

Zeinab Mohammadi, PhD

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TARGETED PROFILE

AI/ML research scientist with a PhD in Electrical Engineering/Neuroengineering and postdoctoral training at Princeton and Northwestern. I build ML, AI, PyTorch, and state-space-model workflows for big data: millions of data points across hundreds of complex experimental conditions. My work emphasizes mechanistic understanding, latent-variable modeling, robust evaluation, computational hypothesis testing, algorithm optimization, and reproducible research artifacts for high-dimensional sequential data.

RESEARCH INTERESTS AND ROLE FIT

- **Mechanistic ML and statistical inference:** state-space models, latent-variable models, probabilistic modeling, uncertainty, nonstationarity, interpretable structure discovery, and model comparison.
- **Robust research methodology:** cross-validation, ablations, recovery analyses, sensitivity checks, failure-mode analysis, and clear scientific interpretation.
- **AI/ML implementation:** Python, PyTorch, deep learning, transformer implementation, NumPy/SciPy, scikit-learn, pandas, Git/GitHub, Docker, and reproducible pipelines.
- **Research-to-artifact execution:** converting open-ended research questions into testable models, simulations, evaluation metrics, figures, and publication-quality claims.

RESEARCH AND TECHNICAL EXPERIENCE

Postdoctoral Research Scientist | Northwestern University and University of Chicago, Pinto/Glaser Labs | Chicago, IL | Aug 2024 - present

- Develop ML and state-space models for high-dimensional sequential datasets spanning millions of data points across hundreds of complex behavioral and neural conditions, animals, sessions, regions, and task epochs.
- Build Python/PyTorch-compatible pipelines for preprocessing, feature construction, regression, decoding, GLM/state-space modeling, cross-validation, statistics, visualization, and failure-mode analysis.
- Test mechanistic hypotheses about hidden states, perturbations, and decision dynamics; translate ambiguous research questions into rigorous AI/ML analyses and reproducible computational outputs.
- Communicate assumptions, uncertainty, evaluation tradeoffs, and modeling decisions to computational, experimental, and engineering collaborators.

Swartz Foundation Postdoctoral Fellow / Postdoctoral Researcher | Princeton University, Pillow Lab | Princeton, NJ | Dec 2020 – Dec 2023

- Led ML research using latent state-space models, GLM-HMMs, and Bayesian inference to identify hidden strategies and transition drivers from millions of behavioral data points.
- Developed hundreds of lines of reusable modeling and analysis code for inference, validation, visualization, held-out evaluation, model comparison, robustness checks, and interpretability.
- Authored and presented a first-author Nature Communications study and collaborated with large multi-institutional teams on large-scale behavioral analysis.
- Extended and documented state-space modeling workflows in the SSM/GLM-HMM ecosystem, including input-driven transitions and observation models.

PhD Researcher, Neuroengineering and Machine Learning | University of Colorado / Anschutz Medical Campus | Denver/Aurora, CO | Sep 2016 - Dec 2020

- Developed GEMsort, an adaptive real-time multichannel spike-sorting framework using unsupervised clustering, dimensionality/data reduction, positional features, and hardware-aware constraints.
- Optimized algorithms for hundreds of thousands of neural voltage data points, including online cluster assignment and tradeoffs among accuracy, latency, memory, and computational cost.
- Designed and benchmarked efficient ML algorithms for large neural datasets, evaluating accuracy, robustness, computational efficiency, scalability, and real-time feasibility.
- Produced first-author Journal of Neural Engineering papers and a U.S. patent on adaptive real-time neural spike sorting.

