Technische Universität München
Neurowissenschaftliche Systemtheorie

Project Laboratory Computational Neural Engineering

Applying temporal coding to an existing spiking neural network for EEG motor imagery movements decoding

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Problem description:

Spiking neural networks (SNNs), which are considered as the third generation of brain-inspired neural network techniques, seem to classify the EEG signals more accurately than standard statistical or machine learning techniques [1]. Spiking neurons convey information with spike events which are an activation in time. Since most of the information available from sensors are in real values, the information should be encoded into a spike domain. Depending on different problems, this encoding type may vary to get better results.

The utilized SNN in [2] classifies preprocessed EEG signals to decode motor imagery movements by using the architecture of the insect olfactory system [3]. The preprocessed real-valued EEG signals are converted into spikes by a population coding in [2]. In this project, students are asked to employ temporal coding ([4]) for the same network and evaluate the accuracies on SpiNNaker neuromorphic hardware to compare with the obtained results in [2].

Task:

- Get familiar with temporal coding and choose one of the temporal coding schemes
- Implement temporal coding for the provided network
- Compare the achieved accuracy with the one obtained in [2]
- Prepare the documentation and the report.

Requirements:

- Good knowledge of Python

References:

[1] Dethier J, Nuyujukian P, Eliasmith C, et al. A Brain-Machine Interface Operating with a Real-Time Spiking Neural Network Control Algorithm. Advances in neural information processing systems. 2011; pp. 2213-2221.

[2] Tayeb, Zied, Emeç Erçelik, and Jörg Conradt. "Decoding of motor imagery movements from EEG signals using SpiNNaker neuromorphic hardware." *Neural Engineering (NER), 2017 8th International IEEE/EMBS Conference on*. IEEE, 2017.

[3] Lungu, I-A., et al. "Predicting voluntary movements from motor cortical activity with neuromorphic hardware." *IBM Journal of Research and Development* 61.2/3 (2017): 5-1.

[4] Kheradpisheh, Saeed Reza, et al. "STDP-based spiking deep neural networks for object recognition." *arXiv preprint arXiv:1611.01421* (2016).

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