

Collaborative PhD Position in Computational Neurosciences between School of Advanced Studies Pisa and University Mainz

Project title: Functional modeling of brain dynamics: understanding reinforcement learning through the lens of dynamical systems.

Key words: RNN, dynamical system reconstruction, neural coding, neuronal manifolds, modelling, statistical mechanics, machine learning, reinforcement learning, dopamine.

Host Institution: Sant'Anna School of Advanced Studies, BioRobotics Institute

Reference person/supervisor: Prof. Dr. Russo Eleonora; eleonora.russo@santannapisa.it

Research topic description: Understanding the dynamical systems governing neuronal activity is crucial for unraveling how the brain performs cognitive functions. Historically, various forms of recurrent neural networks (RNNs) have been proposed as simplified models of the cortex. Recently, due to remarkable advancements in machine learning, RNNs' ability to capture temporal dependencies has been used to develop tools for approximating unknown dynamical systems by training them on observed time-series data. This approach allows us to use time series of electrophysiological multi-single unit recordings as well as whole brain ultra-high field functional imaging (fMRI) to parametrize neuronal population dynamics and build functional models of cognitive functions. The objective of this research project is to investigate the neuronal mechanisms underlying the reinforcement and depreciation of perceived stimuli in the extended network of the mouse forebrain regions.

Research team and environment: The PhD student will carry out his/her/their studies primarily at the BioRobotics Institute of Sant'Anna School of Advanced Studies. The project will expose the student to a highly international and interdisciplinary context, in tight collaboration with theoretical and experimental neuroscientists in Italy and abroad. At the BioRobotics Institute, the research groups involved will be the Brain Dynamics Lab, <https://www.santannapisa.it/en/institute/biorobotics/brain-dynamics-laboratory>, the Computational Neuroengineering Lab, and the Bioelectronics and Bioengineering Area. Moreover, the project will be carried out in tight collaboration with the experimental group of Prof. Wolfgang Kelsch, Johannes Gutenberg University, Mainz, Germany, www.kelschlab.com. During the PhD, the student will have the opportunity to spend a period abroad.

Preferred Research Skills and Competences

The ideal candidate has a strong interest in neuroscience and a background in physics/math/biomedical engineering with computational and programming skills (ideally, knowledge of Matlab and/or Python). The ideal candidate carries out his/her/their work in a diligent, independent, and highly collaborative manner. The project will not require any experimental work.

For questions please contact Dr. Eleonora Russo, Eleonora.Russo@santannapisa.it

The deadline for applying to the position is at **13:00** on **29 July 2024**.

The project description can be found under 'Code 4.2' in:

https://www.unicam.it/sites/default/files/bandi/2024/06/ANNEX%201_TAN_ciclo%20XL_0.pdf

Further information about the call can be found here:

<https://www.unicam.it/bandi/2024/bando-n0046958-del-28062024>