Neuromorphic electronic circuits for building autonomous cognitive systems

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Venue  Empa, Dübendorf, Überlandstrasse 129, VE 102

Presentation language is English, Free entrance, guests are welcome

Abstract

Neural networks and deep learning algorithms are currently achieving impressive state-of-the-art results on computing tasks that operate on stored data sets. However, artificial computing systems are still vastly outperformed by biological neural processing ones for tasks that involve processing of sensory data acquired in real-time in complex and uncertain settings, and closed-loop interactions with the environment. This difference is remarkable especially when size and energy consumption are factored in.

One of the reasons for this gap is that, as opposed to conventional computing architectures, in biological neural systems computation is tightly linked to the to the physics of their computing elements and to their temporal dynamics. In this talk I will present hybrid analog/digital microelectronic circuits that use their physics to directly emulate the biophysics of the neural processes and memory elements they model. I will demonstrate examples of brain-inspired architectures that integrate massively parallel arrays of such circuits to implement on-chip on-line spike-based learning and computation, and will describe the advantages and disadvantages of these types of computing architectures compared to conventional computing systems. I will argue that the circuits proposed represent a promising approach for building intelligent and energy-efficient autonomous cognitive agents that need to process input data as it arrives, in real-time, without having to use eternal memory storage.

Short biography

Giacomo Indiveri is a Professor at the Faculty of Science of the University of Zurich, Switzerland, and director of the Institute of Neuroinformatics of the University of Zurich and ETH Zurich. He obtained a M.Sc. degree in electrical engineering and a Ph.D. degree in computer science from the University of Genoa, Italy. He was a post-doctoral research fellow in the Division of Biology at Caltech and at the Institute of Neuroinformatics of the University of Zurich and ETH Zurich. He holds a "habilitation" in Neuromorphic Engineering at the ETH Zurich Department of Information Technology and Electrical Engineering. He was awarded an ERC Starting Grant on "Neuromorphic processors" in 2011 and an ERC Consolidator Grant on neuromorphic cognitive agents in 2016. His research interests lie in the study of neural computation, with a particular focus on spike-based learning and selective attention mechanisms. His research and development activities focus on the full custom hardware implementation of real-time sensory-motor systems using analog/digital neuromorphic circuits and emerging VLSI technologies.