Mansheej Paul

mansheej@stanford.edu • mansheej.github.io

Education

Stanford University **Stanford, CA**
Ph.D. in Applied Physics *2017 – Present*
Advisor: Surya Ganguli

Brown University **Providence, RI**
B.S. in Applied Mathematics, Honors, Magna Cum Laude *2013 – 2017*
Honors Thesis: Random Matrix Theory and the SYK Model, Advisor: Antal Jevicki

Research Interests

I am broadly interested in the questions:

- What are the principles and mechanisms that drive learning in neural networks?
- How can we exploit them during training to make networks more efficient, reliable, and controllable?

Recently, my research has focused on understanding how the data distribution and loss landscape properties affect what information and computational abilities are learned by the network. Currently, I am investigating how the data distribution influences in-context learning, memorization, federated learning and continual learning.

Conference Publications

- **Unmasking the Lottery Ticket Hypothesis: What's Encoded in a Winning Ticket's Mask?**
  Mansheej Paul*, Feng Chen*, Brett W. Larsen*, Jonathan Frankle, Surya Ganguli, Gintare Karolina Dziugaite
  In Submission (arXiv Preprint), 2022
- **Lottery Tickets on a Data Diet: Finding Initializations with Sparse Trainable Networks**
  Mansheej Paul*, Brett W. Larsen*, Surya Ganguli, Jonathan Frankle, Gintare Karolina Dziugaite
  Accepted at Neural Information Processing Systems (NeurIPS), 2022
- **Deep Learning on a Data Diet: Finding Important Examples Early in Training**
  Mansheej Paul, Surya Ganguli, Gintare Karolina Dziugaite
  Advances in Neural Information Processing Systems 34 (NeurIPS), 2021
- **Deep learning versus kernel learning: an empirical study of loss landscape geometry and the time evolution of the Neural Tangent Kernel**
  Stanislav Fort*, Gintare Karolina Dziugaite*, **Mansheej Paul**, Sepideh Kharaghani, Daniel M. Roy, Surya Ganguli
  Advances in Neural Information Processing Systems 33 (NeurIPS), 2020

Peer-Reviewed Workshops

- **Unmasking the Lottery Ticket Hypothesis: Efficient Adaptive Pruning for Finding Winning Tickets**
  Mansheej Paul*, Feng Chen*, Brett W. Larsen*, Jonathan Frankle, Surya Ganguli, Gintare Karolina Dziugaite
  Poster at Has it Trained Yet? A Workshop for Algorithmic Efficiency in Practical Neural Network Training, Conference on Neural Information Processing Systems (NeurIPS), 2022
- **Pre-Training on a Data Diet: Identifying Sufficient Examples for Early Training**
  Mansheej Paul*, Brett W. Larsen*, Surya Ganguli, Jonathan Frankle, Gintare Karolina Dziugaite
  Poster at The First Workshop on Pre-training: Perspectives, Pitfalls, and Paths Forward, International Conference on Machine Learning (ICML), 2022
- **Lottery Tickets on a Data Diet: Identifying Sufficient Data for Finding Sparse Trainable Networks**
  Mansheej Paul*, Brett W. Larsen*, Surya Ganguli, Jonathan Frankle, Gintare Karolina Dziugaite
  Spotlight at Sparsity in Neural Networks Workshop (SNN), 2022
- **Uncovering Neural Representations of Reinforcement Learning**
  Mansheej Paul*, Forea E. Wang*, Tony Hyun Kim, Surya Ganguli, Mark Schnitzer
  Poster at Mechanisms of Learning Conference, Emory University, 2019

Talks

- **Google Brain**, November 2022
- **MosaicML**, October 2022

Research Experience

Neural Dynamics and Computation Lab — **Stanford University, CA**
Ph.D. Advisor: Surya Ganguli — *2018 – 2020, 2022 – Present*

- Published papers at top tier machine learning conferences on data pruning, the lottery ticket hypothesis, loss landscapes, Neural Tangent Kernels, and the science of deep learning.
- Uncovered latent variables represented in the prefrontal cortex of mice brain during learning by fitting reinforcement learning models to neural recordings of mice learning to perform a task.

FAIR CoreML Team, Meta AI — **Menlo Park, CA**
Research Intern — *2022*

Constructed a mechanistic explanation for why Iterative Magnitude Pruning (a neural network pruning algorithm) is able to find well-performing sparse networks. Demonstrated a new connection between error landscapes and the Lottery Ticket Hypothesis.

Regulation, Evaluation, and Governance Lab — **Stanford University, CA**
Research Fellow — *2020 – 2022*

This research was done with partners at the Internal Revenue Service (IRS) and the Department of Labor (DOL) under the Intergovernmental Personnel Act.

- Implemented a data processing pipeline for the IRS to derive insights about tax planning in networks of business partnerships by efficiently processing millions of tax returns.
- Improved sample efficiency for estimating population statistics for the IRS by developing an active learning algorithm for detecting and adapting to changes in tax evasion behavior.
- Developed a proof-of-concept model for making the worker disability compensation adjudication process at the DOL more efficient by identifying relevant language in claims to suggest to human auditors.

Druckmann Lab **Stanford University, CA**
Ph.D. Rotation Advisor: Shaul Druckmann *2018*
Built a model for decision making in neural circuits based on implementing Bayesian inference algorithms in recurrent neural networks.

Material Computation and Theory Group **Stanford University, CA**
Ph.D. Rotation Advisor: Evan Reed *2017*
Helped develop an algorithm to speed up simulation of chemical reactions by orders of magnitude through model order reduction of molecular dynamics simulations.

Physics High Energy Theory Group **Brown University, RI**
Undergraduate Researcher, Advisor: Antal Jevicki *2016 – 2017*
Developed an analytical method for exactly computing a class of correlation functions in a theory of quantum gravity that was previously only numerically approximated.

Physical Chemistry Theory Group **Brown University, RI**
Undergraduate Researcher, Advisor: Richard Stratt *2015 – 2016*
Developed a theoretical method for predicting the emergence of chaotic behavior in systems from the geometry of their energy landscapes without expensive monte carlo simulations.

Large Underground Xenon (LUX) Dark Matter Experiment **Brown University, RI**
Undergraduate Researcher, Advisor: Richard Gaitskell *2014*
Helped calibrate the LUX detector for its second run by simulating the energy spectrum from neutron scattering, which served as the null model for detecting WIMP dark matter particles.

Awards and Honors

- **Robin Truell Prize**, Brown University, 2017
  Department of Applied Mathematics award for special distinction in undergraduate studies
- **Honors in Applied Mathematics**, Brown University, 2017
- **Magna Cum Laude**, Brown University, 2017
- **Karen T. Romer Undergraduate Teaching and Research Award**, Brown University, 2014 and 2016
  Competitive award to fund undergraduate research

Leadership, Service, and Teaching

- **Reviewer**: EEML 2022, NeurIPS 2022
- **Program committee**, Eastern European Machine Learning Summer School (EEML), 2022
- **Financial Officer**, Cardinal West Coast Swing, Stanford University, 2021 – 2022
- **Economic Impact Assessment and Data Teams**, SF New Deal, 2020
  Quantify the economic impact of SF New Deal's COVID-19 relief program on small businesses and communities, used to get funding and government contracts
- **First Year Student Mentoring Program Organizer**, Stanford University, 2019 – 2020
  Graduate Students of Applied Physics and Physics
- **Teaching Assistant**, Recent Applications of Probability and Statistics, Brown University, 2017