Call for Participation:
Beyond correlations: Developments in supervised learning algorithms for spiking neural networks

Workshop at ICANN 2011, Helsinki, 14/06/2011, 1000-1630

Organiser:
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Outline

There is a wide gap in understanding learning between those researchers coming from the neuroscientific side and those coming from a more technical or cognitive side: People with a neuroscientific background are interested in biologically plausible details and hence are often critical towards technically and cognitively motivated approaches towards learning that are only biologically inspired but not biologically realistic. On the other hand researchers that want to apply bio-inspired algorithms are rather interested in that "things work" somehow.

Can we bridge this gap through developing learning algorithms that are both biologically plausible but still technically efficient? And in doing so, can we also increase our understanding of how the brain really works?

We are looking to bring together young and experienced researchers from computational neuroscience, neuro-inspired computing, machine learning and cognitive science interested in developing and applying learning algorithms for spiking neural networks that

- make use of learning beyond purely correlative learning,
- are supervised or unsupervised,
- aim to be biologically plausible,
- aim to be cognitively plausible or
- aim to be technically efficient.

Ideally the workshop will stimulate a wider discussion, identify new directions of research and make matches between people interested in different aspects of learning in spiking neural networks. Some sample questions for discussion are:

- How can correlation-based learning on the neural level lead to supervised learning behaviour on a higher functional level?
- Which level of abstraction is it that goal-directedness and supervision enter learning behaviour? Is it desirable at all?
- Can we implement learning algorithms that are technically efficient *in a biologically plausible way* in networks of spiking neurons?

- What are applications of spiking neural networks where the spiking behaviour is a real plus over the standard use of rate neurons?

But certainly many more question can and will be discussed!

Venue

The workshop will take place on 14/06/2011 as part of the ICANN conference in Helsinki. Precise rooms within the ICANN venue to be confirmed.

Format

This workshop tries to be different from yet another special session and encourages active participant involvement. Hence, in order to stimulate open discussions between participants it takes the form of a seminar both with introductory talks about recent progress to set a framework and *short presentations of research ideas by the participants themselves (**you!**)*. The workshop will also give ample space for an open and unconstrained discussion.

Participation

Please indicate your interest to participate by 03/06/2011 sending an email to `a.gruning@surrey.ac.uk` with subject `ICANN workshop: Beyond correlations` with the following information:

- Title (max 15 words)
- Abstract (max 150 words) indicating the nature of your research question, interest or idea,

and then prepare 3-6 slides in pdf format for presentation at the workshop.

Titles and abstract will be made available online prior to the workshop. They will be used to sort contributions into subject streams (not limited to the ones listed below).

Schedule

1000-1005 Welcome and Overview of the Workshop
1005-1030 Introduction to extensions of gradient-based learning algorithms to spiking neural networks, Andre Gruning, University of Surrey.
1030-1130 Stream "Gradient-based algorithms" – participant presentations and discussion.
1130-1200 Introduction to supervised and reinforcement learning based on Liquid State Machines, Scott Notley, University of Surrey.
1200-1300 Stream "Liquid State Machines", participant presentations and discussion.
1300-1430 Lunch break
1430-1500 Introduction to supervised learning and reinforcement learning based on STDP, Scott Notley and Andre Gruning, University of Surrey.
1500-1600 Stream "STDP" – participant presentations and discussion.
1600-1630 Wrap-Up: What have we learnt? Where do we go from here?

Background

Today we have good neuroscientific evidence for correlation-based (Hebbian-style, eg STDP etc) learning in natural neural networks (although also here evidence is not as straight-forward as one might think). However cognitive behaviour is often thought of as target-driven, which indicates a more supervised approach to learning than purely correlation-based learning can offer to-date.

Furthermore, technically efficient algorithms do exist for artificial neural networks of *rate* neurons, implementing both unsupervised and supervised learning, and using both correlation-based learning and optimisation strategies (eg gradient-descent, reinforcement), however often making biologically implausible assumptions about error-signal propagation. On the other hand learning algorithms for networks of *spiking* neurons have mainly been based on correlation-based learning which cannot yet tackle the same set of problems as gradient-descent algorithms for rate neurons.

Participants are encouraged to browse the following literature (eclectic):

1. S.M. Bohte, J.N. Kok, and H. La Poutré. Spike-prop: error-backpropagation in multi-layer networks of spiking neurons. *Neurocomputing*, 48(1–4):17–37, 2002
2. Uwe Frey and Richard G.M. Morris. Synaptic tagging and long-term potentiation. *Nature*, 385:533–536, February 1997
3. W. Gerstner and W. Kistler. *Spiking Neuron Models: Single Neurons, Populations, Plasiticity*. Cambrige University Press, 2002
4. Kenneth D. Harris. Stability of the fittest: organizing learning through retroaxonal signals. *Trends in Neuroscience*, 31(3):130–136, February 2008
5. Eugene M. Izhikevich. Polychronization: Computation with spikes. *Neural Computation*, 18: 245–282, 2006
6. Eugene M. Izhikevich. Solving the distal reward problem through linkage of STDP and Dopamine signalling. *Cerebral Cortex*, 17:2443–2452, 2007. 10.1093/cercor/bhl152
7. Robert Legenstein, Dejan Pecevski, and Wolfgang Maass. A learning theory for reward-modulated spike-timing-dependent plasticity with application to biofeedback. *PLoS Computational Biology*, 3(10):1–27, October 2008
8. Wolfgang Maass, Thomas Natschläger, and Henry Markram. Real-time computing without stable states: A new framework for neural computation based on perturbations. *Neural Computation*, 14(11):2531–2560, November 2002
9. Hélène Paugam-Moisy, Régis Martinez, and Samy Bengio. Delay learning and polychronization for reservoir computing. *Neurocomput.*, 71(7-9):1143–1158, 2008. ISSN 0925-2312. http://dx.doi.org/10.1016/j.neucom.2007.12.027
10. Filip Ponulak and Andrzej Kasiński. Supervised learning in spiking neural networks with ReSuMe: Sequence learning, classification and spike shifting. *Neural Computation*, 22:467–510, 2010
11. Hui Zhong W. Tao, Li I. Zhang, Guo Qiang Bi, and Mu Ming Poo. Selective presynaptic propagation of long-term potentiation in defined neural networks. *Journal of Neuroscience*, 20(9):3233–3243, May 2000
12. Peter Tiňo and Ashley J.S. Mills. Learning beyond finite memory in recurrent networks of spiking neurons. *Neural Computation*, 18(3):591–613, 2006
13. Florentin Wörgötter and Bernd Porr. Temporal sequence learning, prediction, and control – a review of different models and their relation to biological mechanisms. *Neural Computation*, 17(2):245–319, February 2005