# Amin Nejatbakhsh | Curriculum Vitae

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## Academic Positions

Current **Flatiron Institute, Postdoctoral Research Fellow**.
- Estimating noise correlations in neural data using Gaussian and Wishart processes and estimating the alignment between neural mean and covariance manifolds.
- Developing new representational similarity analysis methods for comparing neural representation across animals, species, and neural networks.
- Developing causal dynamical systems for time series analysis and causal representation learning in time series.

2017–2022 **Columbia University, Graduate Research Assistant**.
- In ML and statistics, I worked on applied optimal transport, partial information decomposition, and switching linear dynamical systems.
- 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 **Columbia University, 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 **IPM - Institute for Research in Fundamental Sciences, Research Assistant**.
- Designed and implemented an experimental task design and data collection system.
- Ran a distributed computing system on the computers in the lab for parallel computing.
- Analyzed LFP signals to cluster V1 neurons based on their functional similarities.

## Fields of Interest

**Machine Learning, Statistics, Computational Neuroscience, Causal Inference, Dynamical Systems**

## Education

2017–2022 **Ph.D. in Neuroscience**, *Columbia University, New York, NY*.
- **Thesis:** Scalable Tools for Information Extraction and Causal Modeling of Neural Data.
- **Adviser:** Liam Paninski.

2017–2019 **M.A. & M.Phil. in Neuroscience**, *Columbia University, New York, NY*.
- **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, Tehran, Iran*.
- **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.

## 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 David Lipshutz*, Amin Nejatbakhsh*, and Alex H Williams. "Disentangling Recurrent Neural Dynamics with Stochastic Representational Geometry". In: ***International Conference on Learning Representations (ICLR) Workshops*** (2024).

2 Amin Nejatbakhsh, Isabel Garon, and Alex H Williams. "Estimating Noise Correlations Across Continuous Conditions With Wishart Processes". In: ***Thirty-Seventh Conference on Neural Information Processing Systems (NeurIPS)*** (2023). URL: https://openreview.net/forum?id=3ucmcMzCXD.

3 Amin Nejatbakhsh, Neel Dey, Vivek Venkatachalam, Eviatar Yemini, Liam Paninski, and Erdem Varol. "Learning Probabilistic Piecewise Rigid Atlases of Model Organisms via Generative Deep Networks". In: ***Information Processing in Medical Imaging (IPMI)*** (2023). Ed. by Alejandro Frangi, Marleen de Bruijne, Demian Wassermann, and Nassir Navab, pp. 332–343.

4 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).

5 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.

6 Ari Pakman, Amin Nejatbakhsh, Dar Gilboa, Abdullah Makkeh, Luca Mazzucato, Michael Wibral, and Elad Schneidman. "Estimating the Unique Information of Continuous Variables". In: ***Neural Information Processing Systems (NeurIPS)*** (2021). URL: https://openreview.net/forum?id=LeW4XOVCrl.

7 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.

8 Gonzalo Mena, Amin Nejatbakhsh, Erdem Varol, and Jonathan Niles-Weed. "Sinkhorn EM: An Expectation-Maximization algorithm based on entropic optimal transport". In: ***Neural Information Processing Systems (NeurIPS) Workshops*** (2021). eprint: 2006.16548.

9 Amin Nejatbakhsh and Erdem Varol. "Neuron Matching in *C. elegans* with Robust Approximate Linear Regression Without Correspondence". In: ***IEEE/CVF Winter Conference on Applications of Computer Vision (WACV)*** (2021). Accepted. arXiv: 1906.00273 [stat.ML].

10 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.

11 Amin Nejatbakhsh, Francesco Fumarola, Saleh Esteki, Taro Toyoizumi, 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.

12 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.

13 Amin Nejatbakhsh, Erdem Varol, Eviatar Yemini, Oliver Hobert, and Liam Paninski. "Probabilistic Joint Segmentation and Labeling of *C. elegans* Neurons". In: ***Medical Image Computing and Computer Assisted Intervention (MICCAI)*** (2020). Accepted.

14 Erdem Varol, Amin Nejatbakhsh, Eviatar Yemini, Ruoxi Sun, Gonzalo Mena, Oliver Hobert, and Liam Paninski. "Statistical Atlas of *C. elegans* Neurons". In: ***Medical Image Computing and Computer Assisted Intervention (MICCAI)*** (2020). Accepted.

15 Gonzalo Mena, Erdem Varol, Amin Nejatbakhsh, Eviatar Yemini, and Liam Paninski. "Sinkhorn Permutation Variational Marginal Inference". In: ***Advances in Approximate Bayesian Inference (AABI)*** (2020). URL: `https://openreview.net/forum?id=HkxPtJh4YB`.

16 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 **Poster**. Estimating Noise Correlations Across Continuous Conditions With Wishart Processes. Neural Information Processing Systems (NeurIPS), Computational and Systems Neuroscience (COSYNE). 2023.

2 **Oral Presentation**. Learning Probabilistic Piecewise Rigid Atlases of Model Organisms via Generative Deep Networks. Information Processing in Medical Imaging (IPMI). 2023.

3 **Poster**. Controlled Switching Linear Dynamical Systems: a Framework for Perturbative Interrogation of RNNs. Society for Neuroscience (SfN), Neuromatch (NMC4). 2021.

4 **Recorded Talk**. Bayesian Neural Nets for Characterizing Neural Dynamics Across the Population. Neuromatch (NMC4). 2021.

5 **Poster**. Nonparametric Inference of Neural Correlations from Sequential Recordings. Computational and Systems Neuroscience (COSYNE). 2021.

