Analysis of and dynamics on the mutli-layer network of C. elegans

Philipp Hövel

The nematode Caenorhabditis elegans (C. elegans) is a model oranism to demonstrate the power of dynamical systems on networks, because its connectome and physiology are well documented. In this presentation, I will highlight recent results on this complex system. First, I will discuss how synchronization patterns and chimera-like states emerge in the Hindmarsh-Rose equations for neuronal activity on the modular multi-layer topology that reflects the electrial, chemical, and (putative) wireless coupling between neurons [1]. Then, I will present how locomotory behavior can be modelled by combining neuronal and muscular activity patterns that control forward locomotion [2]. For this purpose, the neuronal equations are augmented by a leaky integrator model for muscular activity. The dynamics of the forward locomotion of the worm is inferred based on a harmonic wave model. Finally, I will show a preliminary visualization of worm in form of an augmented-reality app.

References:

[1] Armin Pournaki, Leon Merfort, Jorge Ruiz, Nikos E. Kouvaris, Philipp Hövel, and Johanne Hizanidis: Synchronization Patterns in Modular Neuronal Networks: A Case Study of C. elegans, Front. Appl. Math. Stat. 5, 52 (2019).

[2] Thomas Maertens, Eckehard Schöll, Jorge Ruiz, and Philipp Hövel: Multilayer network analysis of C. elegans: Looking into the locomotory circuitry, Neurocomputing 427, 238–261 (2021).