



18<sup>th</sup> - 20<sup>th</sup> December 2018, Hannover, Germany

[www.cognitive-comp.org](http://www.cognitive-comp.org)

## Call for Abstracts

### Background, scope and aims of this conference

Performance growth of digital microchips is flattening out and their energy consumption is becoming a serious issue. This impasse has re-invigorated two lines of investigation that have been explored for decades without leading yet to decisive breakthroughs. The first is *learning from the brain* with its amazing intelligence-per-Watt ratio. However, current “neuromorphic” microchips exhibit many biologically implausible features. The second line is the exploration of *unconventional physical substrates* and nonlinear phenomena, for instance optical, nano-mechanical, quantum-dynamical, or (bio-)chemical. Many of these hold promise, in principle, for extremely low-energy / high-bandwidth information processing. However, these unconventional alternatives suffer from numerous defects like stochasticity, low precision, drift, aging and device mismatch. Biological brain tissue exhibits all such problematic properties, too. But it largely remains a riddle what “computing” could mean both in brains and/or other unconventional substrates.

The scientific aims of our conference are twofold. First, to critically explore technological options arising from novel computational architectures in unconventional substrates, and second, to work towards a general, productive, and rigorous theory of “computing” in non-digital, nonlinear physical substrates. Biological brains and future unconventional computing machines would be seen as different instantiations of the same underlying principles. We want to get a clearer view on a future fundamental theory of computational dynamics. The conference adopts a decidedly wide-angle view on cognitive dynamics, unconventional or neural substrates, and the mathematics of nonlinear phenomena and – possibly – of novel definitions of “computing”.

Besides its scientific aims, the second, equally important goal of the conference is to foster discussion and cross-disciplinary awareness.

An overview of the five topical sessions, keynote and plenary lectures, and review Panel Chairs is provided in an appendix at the end of this call.

### **Invitation to submit abstracts (paper/poster)**

We solicit the submission of abstracts of which upon acceptance will be featured as an oral presentation or a poster. Scientific quality and alignment with the conference themes are the sole evaluation criteria. We equally appreciate contributions of the following kinds:

- Reports on discipline-specific scientific progress (the standard kind of conference contributions)
- Overviews on current developments in the author's field, formulated in a way that is accessible for an interdisciplinary audience
- Efforts to identify and clarify crucial unsolved issues ("asking the right questions" kind of contributions).

For each of the five topical sessions of the conference, 3 submissions will be selected for an oral plenary presentation (the conference is single-track) of 30 min (including discussion) each. Another 20 submissions will be selected for a poster presentation. The relatively small number of accepted submissions is intended to enable productive discussion. Revised abstracts will be published online, thus authors must ensure that contained material does not infringe copyrights.

### **Format of abstracts, submission and reviewing procedures**

Please prepare an abstract not exceeding in length 2 pages including images and references (letter or A4, 11 pt font, single-spaced) and submit via the form provided on the Conference Webpage ("Submission"). Please use the provided templates (Latex, Word). The online submission form will ask you to which of the five topical submissions you want to submit. Please consult the detailed session description in the Appendix below for the scope of each session and topic suggestions. Each submission will be reviewed by at least two reviewers from a session-specific review board, headed by a Panel Chair. Acceptance and oral/poster decisions will be made jointly by the respective Panel Chair and the conference organizers.

The deadline for submitting abstracts is July 31, 2018. Notification of acceptance: September 31.

We are looking forward to your contributions and seeing you in Hannover!

#### *The organizers:*

- Daniel Brunner (photonics, neuromorphic architectures; Université Bourgogne Franche-Comté/CNRS)
- Herbert Jaeger (machine learning, nonlinear dynamics; Jacobs University Bremen)
- Stuart Parkin (nano systems, quantum electronic materials; Max-Planck-Institute for Microstructure Physics, Halle)
- Gordon Pipa (neuroinformatics and cognitive computing; University of Osnabrück)

## Appendix: Our Five Sessions: Themes and Suggestive Topics

The conference is structured in five topical sessions. Each session is opened by an invited keynote talk, followed by three oral presentations.

