Behrooz Ghorbani

CONTACT INFORMATION

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RESEARCH INTERESTS

Deep Learning Theory, High-Dimensional Statistics, Random Matrix Theory

EDUCATION

Stanford University, Stanford, California USA 2014-2020
PhD in Electrical Engineering
- Dissertation title: "Topics in High-Dimensional Estimation."
- Advisor: David L. Donoho

University of British Columbia, British Columbia, Canada 2010-2014
BA Double Major in Mathematics and Economics
- Thesis Title: "Sparse Regression With Highly Correlated Predictors."
- Advisor: Ozgur Yilmaz

PROFESSIONAL EXPERIENCE

Software Engineering Intern, Google Inc. June - December, 2018
Examination of the loss landscape of large neural networks:
- Designed and implemented a scalable algorithm for estimating the full spectrum of the Hessian in large neural networks. Our TensorFlow implementation computes the full Hessian spectrum of a ResNet with 0.46 million parameters in under 30 minutes.
- Designed and tested second-order optimization algorithms for speeding up the optimization of deep neural networks.

Software Engineering Intern, Google Inc. June - September, 2017
Scalable and interpretable dimension reduction algorithms for time-series data:
- Built interpretable factor models that reduce the dimension of large time-series datasets in real-time.
- Designed and implemented feature transformations allowing for incorporation of sparse discrete time-series in the factor model.
- Demonstrated the use of the factor model in explaining anomalies in the data.

ACADEMIC PROJECTS

Large Scale Study of the Behavior of Wide Neural Networks 2019-present
- Developed TensorFlow code to effectively optimize extremely large (up to 2×10^5 features) random feature regression models via second-order optimization.
- Designed and conducted thousands of GPU hours of experiments examining the function approximation capabilities of neural network, random feature regression, and kernel predictors.
- Derived precise mathematical characterization of the approximation error of the predictors under consideration in asymptotic setting.

Analysis of Variational Inference in Topic Modeling 2017-2018
- Designed and ran tens of thousands of CPU hours of experiments to empirically examine the behavior of variational inference in low signal to noise ratio regime.
- Provided theory that characterizes the regions in the parameter space where the results of the variational approximation are misleading.

Optimal Estimation of Large Covariance Matrices for Preconditioning 2015-2017
- Derived optimal non-linear shrinkage estimators for estimating a high-dimensional covariance matrix when the estimated covariance matrix is to be used for preconditioning unseen data.

Publications & Submissions

Ghorbani, B., Mei, S., Misiakiewicz, T., Montanari, A. "Linearized Two-Layers Neural Networks in High Dimension" Submitted to Annals of Statistics (2019).

Ghorbani, B., Mei, S., Misiakiewicz, T., Montanari, A. "Limitations of Lazy Training of Two-layers Neural Networks" NeurIPS (2019) (Accepted for Spotlight- Representing Top 3% of Submissions).

Ghorbani, B., Xiao, Y., Krishnan, S. "An Investigation into Neural Net Optimization Via Hessian Eigenvalue Density" ICML (2019).

Ghorbani, B., Xiao, Y., Krishnan, S. "The Effect of Network Depth on the Optimization Landscape" ICML Workshop on Deep Phenomena (2019).

Ghorbani, B., Javadi, H., Montanari, A. "An Instability in Variational Inference for Topic Models" ICML (2019).

Donoho, D., Ghorbani, B. "Optimal Covariance Estimation for Condition Number Loss in the Spiked Model" submitted to the Annals of Statistics (2018).

Software Development

Spectral Density Estimation for Hessian of Deep Networks:
`https://github.com/google/spectral-density`

Lazy Training of Wide Neural Networks:
`https://github.com/bGhorbani/Lazy-Training-Neural-Nets`

Variational Inference for Topic Models in High-Dimensions:
`https://github.com/bGhorbani/Variational-Inference-Instability`

Invited Talks

UC Berkeley Statistics
An Investigation into Neural Net Optimization via Hessian Eigenvalue Density April 2019

NYU Center for Data Science
Understanding the Loss Hessian in Deep Neural Networks April 2019

Google Brain
Understanding the Loss Hessian in Deep Neural Networks April 2019

International Conference on Machine Learning (ICML)
An Instability in Variational Inference for Topic Models June 2019

International Conference on Machine Learning (ICML)
An Investigation into Neural Net Optimization via Hessian Eigenvalue Density June 2019

Fellowships and Awards

Stanford Graduate Fellowship (2014)
Three years of funding awarded to the top entering graduate students.

Governor General Silver Medal in Arts (2014)
Medal from Governor General of Canada awarded to the top graduating student of the UBC Faculty of Arts.

Reginald Palliser-Wilson Scholarship in Mathematics (2014)
Awarded by the UBC Mathematics Department to the top students majoring or honoring in mathematics.

Wesbrook Scholar (2013)
The University of British Columbia's most prestigious designation awarded to 20 senior students university-wide for outstanding achievements in research, leadership, academic performance, and community activity.

Trek Excellence Scholarship (2012 & 2013)
Awarded for ranking in the top 5% of the Faculty of Arts at UBC.

Peer Review

Journals: Journal of Machine Learning Research (JMLR), Journal of Multivariate Analysis

Conferences: Advances in Neural Information Processing Systems (NeurIPS), International Conference on Machine Learning (ICML), The Association for the Advancement of Artificial Intelligence (AAAI)

Teaching Experience

Teaching Assistant, Stanford University

STATS 325: Multivariate Analysis and Random Matrices in Statistics Spring 2019
Advanced Graduate course in statistics. Held office hours and was responsible for grading homework assignments.

Languages and Technologies

C++, Python, TensorFlow, R, LaTeX