AbbVie Internship, Biotech Company | Chicago, IL | Summer 2019

- Analyzed medical and engineering test data to support validation of wireless communication and electromechanical systems.
- Applied data analysis and ML-oriented quality-control thinking to evaluate device/test performance, detect inconsistencies, and support reliable experimental workflows.
- Validated equipment and workflows for Bluetooth

SELECTED PROJECTS & CODE

- PyTorch Transformer Interpretability - code: [pytorch-AI-interpretability-transformer_ZM](#)

Implemented a decoder-only transformer from scratch in PyTorch with causal self-attention, embeddings, residual streams, MLP blocks, training loop, and activation extraction; trained on non-ergodic hidden-process sequences and used PCA, effective dimensionality, and linear probes to test for interpretable belief-state representations. The project achieved $R^2 > 0.989$ for belief-state decoding and ~60% process-identity decoding versus 33% chance.

- Scientific Coding-Agent Benchmark - code: [AI-coding-agent-benchmark_ZM](#)

Built a reproducible benchmark for evaluating AI coding agents on real merged scientific-Python pull requests, with task generation, Docker-based sandboxed execution, automatic [0, 1] scoring, multi-model comparisons, log review, and failure analysis.

- Latent-State Modeling Pipeline for Nonstationary Decision-Making - code: [glm-hmm_final](#)

Developed end-to-end state-space/GLM-HMM workflows for preprocessing, model fitting, model selection, cross-validation, recovery analyses, and figure generation on large-scale behavioral datasets.

- Input-Driven State-Space Modeling Notebook - code: [2c-Input-Driven-Transitions-and-Observations-GLM-HMM.ipynb](#)

Implemented and documented input-driven transition and observation models in the SSM/GLM-HMM ecosystem, showing how covariates modulate latent-state dynamics and observation probabilities.

TECHNICAL SKILLS

- **Programming and ML systems:** Python, PyTorch, MATLAB, C, Git/GitHub, Docker, Conda, reproducible pipelines, experiment organization, large-scale analysis workflows.
- **Deep learning and AI tools:** PyTorch training loops, decoder-only transformer implementation, deep learning, NumPy, SciPy, scikit-learn, pandas, matplotlib, model prototyping, debugging, and visualization.
- **Modeling and evaluation:** state-space models, latent-variable models, GLM-HMMs, HMMs, Bayesian inference, regularized regression, cross-validation, ablations, simulations, model comparison, robustness checks.
- **Research strengths:** mechanistic interpretation, computational hypothesis testing, uncertainty-aware analysis, failure-mode analysis, scientific communication, publication-quality artifacts.

SELECTED PUBLICATIONS, MANUSCRIPTS, AND PATENT

- **Mohammadi, Z.**, Tank, D. W., Brody, C. D., Pillow, J. W., Pinto, L., & Glaser, J. I. Interpretable Latent State-Space Modeling of State-Specific Dynamics in Decision-Making. Manuscript in preparation, to be submitted to Nature.
- **Mohammadi, Z.**, Tank, D. W., Brody, C. D., Pillow, J. W., Pinto, L., & Glaser, J. I. Elucidating the state-dependence of cortical involvement in decision-making. Presented at COSYNE, 2025.
- **Mohammadi, Z.**, Ashwood, Z. C., International Brain Laboratory, & Pillow, J. W. Identifying the factors governing internal state switches during nonstationary sensory decision-making. Nature Communications, 2025.
- International Brain Laboratory (IBL), **Mohammadi, Z.**, ..., Witten, I. B. Reproducibility of in vivo electrophysiological measurements in mice. eLife, 2025.
- **Mohammadi, Z.**, Denman, D. J., Klug, A., & Lei, T. C. Multichannel neural spike sorting with spike reduction and positional feature. Journal of Neural Engineering, 2024. PMCID: PMC11298775.
- **Mohammadi, Z.**, Ashwood, Z., Pinto, L., Tank, D. W., Brody, C. D., & Pillow, J. W. Identifying latent states in decision-making from cortical inactivation data. Presented at COSYNE, 2022.
- **Mohammadi, Z.**, Kincaid, J. M., Pun, S. H., Klug, A., Liu, C., & Lei, T. C. Computationally inexpensive enhanced growing neural gas algorithm for real-time adaptive neural spike clustering. Journal of Neural Engineering, 2019. PMID: 31071700.
- **Mohammadi, Z.**, Klug, A., Liu, C., & Lei, T. C. Data reduction for real-time enhanced growing neural gas spike sorting with multiple recording channels. IEEE/EMBS Neural Engineering, 2019.
- Patent: Lei, T. C., **Mohammadi, Z.**, Klug, A., & Liu, C. Process and hardware implementation of adaptive real-time neural spike sorting. U.S. Patent No. US 11,622,727 B2, 2023.
- Pergoloni, S., **Mohammadi, Z.**, Vegni, A. M., Ghassemlooy, Z., & Biagi, M. (2017). Metameric indoor localization schemes using visible lights. Journal of Lightwave Technology, 35(14), 2933-2942. IEEE.
- Pergoloni, S., **Mohammadi, Z.**, Vegni, A. M., Ghassemlooy, Z., & Biagi, M. (2017, May). Visible Light indoor positioning through colored LEDs. In 2017 IEEE International Conference on Communications Workshops (ICC Workshops) (pp. 150-155). IEEE.
- **Mohammadi, Z.**, & Zamiri-Jafarian, H. (2015, May). MIMO filter-bank multicarrier system using unique word OFDM. In Electrical Engineering (ICEE), 2015 23rd Iranian Conference on (pp. 483-488). IEEE.

