

Amin Nejatbakhsh | Curriculum Vitae

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Education

- 2022–Now **Postdoctoral Research Fellow**, *Flatiron Institute*.
- 2017–2022 **Ph.D. Student in Theoretical Neuroscience**, *Columbia University*.
- Adviser: Liam Paninski.
 - Thesis: *"Scalable Tools for Information Extraction and Causal Modeling of Neural Data"*.
- 2017–2019 **M.A. & M.Phil in Theoretical Neuroscience**, *Columbia University*.
- **Relevant Courses:** Applied Causality, Self-Supervised Learning, Causal Inference, Unsupervised Learning, Mathematics of Deep Learning, Nonparametric Theory of ML, Optimal Transport, Reinforcement Learning, Neuronal Dynamics, Representation Learning, Machine Learning Theory, Natural Language Processing, Differentiable Manifolds, High Dimensional Geometry, Deep Generative Models, Graphical Models, Advanced Machine Learning, Theoretical Neuroscience, Computational Statistics
- 2011–2016 **B.Sc. in Computer Engineering, Minor in Pure Mathematics**, *Sharif University of Technology*.
- Thesis: *"Design and Implementation of a Voice Recognition System Based on the Rat's Auditory System"*.
 - **Relevant Courses:** Linear Algebra, Advanced Algebra, Combinatorics, Biological Mathematics, Neuroscience, Computational Neuroscience, Machine Learning, Modern Information Retrieval, Medical Neuroscience.

Fields of Interest

Computational Neuroscience, Statistics, Machine Learning, Dynamical Systems, Computer Vision, Optimization

Research Experience

- Current **Research Fellow**.
- Estimating noise correlations in neural data.
 - Developing new representational similarity analysis methods for comparing neural representation across animals, species, and neural networks.
- 2017–2022 **Graduate Research Assistant**.
- In ML and statistics, I worked on applied optimal transport, partial information decomposition, switching linear dynamical systems, causal dynamical systems, and covariance estimation.
 - In computer vision, I built automated tools for the segmentation, detection, and tracking of cells in microscopy images and videos. I also developed statistical atlas construction methods for capturing structural variability across a population of animals. Additionally, I extended non-negative matrix factorization (NMF) to deformable NMF and applied it to calcium demixing in non-stationary videos.
 - In computational neuroscience, I developed and applied functional and interventional connectivity estimation techniques.
- 2017–2018 **Data Analyst**.
- Analyzed LFP and spiking data using tools from signal processing and information theory to study the effect of probabilistic cues on the attention network. Co-supervised by Prof. J. Gottlieb and Prof. R. Lashgari.
- 2016–2017 **Research Assistant in Brain Engineering Research Center at IPM**.
- Designed and implemented an experimental design and data collection system (more info).
 - Ran a distributed computing system on the computers in the lab for parallel computing.
 - Analyzed LFP signals to cluster V1 neurons.

Honors and Awards

- 2021 **Acceptance in the Doctoral Consortium**, in *WACV Conference*, (Virtual).
- 2020 **Student Travel Award**, in *MICCAI Conference*, Peru (Virtual).
- 2015 **Gold Medal**, in *22nd International Mathematical Competition (IMC)*, Blagoevgrad.
- 2015 **Gold Medal**, in *39th Iranian Mathematical Society Competition (IMS)*, Yazd.
- 2014 **Ranked 3/7**, in *13th International German Open Robocup*, Magdeburg.
- Member of Paaydar Team in 3D Soccer Simulation League.

- 2014 **Ranked 2/6**, in *3rd National Sharifcup Competition*, Tehran.
 ○ Leader of Paaydar Team in Traffic Control League.
- 2010 **Gold Medal**, in *28th Iranian National Mathematical Olympiad (INMO)*, Tehran.
- 2009 **Silver Medal**, in *27th Iranian National Mathematical Olympiad (INMO)*, Tehran.

