

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.