**Session 1: Applications of unconventional computing systems:** *novel computing systems will look, feel and work differently from digital computers - for what (cognitive) tasks are they inherently suitable (and for what tasks classical digital systems are maybe inherently unsuited)?* Suggestive topics:

- Optical devices for communication systems
- Implantable neurochips, neuroprosthetics
- Ultra-low power devices, embedded systems
- Artificial agents (avatars, game characters, robots): lifelong learning and evolution
- Distributed control systems for compliant or soft motor systems

Keynote: Susan Stepney, University of York, UK

Panel Chair: **Geoffrey Burr, IBM, Almaden, USA**

**Session 2: Theoretical concepts and mathematical foundations:** *what mathematical tools are candidates, and which extensions need to be found, to formulate a theory of computational dynamics in brainlike materials.* Suggestive topics:

- Non-autonomous (stochastic, input-driven) dynamical systems
- Spatial / temporal multiscale modeling; nonlinear phenomena in ultra-high-dimensional inhomogeneous systems
- “Softening” classical logic: fuzzy, stochastic,... ; metalogical frameworks
- Non-Shannon definitions and measures of information
- Robust phenomena in systems with less-than-1-bit precision, drifting parameters

Keynote: Edward A Lee, Berkeley, USA

Panel Chair: **Raoul-Martin Memmesheimer, University of Bonn, Germany**

**Session 3: Neuromorphic hardware:** *what insights can be obtained from the rich, already accumulated engineering experience, and which novel concepts are out there.* Suggestive topics:

- Digital versus analog: communication and nonlinear mapping
- Fully parallel neuromorphic hardware concepts
- Three dimensional architecture implementation
- Cascadability and scalability for hierarchical and modular, large-scale systems
- Hardware-inherent homeostasis and self-organization

Keynote: Kwabena Boahen, Stanford University, USA

Session Chair: **Thomas Van Vaerenbergh, Hewlett Packard Enterprise Labs, Palo Alto, USA**

**Session 4: Novel physical substrates:** *A discovery tour through the zoo of nonlinear effects that are being explored for computational dynamics.* Suggestive topics:

- Electronic analog neuron models
- Novel substrates (dielectric, spin based, ionic, optical, etc.) for neurons and synapses
- Accelerating neuromorphic hardware via ultra-fast devices
- Low-noise substrates for analog neuromorphic hardware
- Substrate physics that facilitate signal propagation

Keynote: Demetri Psaltis, EPFL, Lausanne, Switzerland

Session Chair: **Martin Ziegler University of Kiel, Germany**

**Session 5: Guides from neuroscience for computing technologies:** *what insights and constraints can already be gleaned from the cognitive and computational neurosciences?*

Suggestive topics:

- Information coding and processing with spiking or other stochastic dynamics
- Homeostatic and functional stabilization mechanisms
- Representing conceptual/symbolic knowledge in dynamical phenomena
- Multi-timescale dynamics; memory hierarchies
- Large-scale multi-modular systems; 3D connectivity

Keynote: Pieter R. Roelfsema, NIN Amsterdam, Netherlands

Session Chair: **Alberto Bernacchia, Cambridge University, UK**

In addition to the five topical sessions, there will be four 1-hr **plenary lectures**, where speakers with an interdisciplinary profile will share their insights for an over-arching cohesion of our themes.

**Public lecture (Computation and system autonomy):** Ipke Wachsmuth, Bielefeld University, Germany.

**Plenary Lecture I (Fundamental limits on the thermodynamics of circuits):** David Wolpert, Santa Fe Institute, USA.

**Plenary Lecture II (Computing brains):** Chris Eliasmith, University of Waterloo, Canada.

**Plenary Lecture III (Ethical and societal implications):** Joanna Bryson, Princeton, USA.

## Registration Fees

**Account Name:** Universitaet Osnabrueck

**Bank Name:** Norddeutsche Landesbank, Hannover

**Bank details:** IBAN: DE82 2505 0000 0101 4320 03 BIC: NOLADE2H

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