Tentative Outline

Nanostructured Neuromorphic Devices: Towards in Materia Computing

Guest Editor: Francesca Borghi

Scope of the Thematic Issue:

The efforts pursued in the last decade to build up brain-inspired systems with electronic hardware solutions to solve complex data processing tasks, have leaded to the development of a new generation of devices, as memristor crossbar arrays, and their different applications became more and more reliable. One of the basic features characterizing these devices is the non-linearity of the physical processes taking place into the material. The advent of the memristor, characterized by resistive switching activity able to mimic synapses, ideally allows the implementation of an architecture where the processor and the memory coincide in the same unit, beyond the Von Neumann bottleneck. The data processing tasks are mostly implemented in hardware solutions based on conventional microfabrication techniques. These solutions are not fault tolerant and are not able to mimic the redundance typical of the biological neural networks. On the contrary, employing randomly assembled systems to perform data processing may provide additional brain-like features to the neuromorphic devices. In fact, as the biological nervous systems, random-assembled networks (whether they are formed by clusters, nanowires or nanotubes) are not deterministically designed and the complex network organization enhances the role of spatio-temporal correlations. Moreover, the low energy overhead used both to produce and to employ them increases their appeal, as also the possibility to exploit them as implementable platforms for the study of plasticity and reconfigurability of interconnected computing network. This issue provides an overview of the state of art of the research concerning the conventional strategy (based on microfabrication method) to implement neuromorphic devices based on in materia solutions, as also their practical applications in specific fields. Moreover, part of the review articles is focused on unconventional strategy based on random assembled materials to fabricate in materia computing devices, characterized by redundant and interconnected network architectures resembling the biological one. An in-depth discussion of the interplay between the morphological properties and the computational capability of the network is also treated.

Keywords: Nanostructures, non-linear dynamics, memristive devices, neuromorphic systems, random-assembled material, unconventional computing, in-materia solution.

Sub-topics:

- Fabrication of nanostructured neuromorphic devices.
- New generation of memristive devices.
- Random-assembled network used to perform data processing.
- Application of nanostructured neuromorphic devices to solve computational tasks.
- In-materia Reservoir Computing.

Schedule:

➢ Complete Thematic issue submission deadline: **December 5, 2023**

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