# 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

2022–present: PhD, Theoretical Neuroscience and Machine Learning, UCL

2017–2019: MSc, Biomedical Engineering, Amirkabir University of Technology

2013–2017: BSc, Electronics Engineering, Shiraz University

## Research Experiences

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

*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.

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.
- Modelled a memristive neuron and demonstrated that neuronal electromagnetic fields induce new firing patterns.

## Publications

- **Mohadeseh Shafiei Kafraj**, et al. "A biologically plausible associative memory network." *New Frontiers in Associative Memories workshop ICLR* (2025).
- Yousef Mohammadi, **Mohadeseh Shafiei Kafraj**, et al. "Decreased Resting-State Alpha Self-Synchronization in Depressive Disorder." *Clinical EEG and Neuroscience* (2024).

- Fatemeh Parastesh, **Mohadeseh Shafiei Kafraj**, et al. "Complete and Partial Synchronization in Empirical Brain Networks." *AEU-International Journal of Electronics and Communications* 170 (2023).
- **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).
- 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. "Firing Patterns of an Improved Izhikevich Neuron Model under the Effect of Electromagnetic Induction and Noise." *Chaos, Solitons & Fractals* 137 (2020).
- **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. "Effects of Partial Time Delays on Synchronization Patterns in Izhikevich Neuronal Networks." *The European Physical Journal B* 92 (2019).

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

## 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

## 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++.