Raghav Somani

First year Ph.D. student at
Paul G. Allen School of Computer Science & Engineering
University of Washington
Advisors: **Prof. Sewoong Oh**

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Research Interests

I seek to solve theoretical machine learning problems using ideas from optimization, high dimensional probability and statistics.

Major Interests	Machine Learning, Large Scale Optimization, High Dimensional Probability
Others	Random Matrix theory, Learning Theory, Applied Mathematics

Education

- **University of Washington**
  Ph.D. in Computer Science and Engineering   *Sept'19 - Present*
  Advisor: Prof. Sewoong Oh
- **Indian Institute of Technology Guwahati**
  Bachelor of Technology in Mathematics and Computing   *July'13 - June'17*
  GPA: 9.10/10 (9.30/10 in major courses)

Work Experience

- **University of Washington - Graduate Research Assistant**   *Sept'19 - Present*
  Advisor: Prof. Sewoong Oh
  Machine Learning Lab
- **Microsoft Research India - Research Fellow**   *July'17 - July'19*
  Advisors: Dr. Praneeth Netrapalli & Dr. Prateek Jain
  Project group - Provable Non-convex Optimization for Machine Learning Problems
- **Microsoft Research India - Research Intern**   *May'16 - July'16*
  Advisor: Dr. Sreangsu Acharyya
  Project - Recommendation systems
- **CAFRAL, Reserve Bank of India - Summer Research Intern**   *June'15 - July'15*
  Advisor: Dr. Nagpurnanand R. Prabhala
  Project - Modeling 'Economic Policy Uncertainty Index' for India

Publications

1. A. Panigrahi, **R. Somani**, N. Goyal & P. Netrapalli. **Non-Gaussianity of Stochastic Gradient Noise**. In *Science meets Engineering of Deep Learning (SEDL)* workshop at *Neural Information Processing Systems (NeurIPS), Vancouver, Canada, December 2019.*   [arXiv]

2. **R. Somani**, C. Gupta, P. Jain & P. Netrapalli. **Support Recovery for Orthogonal Matching Pursuit: Upper and Lower bounds**. In *Advances in Neural Information Processing Systems (NeurIPS), Montréal, Canada, December 2018.* **Spotlight** Presentation (168/4856 submissions).   [paper]

3. **R. Somani**, G. Hiranandani, O. Koyejo & S. Acharyya. **Clustered Monotone Transforms for Rating Factorization**. In *Proceedings of the 12th ACM International Conference on Web Search and Data Mining (WSDM), Melbourne, Australia, February 2019* (84/511 submissions).   [arXiv]

4. A. K. Dey, **R. Somani** & S. Acharyya. **A case study of empirical Bayes in a user-movie recommendation system**. In *Communications in Statistics: Case Studies, Data Analysis and Applications Vol 3, 2017.*   [arXiv]

Research Projects

Optimization and Generalization in Deep Neural Networks
July'18 - Sept'19
Advisors: Dr. Prateek Jain, Dr. Praneeth Netrapalli & Dr. Navin Goyal, Microsoft Research

- Understanding the dependence of batch-size (stochasticity), over-parameterization, and optimization on the generalization properties of a variety of neural networks on real world data distributions for classification tasks.
- Analyzing the dependence of support separation, number of hidden neurons, ambient dimension of data distribution, number of training points on optimization and generalization of neural networks.

Sparse Regression and Optimal Bounds for Orthogonal Matching Pursuit (OMP)
Sept'17 - June'18
Advisors: Dr. Prateek Jain & Dr. Praneeth Netrapalli, Microsoft Research [Project page]

- Analyzed Accelerated IHT, trying to strengthen Jain et al.'s results for better support expansion and generalization.
- Analyzed OMP for the Sparse Linear Regression problem under Restricted Strong Convexity (RSC) assumptions obtaining its support recovery and generalization guarantees. Also provide tight lower bounds for OMP. Our results are the first such matching upper and lower bounds (up to log factors) for *any* Sparse Regression algorithm under RSC assumption.
- The work on OMP got accepted for **Spotlight** paper presentation at **NeurIPS'18**. [Spotlight video]

