TECHNISCHE UNIVERSITÄT MÜNCHEN
NEUROWISSENSCHAFTLICHE SYSTEMTHEORIE
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A D V A N C E D S E M I N A R

Survey of Learning Approaches for Spiking Neural Networks

Problem description:

Biological neurons exchange information by sending short and sudden pulses, so-called action potentials or spikes. While traditional Artificial Neural Networks (ANNs) used in machine learning neglect these biological details, Spiking Neural Networks (SNNs) embody these spike times and are therefore often referred to as the third generation of neural networks [5]. One major hindrance for their widespread adoption has been the problem, that standard learning algorithms for traditional ANNs like backpropagation [6] can not be directly applied to SNNs. Although an analogon, the so-called SpikeProp algorithm [2] for SNNs has been developed, the more natural approach is to transfer and mimic biologically inspired learning approaches like Hebbian learning [3] or Spike Timing Dependant Plasticity (STDP) [1]. Another possibility is to train a traditional ANN and convert the resulting network into a SNN [4].
In this seminar, the student is expected to research relevant literature concerning learning algorithms for SNNs. Furthermore, the student should differentiate the approaches regarding e.g. biological plausibility, offline vs. online, accuracy and potential applications. Instead of giving an overview of several learning approaches, it is also possible for the student to choose and research in-depth one particular learning scheme.

This seminar requires the student to

- introduce the theoretical background of SNNs
- give an overview of current research regarding learning algorithms for SNNs
- compare and rank the learning algorithms regarding metrics like biological plausibility, accuracy and potential applications or research one approach in-depth
- write down the results in text form (report)
- present an overview of the results in oral form (presentation)

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Bibliography:

[1] G. Bi and M. Poo. Synaptic modification by correlated activity: Hebb's postulate revisited. *Ann Rev Neurosci*, 24:139–66, Jan. 2001.
[2] S. M. Bohte, J. N. Kok, and H. LaPoutre. Error-backpropagation in temporally encoded networks of spiking neurons. *Neurocomputing*, 48:17–37, 2002.
[3] D. O. Hebb. *The Organization of Behavior*. John Wiley, 1949.
[4] E. Hunsberger and C. Eliasmith. Spiking Deep Networks with LIF Neurons. *CoRR*, abs/1510.08829, 2015.
[5] H. Paugam-Moisy and S. M. Bohte. *Handbook of Natural Computing*, chapter Computing with Spiking Neuron Networks. Springer-Verlag, Sept. 2009.
[6] P. J. Werbos. *Beyond regression: new tools for prediction and analysis in the behavioral sciences*. PhD thesis, Harvard University, 1974.