Elitenetzwerk Bayern

Einblicke in die Forschungsarbeit

**MASTERARBEIT**

# „Adaptation in Brains and Machines“

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# Adaptation in Brains and Machines Ottilien

Steffen Schneider is an alumnus of the Elite Graduate Program “Neuroengineering” at the Technical University of Munich. Advised by Prof. Jakob Macke in Munich and Dr. Alexander Ecker and Prof. Matthias Bethge at the University of Tübingen, he investigated adaptation mechanisms for learning algorithms.

## Towards Robust Learning

Despite the successes of machine learning in recent years, deep neural networks fall short of the capabilities of biological brains when it comes to data efficiency and robustness to perturbations and changing environments. In particular, biological brains are able to rapidly adapt to changing conditions and are robust across a large variety of perturbations to their input signals, such as background noise, occlusions in an image or color variations over the course of a day.

Consider changing lighting over the course of a day: Inferring that it is bright or dark in a room is an easier task than determining the content of the room. However, after determining the lighting conditions, it is very easy to adapt parts of the perception process to account for them and improve on the actual recognition task.

This high level intuition of a source for robustness and adaptation in biological brains can then be translated into concrete experiments for artificial learning systems, which Steffen Schneider investigated in his thesis. To foster reproducible research for domain adaptation, all experiments are build on top of a modular and open source software library comprising popular existing domain adaptation approaches as baselines for the various experiments.

## One network, many conditions

An important sub-problem for the outlined adaptation scheme is the question of how the parameters of a single neural network can be quickly adapted to a range of conditions. Two commonly applied approaches to this problem are to fine-tune either the full learning system, or the high-level parts of it, which either requires to adapt many parameters, or relies on the assumption that the previous high-level representation can easily be re-used even after the change.

A more sensible approach to account for both low level (brightness, local noise, etc.) and high level changes (rotations, scene composition, presence of background, etc.) is the adaptation of just a few parameters spread across the whole network. Steffen Schneider’s empirical results demonstrate that this adaptation scheme is already quite powerful and often already sufficient to “solve” commonly studied adaptation problems in computer vision, as well as implementing adaptation to noise in a parameter-efficient way.

More information:

***http://domainadaptation.org***