Publications

- 1 James Yu, Amin Nejatbakhsh, Mahdi Torkashvand, Sahana Gangadharan, Maedeh Seyedolmohadesin, Jinmahn Kim, Liam Paninski, and Vivek Venkatachalam. "Versatile Multiple Object Tracking in Sparse 2D/3D Videos Via Diffeomorphic Image Registration". In: *bioRxiv* (2022).
- 2 Michael Skuhersky, Tailin Wu, Eviatar Yemini, Amin Nejatbakhsh, Edward Boyden, and Max Tegmark. "Toward a more accurate 3D atlas of *C. elegans* neurons". In: *BMC bioinformatics* 23.1 (2022), pp. 1–18.
- 3 Ari Pakman, Amin Nejatbakhsh, Dar Gilboa, Abdullah Makkeh, Luca Mazzucato, Michael Wibral, and Elad Schneidman. "Estimating the Unique Information of Continuous Variables". In: *NeurIPS* (2021). URL: <https://openreview.net/forum?id=LeW4X0VCr1>.
- 4 Tessa Tekieli, Eviatar Yemini, Amin Nejatbakhsh, Chen Wang, Erdem Varol, Robert W. Fernandez, Neda Masoudi, Liam Paninski, and Oliver Hobert. "Visualizing the organization and differentiation of the male-specific nervous system of *C. elegans*". In: *Development* (Aug. 2021). dev.199687. ISSN: 0950-1991. DOI: 10.1242/dev.199687. eprint: <https://journals.biologists.com/dev/article-pdf/doi/10.1242/dev.199687/2101868/dev199687.pdf>. URL: <https://doi.org/10.1242/dev.199687>.
- 5 Gonzalo Mena, Amin Nejatbakhsh, Erdem Varol, and Jonathan Niles-Weed. "Sinkhorn EM: An Expectation-Maximization algorithm based on entropic optimal transport". In: *NeurIPS Workshops* (2021). eprint: 2006.16548.
- 6 Amin Nejatbakhsh and Erdem Varol. "Neuron Matching in *C. elegans* with Robust Approximate Linear Regression Without Correspondence". In: *WACV* (2021). Accepted. arXiv: 1906.00273 [stat.ML].
- 7 Eviatar Yemini, Albert Lin, Amin Nejatbakhsh, Erdem Varol, Ruoxi Sun, Gonzalo E. Mena, Aravinthan D.T. Samuel, Liam Paninski, Vivek Venkatachalam, and Oliver Hobert. "NeuroPAL: A Multicolor Atlas for Whole-Brain Neuronal Identification in *C. elegans*". In: *Cell* (2020). URL: <http://www.sciencedirect.com/science/article/pii/S0092867420316822>.
- 8 Amin Nejatbakhsh, Francesco Fumarola, Saleh Esteki, Taro Toyozumi, Roozbeh Kiani, and Luca Mazzucato. "Predicting perturbation effects from resting state activity using functional causal flow". In: *bioRxiv* (2020). URL: <https://www.biorxiv.org/content/early/2020/11/24/2020.11.23.394916>.
- 9 Amin Nejatbakhsh, Erdem Varol, Eviatar Yemini, Vivek Venkatachalam, Albert Lin, Aravinthan D.T. Samuel, and Liam Paninski. "Extracting neural signals from semi-immobilized animals with deformable non-negative matrix factorization". In: *bioRxiv* (2020). DOI: 10.1101/2020.07.07.192120.
- 10 Amin Nejatbakhsh, Erdem Varol, Eviatar Yemini, Oliver Hobert, and Liam Paninski. "Probabilistic Joint Segmentation and Labeling of *C. elegans* Neurons". In: *MICCAI* (2020). Accepted.
- 11 Erdem Varol, Amin Nejatbakhsh, Eviatar Yemini, Ruoxi Sun, Gonzalo Mena, Oliver Hobert, and Liam Paninski. "Statistical Atlas of *C. elegans* Neurons". In: *MICCAI* (2020). Accepted.
- 12 Gonzalo Mena, Erdem Varol, Amin Nejatbakhsh, Eviatar Yemini, and Liam Paninski. "Sinkhorn Permutation Variational Marginal Inference". In: *AABI* (2020). URL: <https://openreview.net/forum?id=HkxPtJh4YB>.
- 13 Erdem Varol and Amin Nejatbakhsh. "Wasserstein Total Variation Filtering". In: *arXiv* (2019). eprint: 1910.10822.
- 14 Erdem Varol, Amin Nejatbakhsh, and Conor McGrory. "Temporal Wasserstein Non-negative Matrix Factorization for Non-rigid Motion Segmentation and Spatiotemporal Deconvolution". In: *arXiv* (2019). eprint: 1912.03463.

