Workshop: Neuroplasticity: From Bench to Machine Learning 13-14/07/18

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Workshop Report

Neuroplasticity: From Bench to Machine Learning was a two day workshop held at the University of Surrey on 13+14/07/2018. The event was organised by Dr Julie Seibt (Surrey Sleep Research Centre) and Dr André Grüning (Department of Computer Science). About 32 participants, of which 12 where invited speakers, attended the workshop which included invited and a contributed talk, an open forum discussion and contributed posters, as well as a networking dinner.

Workshop Objectives

The main objective of this workshop was to kindle discussions of the missing links between neural-level phenomena and their computational function on behavioural or technical level, and to bring together international and national leaders in the fields of synaptic

function and plasticity, network dynamic, computational neuroscience and machine learning, in order to offer a unique platform to establish new interdisciplinary collaborations.

Scientifically, this workshop focused on recent developments in neuroscience and machine learning and their mutual inspiration and understanding: On the one hand neuroscience is constantly discovering new mechanisms of plasticity. However the functional and computational role of these synaptic and neural-level plasticity mechanisms is often not clear on a functional and computational level. On the other hand, current machine learning (despite huge advances since the advent of "Deep learning", especially in well-defined and limited domains and with billions of training runs such as in Go, Chess or Restricted-domain image classification) still does not achieve general level intelligence of naturally behaving system.

Bringing together these complementary views requires a deeper mutual understanding of the involved disciplines, and this objective pursued and achieved with the workshop.

- Workshop Web Site:
  http://www.ias.surrey.ac.uk/workshops/Neuroplasticity/index.php

Summary of Presentations
- At the encouragement of the organisers, some speaker chose to make their presentations available online at https://zenodo.org/communities/neuroplasticity-workshop/?page=1&size=20.

- *Giorgos Kastellakis* (neuroscience) talked about linking memories across time via excitability and synaptic tagging, giving us an update on how plasticity mechanism shape memory.
- *Conor Houghton (computational modelling) explored how Hebbian learning can be* with spike timing dependent plasticity in a series of computer models based on neuroscientific data.
- *Matthew Larkum* (neuroscience) gave an overview how memory might be embedded in L1 of the cortex, utilising plasticity rules depending on neuronal compartmentalisation.
- *Tiina Manninen* (computational neuroscience) highlighted the role astrocytes plays for cognitive functions and reviewed a large number of computational models of astrocytes and neuron-astrocyte interactions.
- *Cyril Hanus* (neuroscience) presented us some recent ideas on the biochemical basis of synaptic and neural plasticity looking at the distinct properties of dendritic ion channels.
- *Liam McDaid* (computational modelling) had a look at astrocytes based on biophysical models.
- *Keith Hengen* (systems neuroscience) looked at how neurons self-organise into larger networks based on homeostatic plasticity principles.

- *Mike Davies* (machine learning) presented the latest advances of next generation computing devices based on biological principle in the form of Intel's neuromorphic computer *Loihi*.
- *Katharina Wilmes* (neuroscience) talked about the often overlooked interneuron circuits and underlined their importance for the cognitive-level guided plasticity of sensory representations.
- *Dominik Dold* (theoretical neuroscience, contributed talk) described fundamental optimality principles underlying the optimisation of function in neural networks.
- *Friedemann Zenke* (machine learning) presented learning algorithms that move beyond random spiking neural networks (as are often simulated) to achieve a higher-level learning behaviour.
- *Brendon Watson* (cognitive neuroscience) presented the forms and functions of neural oscillations (mainly found during sleep) and how they contribute to memory and plasticity functions.
- The talk by *David Lester* (Machine learning) on learning and plasticity in a the neuromorphic computer *Spinnaker* had to be cancelled on short notice.

Key Discussion Topics of the Workshop

The discussions at the workshop (in the forum discussion or informal coffee break discussions) were centred around:

- Availability of data
- Replicability of data and simulations.
- Is supervised learning plausible in nature?
- Do we need spike times or just rates?
- Are neuromorphic platforms the way forward for modelling and building better AI?
- Do we have to rebuild the brain in order to understand it?
- Where do we need to direct our attention?
- Robustness: does fine-tuning parameters invalidate our research?
- Do we take embodiment seriously?

Next Steps

Several contacts have been established and/or deepened between the research to explore routes of collaboration (eg Grüning and Zenke or Larkum, Seibt and Wilmes)

The organisers would like to seek future funding to extend the workshop into a yearly event where researchers with a more computational and machine learning background discuss with experimental neuroscientists in order to raise the visibility of neuroscience done at Surrey.

Acknowledgements