

Phys799- Neurophysics Tue 12.30pm-3.15pm

Instructor: Prof. Wolfgang Losert

The neurophysics course will be an interdisciplinary course focused on the physics of living neural networks. The neurons and other brain cells in a human brain form a complex network with unparalleled capabilities for sensing, analysis, and for controlling a wide range of actions. The brain achieves these capabilities using a self-assembled system with heterogeneous, stochastic individual elements. This course will provide a hands-on introduction to the physics and modeling of neural networks across scales.

Fundamentals of whole Brain Architecture and Dynamics

- Network architecture, brain waves

Dynamics of Neural Cells

- Mechano-chemical Dynamics
- electrical dynamics

Biophysics of Neural Cells and Cell Networks

- Cell morphology
- Growth of Neural Networks

Dynamics of Neural Networks

- Spike Analysis
- Cluster Synchrony
- Criticality

Learning in neural networks

- Hebbian Learning
- Machine Learning Models of Neural Networks

Course format: This course will include guest lectures and student-led discussions of topics. The focus will be on data driven understanding of neurophysics using hands-on exploration of data analysis tools and of simulations.

Final project: A report on hands-on exploration of either a model or publicly available neurodynamics dataset.

Grading: 70% Class participation 30% Final project

Learning Goals:

At the conclusion of the course, students will be able to

- Recognize biophysical principles in neuroscience
- Apply physics based models of neural dynamics
- Analyze experimental data
- Critique literature at the convergence of physics and neuroscience