Presentations

- 1 "Controlled switching linear dynamical systems: a framework for perturbative interrogation of RNNs". In: *Society for Neuroscience (SfN)*, 2022.

- 2 "Introduction to Causal Inference". In: **Advanced Theory Seminar Series in the Center for Theoretical Neuroscience**, 2022.
 - 3 "Workshop on Probabilistic Modeling of Neural Data". In: **Neurotheory Workshop Series**, 2022.
 - 4 "Controlled Switching Linear Dynamical Systems: a Framework for Causal Interrogation of Neural Networks". In: **NMC4**, 2021.
 - 5 "Bayesian Neural Nets for Characterizing Neural Dynamics Across the Population". In: **NMC4**, 2021.
 - 6 "Nonparametric Inference of Neural Correlations from Sequential Recordings". In: **Computational and Systems Neuroscience (COSYNE)**, 2021.
 - 7 "Predicting Perturbation Effects from Resting State Activity Using Functional Causal Flow". In: **Computational and Systems Neuroscience (COSYNE)**, 2021.
 - 8 "Neuron matching in *C. elegans* with robust approximate linear regression without correspondence". In: **WACV**, 2021.
 - 9 "Non-parametric Inference of Correlations Between Non-simultaneous Neural Data". In: **NAISYS**, 2020.
 - 10 "Probabilistic Joint Segmentation and Labeling of Neurons in *C. elegans*". In: **NAISYS**, 2020.
 - 11 "Neural Data Analysis Pipelines for Extracting Information from *C. elegans* Microscopy Data". In: **NeuroNex Workshop**, 2020.
 - 12 "Probabilistic Joint Segmentation and Labeling of *C. elegans* Neurons". In: **MICCAI**, 2020.
 - 13 "Extracting Neural Signals from Semi-immobilized Animals with Deformable Non-negative Matrix Factorization". In: **MICCAI**, 2020.
 - 14 "Non-linear Matrix Factorization Methods for Extracting Calcium Traces in Moving *C. elegans* Videos". In: **Computational and Systems Neuroscience (COSYNE)**, 2020.
 - 15 "Expected Value Correlates with Reduction in Alpha-Beta Power in Monkey Dorsolateral Prefrontal and Inferior Parietal Lobe". In: **Society for Neuroscience (SfN)**, 2017.
 - 16 "Response Variability of V1 Neurons in Awake Primate". In: **Society for Neuroscience (SfN)**, 2017.
- Fall 2020 **Invited Talk**, University of Oregon.
 ○ Title: Predicting Perturbation Effects from Resting State Activity Using Functional Causal Flow.
- Summer 2020 **Research Progress Talk**, Columbia University Center for Theoretical Neuroscience.
 ○ Title: Neural Analysis Pipelines for Extracting Information From *C. elegans* Microscopy Data.
- Summer 2019 **Invited Talk**, Northeastern University.
 ○ Title: Semi-automated Cell Identification in NeuroPAL *C. elegans* Strains.

Teaching Experience

- Fall 2020 **Teaching Assistant for Foundations of Graphical Models (more info)**,
 Instructor: David M. Blei.
- Spring 2020 **Teaching Assistant for Theoretical Neuroscience (more info)**,
 Instructors: Prof. L. Abbott, S. Fusi, K. Miller, A. Litwin-Kumar.
- Spring 2020 **Instructor and TA for Math Tools for Neuroscientists (more info)**,
 Instructors: D. Tyulmankov, A. Nejatbakhsh.
- Fall 2019 **Instructor of Probabilistic Programming Workshop (more info)**.
- Summer 2017 **Instructor of Computational Neuroscience Workshop**.
- Spring 2016 & Fall 2015 **Teaching Assistant for Engineering Probability and Statistics**,
 Instructor: Prof. H. Rabiee.
- Fall 2015 **Teaching Assistant for Modern Information Retrieval**,
 Instructor: Prof. M. Soleymani-Baghshah.
- Spring 2013 **Teaching Assistant for Linear Algebra**,
 Instructor: Prof. A. Ranjbar-Motlagh.
- Summer 2015 **Instructor of iOS Application Development Workshop**.

