Doctoral School of Information and Biomedical Technologies Polish Academy of Sciences

Subject
Optimization and large-scale modeling of neural network controlling locomotion

Supervisors, contact, place of research
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Project Description

One of the challenges of the contemporary science is to understand how the nervous system encodes information about the outside world, and how it uses that information to take efficient actions or make decisions [4]. The goal of the project is to perform large-scale modeling of the organism called *C. elegans* in relation to neural control and encoding of locomotion [1,2]. The worm *C. elegans* is the only animal with a known map of neural connections on a single neuron level and well characterized genome, which allows us to perform realistic simulations [3]. (There were several Noble prizes for research on *C. elegans).* Understanding how the nervous system controls locomotion may be helpful in designing software useful for constructing „intelligent" robots that could be capable of performing sophisticated tasks.

We will apply the methods of optimization and feedback control, acting on *C. elegans* neural network to decipher the optimal network parameters, necessary for efficient locomotion. The starting point will be the extension of the research done in Ref. [2].

The project combines several disciplines: Neuroscience, Biocybernetics/Bioengineering, Informatics, and Applied Mathematics, and requires ambitious young people with good mathematical and computational skills.

Basic requirements: the ability to solve numerically systems of differential equations, good programing in Matlab and C++, basic knowledge of statistics, information theory and optimization.

Bibliography

1. Karbowski J (2019) *Current Opinion in Systems Biology* **13:** 44-51.

2. Rakowski F, Karbowski J (2017) *PLoS Computational Biology* **13:** e1005834.

3. Karbowski J, Schindelman G, Cronin CJ, Seah A, Sternberg PW (2008) *Journal of Computational Neuroscience* **24:** 253-276.

4. Dayan P, Abbott LF - *Theoretical Neuroscience.* MIT Press (2001).

5. Rao SS - *Engineering Optimization*. Wiley (2009).

6. Cover TM, Thomas JA - *Elements of Information Theory*. Wiley (2006).