EDUCATION

- Ph.D., Electrical Engineering - Neuroengineering | University of Colorado | 2016 - 2020
- M.Sc., Electrical Engineering - Signal Processing | University of Colorado | 2016 - 2019
- M.Sc., Electrical Engineering - Wireless Systems | Ferdowsi University of Mashhad | 2011 - 2014
- B.Sc., Electrical Engineering - Electronics | Iran University of Science and Technology | 2005 - 2010

AWARDS, PRESENTATIONS, AND LEADERSHIP

- Invited speaker, Computational Neuroscience Next Generation Symposium, Center for Theoretical and Computational Neuroscience, Washington University in St. Louis, 2026
- Presenting at the PCTS Workshop on Physics of John Hopfield, Princeton University, Nov 2025
- Presenting at the Frontiers in NeuroAI symposium at the Kempner Institute, Harvard University, June 2025
- NeuroDataReHack 2023 with travel funding award from the Kavli Foundation, Spain, Sep 2023
- Swartz Foundation Postdoctoral Fellowship, Princeton University, 2021 - 2023.
- IOP Publishing Outstanding Reviewer Award, Neuromorphic Computing and Engineering, 2025.
- Accepted to Methods in Computational Neuroscience, Marine Biological Laboratory; deferral to 2027 approved.
- Selected presentations/workshops: COSYNE, SAND/CCN Statistical Analysis of Neural Data Workshop at Flatiron Institute, IBL Annual Science Meeting, IEEE Brain Neurotech Workshop, Swartz Foundation Annual Meeting.
- Research leadership: owned first-author projects from problem framing through modeling, validation, manuscript writing, mentoring, presentations, and technical communication.
- Ranked 3rd at the AbbVie poster session, IL, August 2019
- The most outstanding applicant award, \$34k, CU, 2016 – 2017.
- Research scholarship, Sapienza University of Rome, Italy, 2015 – 2016.
- Ranked 2nd among students in the Master's in Electrical Engineering program, 2014.

EXTRA ACTIVITIES

- Member of National Institute for Theory and Mathematics in Biology (NITMB) at Northwestern University, 2025
- Participated in the "Chicago Sensorimotor Consortium" meetings in collaboration with the University of Chicago, 2024
- Organizing the Princeton Neuroscience Institute Seminar Series, Princeton University, 2022
- Participating in "WOMEN AS INNOVATORS: Creating success in the workplace", Anschutz Medical Campus, Feb. 7, 2020
- Participating in "Leadership Certificate in Sustainability" program, CU, spring 2020
- Participating in "Emerging Leaders" program, CU, spring 2020