CALL FOR PAPERS

IEEE Journal on Exploratory Solid-State Computational Devices and Circuits

Special Issue on Coupled Oscillators for Non- von Neumann Computation

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Aims and Scope

When oscillators are loosely coupled to each other, energy transfer between the individual oscillators causes their frequencies to synchronize. The same principle can be found in real life; for instance, metronomes placed on a floating wooden board, pendulums connected via springs, and internal organs following a circadian rhythm. Depending on the strength and time lag of the coupling medium, the phases of the oscillators settle in a way that minimizes the contentions among the oscillating signals. Recent works have shown that the coupled oscillator's natural ability to evolve to the ground state can be exploited to solve computationally intractable problems, such as graph coloring, max cut, factorization, neural networks, associative memories and pattern recognition. Here, the problems are first mapped to a coupled oscillator network by configuring the coupling weights, and the phase information is read out once the ground state is found. While resolving to the ground state, the network may get stuck in a local minima state, which can be avoided by a concept called annealing where random noise is added during the early exploration phase to help the oscillators break out of a local minima state.

Coupled oscillator networks vary in their device implementation as well as in their connectivity. For the devices, experimental demonstrations include CMOS oscillators, emerging device based, such as ferroelectric, spintronic, phase change oscillators, optical oscillators, and quantum devices at cryogenic temperatures. In some cases, oscillators were discrete devices assembled on a board, in other cases, they were monolithically integrated on a chip. In terms of connectivity, fully-connected, nearest-neighbor, hybrid networks (e.g. Chimera), and common node coupling architectures have been demonstrated.

Against this backdrop, the IEEE Journal on Exploratory Computational Devices and Circuits (JXCDC) is pleased to announce the next special issue focusing all aspects of coupled oscillator based system specifically targeted for non-von Neumann computing applications. Topics of interest include but are not limited to:

- Emerging device (e.g. optical, NEMS, ferroelectric, spintronic, phase change) based coupled oscillator systems
- CMOS based coupled oscillator systems
- Variability and reliability effects in coupled oscillator systems
- Probabilistic behavior and operation under noise
- Security properties of coupled oscillator systems
- Weight programming and phase readout techniques
- Annealing techniques for coupled oscillator systems
- Network connectivity and architecture considerations

- Testing, parameter turning, and measurements aspects
- Oscillator Neural Networks (ONNs)
- Associative memories based on oscillators
- Techniques for mapping large problems onto coupled oscillator systems
- Graph embedding algorithms for locally connected coupled oscillator systems
- NP-hard and NP-complete problem case studies
- Comparison with quantum computers and software based approaches (e.g. simulated annealing)
- Literature review and historical trends on coupled oscillator systems

Important Dates

- Open for Submission: July 10th, 2020
- Submission Deadline: September 30th, 2020
- First Notification: October 21st, 2020
- Revision Submission: November 15th, 2020
- Final Decision: December 15th, 2020
- Online Issue Publication: January 1st, 2021

Submission Guidelines

The IEEE Journal on Exploratory Solid-State Computational Devices and Circuits (JXCDC) IS AN OPEN ACCESS ONLY PUBLICATION:
Charge for Authors: $1,350 USD per paper. Paper submissions must be done through the ScholarOne Manuscripts website: https://mc.manuscriptcentral.com/jxcdc

Guidelines for papers and supplementary materials, as well as a paper template, are provided at this website (also on the next page).
Inquiries for the JxCDC Journal should be sent to: JXCDC@IEEE.ORG

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PAPER FORMAT DESCRIPTION:

Papers can have 2 parts – the first part is a 4-8 page main paper (following a strict format – template available from website), and the second part is the supplementary material. The main paper itself will just focus on describing why the work is important, the state of the prior art, the key new accomplishment(s) or results, and then what the research directions are going forward. The main paper can have an accompanying supplementary material (detailed methods) part. The supplementary material is not mandatory, but authors are strongly encouraged to submit supplementary material, which will increase the chance of acceptance. The Supplementary material (detailed methods) will be peer reviewed along with the main paper.

Style guidelines for the main paper:

The main report (min. of 4, max. of 8) is written in format of a letter. Due to their letter nature, the research must be original and must be of interest to research scientists/engineers and industry in related fields.

Abstract guidelines: The report begins with a fully referenced paragraph, ideally 200 words aimed at readers in the general area of engineering and physical sciences. The references must be up-to-date (e.g. referring to the best available materials, devices, circuits) & convey the relevance and originality of the research. This paragraph starts with a 3-4 sentence basic introduction to the problem area explaining the relevance and the issues. This is followed by a one-sentence statement of the main conclusions (e.g. 'Here we show' or equivalent phrase); and finally, 2-3 sentences putting the main findings into general context so it is clear how the results described in the paper have moved the field forwards.

Body: The text of the article must be succinct and start with general audience and progressively increase the complexity for experts. The body of the main paper must provide clear context to the present work based on established industry roadmaps, figures of merit or generally accredited framework (computational throughputs, leakage power, long form Reviews of Modern physics, IEEE proceedings, Nobel lectures). To enable the comparison it is encouraged that key quantitative findings of the paper are compared in a table with current references. Any concluding statements at the end of the article must be short since key conclusion is clearly articulated at the introduction. A repetition of the conclusions in the abstract should be avoided. Concluding statements explaining future possibilities or evolution are encouraged.

Style guidelines for supplementary material (methods paper):

The supplementary material is a unique format to encourage complete and clear communication of the relevant information to the experts in the area, while providing a citable source for the students for the innovations in scientific method: processing, modeling and theory. Long form derivations and code submissions are encouraged for theoretical and modeling papers. Modeling papers could for example provide all relevant data (not necessarily the code but they could) required to reproduce or validate the results. The JxCDC encourages the authors to put the experimental details such as fabrication methods, detailed characterizations, models or simulation methods (if it is a theory paper). The supplementary information therefore documents innovations in the experimental and modeling scientific methods, e.g. an innovative process technique to avoid interface effects, newly adopted differential equation solvers or innovative developments in device/circuit analysis can be included (and students/researchers will have a citable source online). Background materials that help the reader can be referenced in the supplemental material.

The supplementary material part begins with an unreferenced abstract (typically 150 words) and is divided into separate sections for introduction, results, discussion and methods. Introduction and discussion are brief and focused. The results section usually contains a general description followed by their validation. The methods section provides technical details necessary for the independent validation of the methodology, without referring to a chain of bibliographical references. The text of the supplementary material (excluding abstract, methods, references and figure legends) is limited to 6000 – 7000 words. Articles have no more than 12 display items (figures and tables). The results and methods should be divided by topical subheadings; the discussion may contain subheadings at the

author's discretion. If statistical testing was used to analyze the data, the methods section can contain a subsection on statistical analysis. If significant EDA tools are employed, relevant validation can be provided for the novel approach. The experimental tools and the instrumentation used must be explained in a clear schematic preferably with the models (part numbers) mentioned.

In summary, all the new contributions and accomplishments are to be summarized in the 4 to 8 page main paper. The main paper format will be such that it can be understood by not only the expert but also the non-expert (providing the context to someone unfamiliar but wanting to follow progress in the field). All experimental or simulation methods to enable reproducing/validating the results of the paper are in the supplementary material (detailed methods) part.