number of awards, among them: INNS Ada Lovelace Meritorious Service Award; NN journal Best Paper Award; 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" and Honorary Citizen of Pavlikeni, Bulgaria; Honorary Member of the Bulgarian-, the Greek- and the Scottish Societies for Computer Science. More information of Prof. Kasabov can be found on: https://academics.aut.ac.nz/nkasabov and on https://knowledgeengineering.ai.