Mohadeseh Shafiei Kafraj

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Executive Summary

I am a PhD student in theoretical neuroscience and machine learning. In my recent project, I developed an associative memory model that achieves high capacity while satisfying key biological constraints—two simultaneous requirements for a model of human memory. I am eager to apply my theoretical and computational expertise to model and understand both the brain and artificial intelligence.

Education

UCL, Gatsby Computational Neuroscience Unit 2022–present

PhD, ***Theoretical Neuroscience and Machine Learning****, Supervisor: Peter Latham*

Research Projects:

- Developing Theoretical Models of Biologically Plausible Associative Memory networks
  Supervised by: Peter Latham, in collaboration with: Brendan A Bicknell and Dmitry Krotov
- Developing Theoretical Models to Explain Persistent Neuronal Activity in the basolateral amygdala network
  Supervised by: Peter Latham, in collaboration with: Cristina Mazuski and John O'Keefe

Relevant Courses:

- Probabilistic and Unsupervised Learning
- Approximate Inference and Learning in Probabilistic Models
- Advanced introduction to kernel methods
- Theoretical neuroscience

Amirkabir University of Technology Distinguished Graduate Student

MSc, Biomedical Engineering, Advisor: Sajad Jafari *2017–2019*

Thesis: Synchronization in Multilayer Neuronal Networks with Time Delays

- Demonstrated that delayed interactions significantly alter the dynamics of neurons, including modifications to their firing patterns and the synchronization of the network.
- Developed a multilayer neuronal network with ephaptic (indirect) coupling, showing that network synchronization is influenced by a complex interplay between intra- and inter-layer coupling delays.
- Modeled a memristive neuron and demonstrated that neuronal electromagnetic fields induce new firing patterns.

Shiraz University (Ranked 1st)

BSc, Electronics Engineering, Advisor: Mehran Yazdi *2013–2017*

Thesis: Review of real-time monitoring systems for biological parameters including blood pressure, heart rate, and glucose levels.

Research Experiences

Internship: Decoding Neural Mechanisms of Speech Processing, FAU Germany *March–June 2022*

- Activities: Analysis of MEG data, analysis of speech data, Advisor: Tobias Reichenbach

Research assistant: Center for Mathematical and Computational Biology, AUT Iran *2019–2022*

- Research Topics: Network synchronization, nonlinear dynamics, and Chaos.

Publications

- Mohadeseh Shafiei Kafraj, et al. "Effects of Partial Time Delays on Synchronization Patterns in Izhikevich Neuronal Networks." The European Physical Journal B 92 (2019).
- Mohadeseh Shafiei Kafraj, et al. "Time Delayed Chemical Synapses and Synchronization in Multilayer Neuronal Networks with Ephaptic Inter-layer Coupling." Communications in Nonlinear Science and Numerical Simulation

84 (2020).

- Mohadeseh Shafiei Kafraj, et al. "Firing Patterns of an Improved Izhikevich Neuron Model under the Effect of Electromagnetic Induction and Noise." Chaos, Solitons & Fractals 137 (2020).
- Nafise Naseri, Sivabalan Ambigapathy, Mohadeseh Shafiei Kafraj, et al. "Connecting Curves as a Tool to Localize Hidden Attractors in a New Chaotic Hyper-jerk System with No Equilibria." International Journal of Bifurcation and Chaos (2021).
- Mohadeseh Shafiei Kafraj, et al. "Effects of Amplitude, Maximal Lyapunov Exponent, and Kaplan-Yorke Dimension of Dynamical Oscillators on Master Stability Function." International Journal of Bifurcation and Chaos (2022).
- Yousef Mohammadi, Mohadeseh Shafiei Kafraj, et al. "Decreased Resting-State Alpha Self-Synchronization in Depressive Disorder." Clinical EEG and Neuroscience (2023).

Talks and Poster Presentations

Talk: At the International Conference on Mathematical Neuroscience, 2025

Poster Presentation: At the New Frontiers in Associative Memory workshop, ICLR 2025

Academic Honors and Awards

2019: Nominated Distinguished Graduate Student, Biomedical Engineering Department, Amirkabir University of Technology.

2017: Awarded for being Ranked 1st, achieving the highest GPA among all undergraduate students majoring in Electronics Engineering, Shiraz University.

2017: Semi-finalist in the national Electrical Engineering Olympiad among the Electrical Engineering students of Iran.

2017: Nominated as Distinguished Undergraduate Student, Department of Electrical and Electronics Engineering, Shiraz University.

2017: Awarded honorary admission as an Exceptional Talent to the graduate school (M.Sc.) of Biomedical Engineering Department, Amirkabir University of Technology.

2017: Awarded honorary Direct Admission to the graduate school (M.Sc.) of the Department of Computer Science Engineering, Shiraz University, in the bio-electric field without entrance exam.

2017: Awarded honorary Direct Admission to the graduate school (M.Sc.) of the Department of Electrical and Electronics Engineering, Shiraz University, in the communication field without entrance exam.

Teaching

2024: Probability, Bridging Programme, Gatsby Computational Neuroscience Unit, UCL. Topics included:

- Estimators, Conditional Models, Bayesian Models, Latent Variable Models, Random Vectors

2023: Probability, Bridging Programme, Gatsby Computational Neuroscience Unit, UCL.

Teaching Assistantship

2024: Theoretical Neuroscience, Gatsby Computational Neuroscience Unit, UCL.

2023: Systems and Theoretical Neuroscience, Gatsby Computational Neuroscience Unit, UCL.

2016: Electronics Laboratory, Shiraz University.

2016: Electronics Course, Shiraz University.

Tools

- Programming Languages: Python, Matlab, C++.
- Version Control: Git.