Abolfazl Ziaeemehr

I got my PhD in **computational neuroscience** at Institute for Advanced Studies in Basic Science (IASBS) Zanjan, Iran and I am working there and also IPM-Institute for Research in Fundamental Sciences as a researcher.

Research Interest

- Network Neuroscience: Complex network approaches to brain structure and function
- Computational Neuroscience: Dynamic models of brain networks, neural synchrony and binding, information-theoretical measures of functional interactions.
- Data science: Analysis and visualization of data.

PhD Theses

Title **Synchronization dynamics on undirected and directed hierarchical networks**

Supervisors Mina Zarei, Alireza Valizadeh

Description The goal of my research was to develop a theoretical framework and computational tools for studying the collective behavior and synchronization of neuron populations. For example, I investigated the effects of the time delay, number, length, and place of directed loops, the interplay between node dynamics and network structure on the collective behavior of the networks. I also worked on the information proccessing at hierarchical complex networks.

Experience

Research

2016-2020 **Prof. Alireza Valizadeh and Prof Mina Zarei's research group**. As a member of this group I studied a wide variety of topics such as synchronization of coupled oscillators and neurons, information processing measurements, graph analysis, simulation and analysis of neural networks and analysing the brain recording data.

2018 **Prof. Joaquin J. Torres research group**. I had a vist for 6 month in the department of electromagnetism and matter physics, Universidad de Granada, Spain. I studied the phase-transition phenomena and analyzing to what extent a weak signal endures in noisy environments. I also studied the noise-induced volatility in a network of interacting LIF neurons. I had useful discussions with prof. Miguel A Muñoz.

Teaching

Jul 2020 **TA** at Neuromatch Academy summer school.

2016-2017 **Workshop Lecturer**, Holding workshops at IASBS on Python scripting for scientific programming several times, and also some other programming sessions on Julia, C++ and neuron simulation packages like Brian and Nest simulator.

2015-2016 Being **TA** several times in PhD period in Classical Electrodynamics (I, II) and Computational Physics.

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Some of open source software development and contributions

- **ziaeeNN2020**, This repository contains the source codes for reproducing results and figures in our recent paper: Frequency-dependent organization of the brain's functional network through delayed-interactions J. Neural Networks, 2020.
- Developing nest simulator by adding new neuron models, available on PR 543, PR560.
- **ModelingNeuraldynamics**, I wrote the codes for this book: "An Introduction to Modeling Neuronal Dynamics" by Borgers in Python scripts and using Brian.
- **itng toolbox**, IASBS Theoretical Neuroscience Group toolbox, to analysis the time series, spike trains and graphs in python (Pypi: itng);
- **SBI**, *sbi* package by mackelab is a *PyTorch* package for simulation-based inference. Simulation-based inference is the process of finding parameters of a simulator from observations. I provide some examples to integrate *sbi* with the *NEST simulator* and *scipy*.
- **workshop scripting** This repository is created for weekly sessions of Python scripting course at IASBS and including many example and application from simple to complex.
- **workshop julia** The source code and examples for the Julia workshop including benchmarking simple and generalized Kuramoto model.
- **workshop C++** The source code and examples for the C++ workshop.

List of Publications

Jul 2020 Ziaeemehr A, Zarei M, Valizadeh A, Mirasso C. **Frequency-dependent organization of the brain's functional network through delayed-interactions**. J. Neural Networks, 2020 Aug.

Feb 2020 Ziaeemehr A, Zarei M, Sheshbolouki A. **Emergence of global synchronization in directed excitatory networks of type I neurons**. *Scientific Reports. 2020 Feb 24;10(1):1-1.*

September 2020 Ziaeemehr, A. and Valizadeh, A., 2020. **Frequency-resolved functional connectivity: Role of delay and the strength of connections**, bioRxiv.

Presentations

Oct 2020 Neuromatch Conference 3, "Effects of Anti-Hebbian learning on the synchronization and structure of directed networks with pure and hybrid inhibitory and excitatory couplings".

Sep 2020 Bernstein Conference online, "Frequency-dependent functional connectivity: Role of delay and connections strength".

May 2020 Neuromatch Conference 2, "Emergence of global synchronization in directed excitatory networks of type I neurons".

Programming skills

OS Linux;

Languages Python, C++, Julia;

packages Nest Simulator, Brian, MNE-Python;

GUI PyQtGraph;

Honors and Awards

Jan 2018 Scholarship by the Ministry of science of Iran to carry out part of ongoing Ph.D research study at the *Department of Electromagnetism and Matter Physics, Universidad de Granada, Spain*;

2014 Rank 26 th among about 5000 people in entrance exames of PhD;

Notable events attended

Jan 2018 Comprehensive Workshop on Analysis and Interpretation of Primate Electrophysiological data, Institute for Research in Fundamental Science(**IPM**), Tehran, Iran;

Mar 2017 5th Workshop on Advanced Techniques for Scientific Programming and Management of Open Source Software Packages, **ICTP**, Sharif University, Tehran, Iran;

Oct 2016 Introductory School on Parallel Programming and Parallel Architecture for High-Performance Computing, **ICTP**, Trieste,Italy;

Nov 2014 High-Performance Computing and Grid computing (HPC8), Institute for Research in Fundamental Science(**IPM**), Tehran, Iran.

Languages

- English:reading,writing,listening — good
- Persian — Native

Advanced Courses Passed

PhD course Advanced scientific computation;

PhD course Parallel Computation and optimization;

PhD course Statistical Physics of Fields;

Reading inside Neuroscience

- Neuroscience : Exploring the Brain (Connors) ;
- Theoritical Neuroscience (Abbott);
- Neuronal Dynamics From Single Neurons to Networks ... (Grestner);
- Dynamical Systems in Neuroscience (Izhikevich);
- Modeling neuronal dynamics, (Borgers);
- An Introduction to Transfer Entropy, (Bossomaier)
- Directed Information Measures in Neuroscience, (Wibral).

References

Mina Zarei, *Assistant Professor of Physics*, mina.zarei@iasbs.ac.ir.
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Alireza Valizadeh, *Associate Professor of Physics*, valizade@iasbs.ac.ir.
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