2009–Now **Instructor of Mathematical and Informatics Olympiad.**

Working Experience

- Summer 2021 **Research Scientist, Spotify.**
- Developed time series statistical models for behavioral transition detection to detect fraud.
 - Worked with big data and learned how to use kube-flow, kubernetes, data-flow, SQL, google cloud platform, and dockers.
- Summer 2015 **Employee of Software Development, Torob Company.**
- Developed an NLP pipeline, an automatic feature extraction, and a clustering system in Python using sickit-learn package to cluster web pages of E-shopping websites into similar product for building a search engine on for online shopping.
- 2012–2014 **Employee of Mobile Application Development, Hasin Company.**
- Developed Taaghche and Gramophone iOS Applications (Objective-C)

Mentoring Experience

- 2018–2019 **Daiki Tagami, undergraduate student in statistics and biology, Columbia University.**
- Role: provided research direction and learning material for statistics, machine learning, and neural networks and co-authored a paper.

Professional Development

- 2019–Now **Reviewer of NeurIPS'20-23, WACV'21-23, AISTATS'21-23, ICML'21-23, MICCAI'21-23, ICLR'22-23, COSYNE'23.**
- 2017–Now **Member of Inference in Dynamical Systems Reading Group.**
- A grad student and post-doc run reading group in which we discuss recent advances of statistical inference methods in linear/non-linear, parametric/non-parametric, latent/non-latent variable models (website).
- 2017–Now **Member of Machine Learning Reading Group.**
- Paper discussion and presentation sessions run by Prof. Blei's group covering a variety of topics in statistics and machine learning.
- Fall 2016 **Three-day Hands-on fMRI Workshop.**
- The common preprocessing and analysis methods on structural and functional MRI data using Freesurfer application was covered by Dr. M. Vaziri and Dr. R. Rajimehr.
- Fall 2016 **Two-week International IBRO School on Brain Mapping.**
- Physics, theories, technologies, and analysis of brain imaging techniques such as fMRI, EEG, fNIRS, TMS, and tDCS was covered by instructors such as Prof. R. Savoy, Prof. N. Muggleton.
- Spring 2016 **Three-day Stereology Course.**
- The three-dimensional interpretation (such as the computation of the volume or finding neurons and synapses) of two-dimensional cross sections of brain tissue was covered by Prof. J. Nyengaard.
- 2015–2017 **Weekly Computational Neuroscience Journal Clubs.**
- Weekly paper reading sessions was held at IPM by Prof. A. Abbasian in which a wide range of the theories in computational neuroscience such as predictive coding theory, graph theory, topology, point process, and dynamical systems were discussed.

Professional Skills

ML & Stats	Pyro, Pytorch, Tensorflow, CVX, Kube-flow, Kubernetes, Data-flow
Neuroscience	Fieldtrip, Freesurfer, Psychtoolbox, Brian SNN Simulator
Programming	Python, Matlab, Java, C, C++, Javascript, Prolog, Objective-C, Verilog, SQL
Web	Django, NodeJS, CSS, HTML
Typesetting	L ^A T _E X, Microsoft Office

Languages

English (Fluent), **Persian** (Native), **Azerbaijani** (Intermediate), **Arabic** (Basic), **Turkish** (Basic)

Extracurricular Activities

- Fall 2019 **7th Rank**, of Newcomer Level Ballroom Dance in Princeton Ballroom Competition.
- 2017–Now Member of **GISU** Cultural Dance Group (website).

2017–Now Player of soccer and basketball at Columbia Intramurals League
Summer 2019 **Medal**, in NYC Triathlon (Olympic Distance).
Spring 2015 **Gold Medal**, in Sharif University Basketball Championships Competition.
Fall 2014 **Technical Staff**, in Association for Computing Machinery (ACM-ICPC) Competition.
2011–2017 Member of Sharif University Mountain Climbing Group.