Clustered Monotone Transforms for Rating Factorization (CMTRF)
May'16 - Aug'18
Advisors: Dr. Sreangsu Acharyya (MSR India) & Prof. Oluwasanmi Koyejo (UIUC) [arXiv]

- Implemented and analyzed CMTRF for recommendation systems which performs regression under shared low-rank structure up to unknown monotonic transforms for a better fit. CMTRF recovers a unique solution under mild conditions and also outperforms other state-of-the-art baselines on 7 real-world and 2 synthetic datasets.
- The work got accepted for oral presentation at **WSDM'19**.

Approaches of Building Recommendation Systems
Aug' 16 - Apr' 17
Advisor: Prof. Arabin K. Dey, Bachelor Thesis Project, IIT Guwahati [Thesis Report]

- Worked on order preserving Regularized Matrix factorization. Used the Empirical Bayes framework to tune hyper parameters for priors used in the Bayesian setup of collaborative filtering.
- Implemented a content similarity based recommendation system by using k-Nearest Neighbors over the dominant eigenspace of the user and item features extracted via matrix factorization.
- Used Auto-encoders, Restricted Boltzman Machines and Deep Belief Networks for feature extraction from various data domains like rating matrices, images and text to build similarity based recommendation systems.

Modelling Economic Policy Uncertainty Index Using Text Classification
June'15 - July'15
Advisor: Dr. Nagpurnanand R. Prabhala, CAFRAL, Reserve Bank of India [Report]

- Modelled the Political, Economic & Economic Policy Uncertainty Indices for India using a Kernel Support Vector Machine based algorithm which classifies newspaper articles using bag of words after text processing and feature selection.
- Labeled 1,100 newspaper articles to create a dataset over 4 years and used it to train the classifier. The model was able to predict events like Union Budgets, General elections, WTO attacks (9/11) and 2008 economic recessions.

Academic Projects

Scientific Computation
Oct'15 - Nov'15
Instructor: Prof. Jiten C. Kalita [Reports]

- Used Cubic Spline interpolation to interpolate curves and self signature.
- Used Gauss-Seidel's method to solve Laplace's PDE. Solved a convection - diffusion equation using Thomas' algorithm.

Monte Carlo Simulations for Financial Engineering
Jan'15 - Apr'15 & Jan'15 - Apr'16
Instructor: Siddhartha P. Chakrabarty, Prof. N. Selvaraju & Prof. Arabin K. Dey [Reports]

- European and American option pricing using binomial model and the Black Scholes model.
- Simulation and sensitivity analysis of different stochastic rate models.

Multi-file Search Engine
Apr'15
Instructor: Prof. Gautam K. Das [GitHub]

- Used 6 data structures to design search engines that output frequency of the queried word from a set of text files.

Relevant Courses and Electives

Machine Learning	Learning from Data: Caltech (MOOC), Statistical Learning (MOOC)
Optimization	Optimization, Convex Optimization: Stanford (MOOC)
Probability	Probability and Random Processes, Advanced Probability, Monte Carlo Simulations
Statistics	Advanced Statistical Algorithms, Statistical Methods and Time Series Analysis
Computer Science	Design and Analysis of Algorithms, Discrete Mathematics, Theory of Computation
Others	Linear Algebra, Calculus, Real and Complex Analysis, Stochastic Calculus, Matrix Computation, Scientific Computation, Mordern Algebra

Scholastic Achievements

2013	Among top 1.7% of all selected candidates (126,000+) in JEE-Advanced.
2013	Among top 0.5% of all candidates (1,400,000+) in JEE-Mains.
2013	Among top 0.15% of all candidates (150,000+) in WBJEE.

References

1. *Dr. Praneeth Netrapalli*, Senior Researcher, Microsoft Research Lab - India
2. *Dr. Prateek Jain*, Senior Principal Researcher, Microsoft Research Lab - India
3. *Dr. Sreangsu Acharyya*, Senior Applied Scientist, Microsoft Research Lab - India