6 **Poster**. Predicting Perturbation Effects from Resting State Activity Using Functional Causal Flow. Computational and Systems Neuroscience (COSYNE). 2021.

7 **Poster**. Neuron matching in *C. elegans* with robust approximate linear regression without correspondence. IEEE/CVF Winter Conference on Applications of Computer Vision (WACV). 2021.

8 **Poster**. Non-parametric Inference of Correlations Between Non-simultaneous Neural Data. From Neuroscience to Artificially Intelligent Systems (NAISYS). 2020.

9 **Poster**. Probabilistic Joint Segmentation and Labeling of Neurons in *C. elegans*. From Neuroscience to Artificially Intelligent Systems (NAISYS). 2020.

10 **Poster**. Neural Data Analysis Pipelines for Extracting Information from *C. elegans* Microscopy Data. Neuronex Workshop. 2020.

11 **Poster**. Probabilistic Joint Segmentation and Labeling of *C. elegans* Neurons. Medical Image Computing and Computer Assisted Intervention (MICCAI). 2020.

12 **Poster**. Extracting Neural Signals from Semi-immobilized Animals with Deformable Non-negative Matrix Factorization. Medical Image Computing and Computer Assisted Intervention (MICCAI). 2020.

13 **Poster**. Non-linear Matrix Factorization Methods for Extracting Calcium Traces in Moving *C. elegans* Videos. Computational and Systems Neuroscience (COSYNE). 2020.

14 **Poster**. Expected Value Correlates with Reduction in Alpha-Beta Power in Monkey Dorsolateral Prefrontal and Inferior Parietal Lobe. Society for Neuroscience (SfN). 2017.

15 **Poster**. Response Variability of V1 Neurons in Awake Primate. Society for Neuroscience (SfN). 2017.

16 **Research Progress Talk**. Predicting Perturbation Effects from Resting State Activity Using Functional Causal Flow. University of Oregon. 2020.

17 **Invited Talk**. Neural Analysis Pipelines for Extracting Information From *C. elegans* Microscopy Data. Columbia University Center for Theoretical Neuroscience. 2020.

## Teaching Experience

Fall 2023 **New York University, Statistical Analysis of Neural Data (Prof. A. H. Williams)**,
*Guest Lecture: Variational Autoencoders and their Applications in Neuroscience*.

Fall 2022 **Columbia University, Advanced Topics in Theoretical Neuroscience**,
*Guest Lecture: Introduction to Causal Inference.*

Fall 2022 **Columbia University, Neurotheory Workshop Series**,
*Co-instructor: Workshop on Probabilistic Modeling of Neural Data.*

Fall 2020 **Columbia University, Foundations of Graphical Models (Prof. D. M. Blei)**,
*Teaching Assistant: Grading and recitation on Variational Inference.*

Spring 2020 **Columbia University, Introduction to Theoretical Neuroscience (Prof. L. F. Abbott, S. Fusi, K. D. Miller, A. Litwin-Kumar)**,
*Teaching Assistant.*

Spring 2020 **Columbia University, Math Tools for Neuroscientists (D. Tyulmankov, A. Nejatbakhsh)**,
*Lectures: ODEs, Complex Numbers, Combinatorics, Probability and Statistics.*

Fall 2019 **Columbia University, Probabilistic Programming Workshop**,
*Instructor: Hands-on workshop on Probabilistic Programming with Pyro.*

Spring 2016 & Fall 2015 **Sharif University, Engineering Probability and Statistics (Prof. Hosseini)**,
*Teaching Assistant.*

Fall 2015 **Sharif University, Modern Information Retrieval (Prof. Soleymani)**,
*Teaching Assistant.*

Spring 2013 **Sharif University, Linear Algebra (Prof. Ranjbar)**,
*Teaching Assistant.*

2009–2015 **Mathematics and Informatics Olympiads**,
*Teacher: Training high-school students on competitive math and informatics problem-solving..*

## 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

2023 **Neuromatch Academy**, *a computational course serving thousands of students each year.*
- Role: Mentored collaborative projects on Machine Learning (Sentiment Analysis Using Pretrained Language Models) and Neuroscience (Building a Choice Prediction Model from Large-Scale Recordings Across the Mouse Brain During a Visual Behavior Task).

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**.

2017–2020 **Member of Inference in Dynamical Systems Reading Group**.
- A grad student and postdoc-run reading group in which we discuss recent advances in statistical inference methods in linear/non-linear, parametric/non-parametric latent variable models.

2017–Now **Member of Machine Learning Reading Group**.
- Paper discussion and presentation sessions run by Prof. Blei's group covering various topics in statistics and machine learning.

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 were covered by instructors such as Prof. R. Savoy, and Prof. N. Muggleton.

2015–2017 **Weekly Computational Neuroscience Journal Clubs**.
- Weekly paper reading sessions at IPM run by Prof. A. Abbasian covering a wide range of topics in computational neuroscience.

## Professional Skills

ML & Stats Jax, Numpyro, Pyro, Pytorch, Tensorflow, CVX, Kube-flow, Kubernetes, Data-flow
Programming Python, Matlab, Java, C, C++, Javascript, Prolog, Objective-C, Verilog, SQL
Web Django, NodeJS, CSS, HTML
Typesetting LaTeX, Microsoft Office

## Languages

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

## Extracurricular Activities

2020–2023 **Figure Skating and Skiing**.
2022–2023 **Soccer Player**, Riverside Squires Team in NYC Cosmopolitan League.
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.