

Raghav Somani

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

📅 January 16, 2022
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RESEARCH INTERESTS

I seek to understand machine learning problems with the help of mathematical optimization and probability theory.

Research Interests	Machine Learning, Large Scale Optimization, Probability theory
Other Learning Interests	Geometry and Analysis, Pure Mathematics

EDUCATION

- **University of Washington**
Ph.D. in Computer Science and Engineering *Sept '19 - Present*
Advisor: Prof. Sewoong Oh
GPA: 3.90/4
- **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

- **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: Prof. Nagpurnanand R. Prabhala
Project - Modeling 'Economic Policy Uncertainty Index' for India

SELECTED PUBLICATIONS

Conference Publications

1. **Robust Meta-learning for Mixed Linear Regression with Small Batches** [[paper](#)]
W. Kong, **R. Somani**, S. M. Kakade, and S. Oh.
Advances in Neural Information Processing Systems (NeurIPS), December 2020.
2. **Meta-learning for mixed linear regression** [[paper](#)]
W. Kong, **R. Somani**, Z. Song, S. M. Kakade, and S. Oh.
International Conference on Machine Learning (ICML), July 2020.
3. **Support Recovery for Orthogonal Matching Pursuit: Upper and Lower bounds.** [[paper](#)]
R. Somani^{*}, C. Gupta^{*}, P. Jain, and P. Netrapalli.
Advances in Neural Information Processing Systems (NeurIPS), Montréal, Canada, December 2018. Spotlight.
4. **Clustered Monotone Transforms for Rating Factorization** [[paper](#)]
R. Somani^{*}, G. Hiranandani^{*}, O. Koyejo, and S. Acharyya.
ACM International Conference on Web Search and Data Mining (WSDM), Melbourne, Australia, February 2019.

Preprints

1. **Gradient flows on graphons: existence, convergence, continuity equations** [arXiv]
S. Oh, S. Pal, **R. Somani**, and R. Tripathi.
OTML workshop, *Neural Information Processing Systems (NeurIPS)*, December 2021.

Workshop Publications

1. **Non-Gaussianity of Stochastic Gradient Noise** [arXiv]
A. Panigrahi, **R. Somani**, N. Goyal, and P. Netrapalli.
SEDL workshop, *Neural Information Processing Systems (NeurIPS)*, Vancouver, Canada, December 2019.

* - equal contribution

Please visit ([dblp](#)) or ([Google Scholar](#)) for the list of all research articles.

RESEARCH PROJECTS

Multi-layer large width Neural Networks May '21 - Present
Advisors: *Prof. Sewoong Oh & Prof. Soumik Pal*, University of Washington

- Analytically understanding the scaling limit of the training dynamics of feed forward neural networks using the lens of limiting graph theory, optimal transport theory, probability theory and analysis. [arXiv]
- ★ Work on existence and convergence of gradient flows on graphons got accepted at **OTML '21** at **NeurIPS '21**. [arXiv]

Robustness and Meta Learning for Mixed Linear Regression (MLR) Nov '19 - Mar '21
Advisors: *Prof. Sewoong Oh & Dr. Weihao Kong*, University of Washington [Page]

- Analyzed conditions under which abundant tasks with small data can compensate for lack of tasks with large data in the context of MLR. [arXiv]
- Tightened the conditions for the above exchange using the sum-of-squares method. Worked on making the subspace estimation step robust for MLR. [arXiv]
- Looked into Robust Subspace estimation for mixture distributions under the batch setting.
- ★ Works on Meta Learning and Robust Meta Learning with small batches got accepted at **ICML '20** and **NeurIPS '20** respectively. [video 1, video 2]

Optimization and Generalization in Deep Neural Networks July '18 - Sept '19
Advisors: *Dr. Prateek Jain, Dr. Praneeth Netrapalli & Dr. Navin Goyal*, Microsoft Research [Page 1, Page 2]

- 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.
- ★ A [work](#) on distributional characterization of SGD got accepted at the workshop **SEDL '19** at **NeurIPS '19**. [arXiv]

Sparse Regression and Optimal Bounds for Orthogonal Matching Pursuit (OMP) Sept '17 - June '18
Advisors: *Dr. Prateek Jain & Dr. Praneeth Netrapalli*, Microsoft Research [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.
- ★ Accepted for a **Spotlight** paper presentation at **NeurIPS '18**. [paper, spotlight video]

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

- Implemented and analyzed CMTRF for recommendation systems which performs regression under shared low-rank structure up to unknown monotonic transforms. 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.
- ★ Accepted for an oral presentation at **WSDM '19**. [arXiv]

RELEVANT COURSES

Machine Learning	Machine Learning, Learning from Data (Caltech MOOC), Statistical Learning (MOOC)
Optimization	Theory of Optimization, Variational Analysis, Convex Optimization (Stanford MOOC)
Probability	Advanced Probability, Probability & Random Processes, Monte Carlo Simulations
Computer Science	Design and Analysis of Algorithms, Randomized Algorithms, Discrete Mathematics
Mathematics	Optimal Transport, Linear Algebra, Real & Complex Analysis, Stochastic Calculus, Modern Algebra, Matrix Computation, Scientific Computation

PROFESSIONAL RESPONSIBILITIES

1. *Reviewing*: [NeurIPS '19](#), [NeurIPS '20](#), [ICML '20](#), [JMLR](#).
2. *Teaching Assistant*: [CSE 446/546](#) Spring '21.

SCHOLASTIC ACHIEVEMENTS

- 2013 Among top 1.7% of all selected candidates (126,000+) in JEE-Advanced (IIT-JEE).
- 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. *Prof. Sewoong Oh*, Associate Professor, University of Washington
2. *Dr. Praneeth Netrapalli*, Research Scientist, Google Research, India
3. *Dr. Prateek Jain*, Sr. Staff Research Scientist, Google Research, India