Internship in the ESA Advanced Concepts Team

on

Network analysis and Machine learning approach to Space Neuroscience

Topic description

Data mining methods are extensively applied to electroencephalography (EEG) data and neuroscience in general. Recent advances in machine learning and network science promise to deliver a higher degree of understanding and possibly reveal previously undiscovered structures in known data sources. With this in mind, a second look at signals previously obtained and studied, appears as an occasion to advance our understanding on a number of important issues related to human spaceflight. Artificial Neural Networks, and in particular LSTMs or CNNs, could for example be used for the detection of neural events (characteristic oscillations: spindles, alpha, local sleep events, K-complexes, sharp wave ripples, etc) in EEG data, a tedious task which to date remains not fully automated. Network science approaches on the other hand could yield interesting insights into changes of the brain connectivity, comparing emerging structures in gravity and in micro-gravity environments.

Candidate's tasks

The specific project tasks include:

- Apply advanced machine learning and/or network science methods to neuroscience data which the ESA/ACT will be providing internally.
- Use statistical analysis to guide the interpretation of the results.

The ideal candidate

Mandatory:

- Strong programming skills in Python or equivalent;
- Prior experience with machine learning and/or network analysis

Desirable:

- Background in neuroscience;
- Experience with acquisition and signal processing of brain-related data.

References

[1] Bullmore, E. and Sporns, O. (2009). Complex brain networks: graph theoretical analysis of structural and functional systems. Nature Reviews Neuroscience, 10(3).

[2] Fisher, S. P., Cui, N., McKillop, L. E., Gemignani, J., Bannerman, D. M., Oliver, P. L., Peirson, S.N. & Vyazovskiy, V. V. (2016). Stereotypic wheel running decreases cortical activity in mice. Nature communications, 7.

[3] Finelli, L. A., Achermann, P., & Borbély, A. A. (2001). Individual ‘fingerprints’ in human sleep EEG topography. Neuropsychopharmacology, 25(5), S57-S62.

[4] Schirrmeister, R. T., Springenberg, J. T., Fiederer, L. D. J., Glasstetter, M., Eggensperger, K., Tangermann, M., Hutter. F., Burgard, W., & Ball, T. (2017). Deep learning with convolutional neural networks for brain mapping and decoding of movement-related information from the human EEG. arXiv preprint arXiv:1703.05051.