Raghav Somani

Research Fellow, Machine Learning & Optimization Group
Microsoft Research India
Advisors: ***Dr. Praneeth Netrapalli*** *&* ***Dr. Prateek Jain***

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Research Interests

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

Major Interests	Machine Learning, Large Scale Optimization, High dimensional probability
Others	Random Matrix theory, Learning Theory, Applied mathematics

Publications

1. **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 (NIPS), Montreal, Canada, December 2018*. **Spotlight** Presentation (168/4856 submissions).

Education

Indian Institute of Technology Guwahati,
Bachelor of Technology in Mathematics and Computing, *Jul'13 - Jun'17*
GPA: 9.10/10 (9.72/10 in 8^{th} sem)

Research Projects

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

- Exploring and understanding the dependence of batch-size (stochasticity), over-parameterization, and optimization on the generalization properties of shallow as well as deep neural networks on real world data distributions.
- 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]

- Explored Accelerated IHT, trying to strengthen Jain et al.'s results for better support expansion and generalization error.
- 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 **NIPS'18**.

Clustered Monotone Transforms for Rating Factorization (CMTRF) *May'16 - Aug'18*
Advisors: Dr. Sreangsu Acharyya & Prof. Sanmi Koyejo (UIUC), Microsoft Research

- Explored and implemented 3 versions of CMTRF for recommendation systems which performs regression up to unknown monotonic transforms. The model combined with an underlying matrix factorization model exploits shared low dimensional structure and results in a better fit.
- CMTRF recovers a unique solution under mild conditions and also outperforms other state-of-the-art baselines on 2 synthetic and 7 real-world datasets. **(In submission, WSDM'19)**

Approaches of Building Recommendation Systems *Aug' 16 - Apr' 17*
Advisor: Prof. Arabin Kumar 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 - [Journal Paper].
- 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. N. 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.
- Read and 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

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

Used 6 data structures like Hash Tables, Balanced Trees to design search engines that output frequency of the queried word in a given folder of text files.

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. A convection - diffusion equation was solved using Thomas' algorithm and visualized graphically.

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.

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	Discrete Mathematics, Data Structures and Algorithms, Theory of Computation
Others	Linear Algebra, Calculus, Real and Complex Analysis, Stochastic Calculus, Matrix Computation, Scientific Computation, Mordern Algebra

Scholastic Achievements

2018 Attended Algorithms and Optimization talk series at ICTS.
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

Available on request