IEEE JOURNAL ON
EMERGING AND SELECTED TOPICS IN CIRCUITS AND SYSTEMS

CALL FOR PAPERS

Dynamical Neuro-AI Learning Systems: Devices, Circuits, Architectures and Algorithms

Guest editors

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- Arindam Basu, City University of Hong Kong, Hong Kong
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Scope and Purpose

The growing demand for artificial intelligence (AI) has spurred the development of: (i) systems that co-locate computation and memory, (ii) circuits and devices optimized for operations prevalent in deep learning, and (iii) lightweight and compressed machine learning models that aim to achieve greater performance with less resources.

More experimental and exploratory approaches to optimizing machine learning harness dynamical devices, circuits and systems. Dynamical systems are a natural fit for modeling real-world phenomena as the world is full of complex, higher-order dynamical systems. Neural network algorithms rely on heavily abstracted models of synapses, neurons, and learning rules, where biological details that may be required for brain-level efficiency are stripped away. Integrating the dynamical behaviors present in the brain has the potential to drive accelerators towards a new level of efficiency.

This IEEE JETCAS special issue seeks to draw attention to how the brain and its constituent components behave as a dynamical system to offer software and hardware benefits in modern AI. Software and hardware cannot be decoupled, as in the brain, the neural substrate is a physical manifestation of a neural algorithm. We aim to attract high-quality research papers that tackle the challenging question of how neural dynamics give rise to ultra-efficient, low-power cognition.

While the dominant trend in deep learning follows gradient-based optimization, we aim to complement this by collating a deeper understanding of how higher-order functions, such as problem solving, decision making, prediction, planning, attention, memory consolidation and working memory, can be obtained from lower-level neural dynamics. Developing an understanding can only be achieved by crossing the stacks from low-level device research, the circuits and architectures they create, to higher-level algorithmic abstractions.

We invite neuromorphic and neuro-AI research that uses the power of dynamical systems to promote low-power, brain-inspired learning. This is a fundamentally cross-stack question, which may integrate devices or circuits with architectures or algorithms. By exploring the principles of dynamical systems, neuromorphic computing, neuro-AI, and the various stacks they span, it may be possible to create new and more powerful computing systems.

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Topics of interest

This special issue of IEEE JETCAS will explore academic and industrial research on topics related to dynamical algorithms, architectures, circuits and devices as applied to neuromorphic systems and neuro-AI. Topics include, but are not limited to:

- Dynamical Neuromorphic and Neuro-AI Models
  - Dynamical Neural Fields, Dendritic Computation, Columnar Neural Networks, Stochastic Synapses, Reservoir Computing, Oscillatory Networks, Spiking Neural Units, Higher-order complexity, etc.
- Neuromorphic Hardware
  - Analog/Mixed-signal neuromorphic circuits, digital accelerators and neural circuits, near/in-memory computation, physics-driven hardware and nanowire networks
- Dynamical Circuits, Devices and Integration
- Neuromorphic Algorithms
  - Local learning and bio-plausible learning, evolutionary algorithms, gradient-based learning, continual learning, etc.
- Neuromorphic Architectures
  - Multiprocessing and parallelism, dataflow and spike routing/collision management, model mapping, etc.
- Neuromorphic and Neuro-AI systems and tools

Submission procedure

Prospective authors are invited to submit their papers following the instructions provided on the JETCAS website: https://mc.manuscriptcentral.com/jetcas. The submitted manuscripts should not have been previously published nor should they be currently under consideration for publication elsewhere.

Important dates

- Manuscript submissions due 2023-05-31
- First round of reviews completed 2023-08-07
- Revised manuscripts due 2023-09-14
- Second round of reviews completed 2023-10-07
- Final manuscripts due 2023-10-21

Request for Information

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