Technische Universität München

Neurowissenschaftliche Systemtheorie

Advanced Seminar

Spiking Neural Network Decoders for Brain-Machine Interfaces

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Problem description:

A major hurdle to clinical translation of brain–machine interfaces (BMIs) is that current decoders, which are trained from a small quantity of recent data, become ineffective when neural recording conditions subsequently change [1]. Hence, it is of the utmost importance to have a decoder that is more robust to future neural variability. Spiking neural network (SNN) which is considered as the third generation of brain-inspired neural network techniques, seems to classify more accurately the EEG signals than standard statistical or machine learning techniques [2]. As an example, a 3D spiking neural network environment called NeuCube has shown significant accuracy of classification and interpretation of EEG brain signals, suggesting its potential application to brain machine interface research [3].
Hence, the student shall give an overview of the use of spiking neural networks algorithms in brain machine interface research. Furthermore, he must provide a comparison between SNN algorithms performance and the traditional machine learning algorithms used in BMIs and present the advantages and limitations of each of them.

Tasks:

This seminar requires the student to:

- Familiarize with scientific literature and research papers
- Present the state of the art of the use of SNN in BMI research.
- Compare between SNN algorithms and standard machine learning algorithms for BMIs and present their advantages and limitations.
- Write down the results in a scientific report
- Present the results of the scientific seminar in oral form

Bibliography:

[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] Kasabov N., Hu J., Chen Y., Scott N., Turkova Y. (2013) Spatio-temporal EEG Data Classification in the NeuCube 3D SNN Environment: Methodology and Examples. In: Lee M., Hirose A., Hou ZG., Kil R.M. (eds) Neural Information Processing. ICONIP 2013
[3] Elisa Capecci, Nikola Kasabov, Grace Y. Wang, Analysis of connectivity in NeuCube spiking neural network models trained on EEG data for the understanding of functional changes in the brain: A case study on opiate dependence treatment, Neural Networks, Volume 68, August 2015, pages 62-77

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