

NeuCube Spiking Neural Network Algorithm for Non-Invasive Brain-Computer Interfaces

25-09-2017

Problem description:

The brain functions as a spatio-temporal information processing machine and deals extremely well with spatio-temporal data. Spatio- and spectro-temporal data (SSTD) are the most common data collected to measure brain signals. Therefore, brain-inspired Spiking Neural Network (SNN) algorithms such as NeuCube [1] have the potential to learn SSTD by using trains of spikes (binary temporal events) transmitted among spatially located synapses and neurons. In NeuCube algorithm, both spatial and temporal information can be encoded [2] as locations of synapses and neurons and time of their spiking activity respectively. Hence, there has been some progress investigating the application of SNN-based NeuCube algorithm in non-invasive brain-computer interfaces (BCIs) research [3].

Consequently, the student shall give an overview of the use of such algorithm in the field of non-invasive BCI. Furthermore, he must provide a comparison between NeuCube and classical machine learning decoders used in BCIs and present the advantages and limitations of each technique.

Tasks:

This seminar requires the student to:

- Familiarize with scientific literature and research papers
- Present the state of the art of the use of NeuCube algorithm to decode EEG signals
- Compare between NeuCube algorithm and standard machine learning techniques used in BCIs
- 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*, pages 62-77, 2015

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