APOORV VIKRAM SINGH

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EDUCATION

New York University
Ph.D. in Computer Science and Engineering Sept 2020 – Aug 2026
Thesis: **Robust Moment Matching: Theory, Algorithms and Applications**
Advisor: Christopher Musco
Expertise: Machine Learning, Differential Privacy, High-Dimensional Probability, Numerical Linear Algebra, Spectral Graph Theory, Randomized Algorithms.

International Institute of Information Technology, Bangalore
Bachelor and Master of Technology Aug 2013 – July 2018
Specialization: Theoretical Computer Science
Thesis: Clustering Perturbation Resilient Instances
Advisor: G. Srinivasaraghavan

RESEARCH EXPERIENCE

Visiting Researcher, INRIA Lille Oct 2019 – Jan 2020
MODAL Team, INRIA Lille, France
Advisors: Hemant Tyagi (INRIA), Mihai Cucuringu (Univ. of Oxford)

Project Associate, IISc Bangalore Aug 2018 – Aug 2019
Department of CSA, Indian Institute of Science (IISc)
Advisors: Anand Louis (IISc), Amit Deshpande (Microsoft Research)

Research Intern, IISc Bangalore Summer 2017
Department of CSA, Indian Institute of Science
Advisor: Anand Louis

PUBLICATIONS

1. **Sliced Chebyshev Moment Matching with Random Slices: Exact-Matching Bound**
with Christopher Musco, and Lucas Rosenblatt
Preliminary version at Theory and Practice of Differential Privacy (TPDP) 2026
Developed practical algorithms for high-dimensional, differentially private synthetic data generation that outperform state-of-the-art techniques in practice while providing strong theoretical guarantees.

2. **Sharper Bounds for Chebyshev Moment Matching, with Applications**
with Cameron Musco, Christopher Musco, and Lucas Rosenblatt
Conference on Learning Theory (COLT) 2025, and Theory and Practice of Differential Privacy (TPDP) 2024, [paper] [code]
Established sharp theoretical bounds for recovering distributions from noisy Chebyshev moments, with extensions to high-dimensions. Implemented the first practical and provable algorithm for private synthetic data generation.

3. **Faster Spectral Density Estimation and Sparsification in the Nuclear Norm**
with Yujia Jin, Ishani Karmarkar, Christopher Musco, and Aaron Sidford
Conference on Learning Theory (COLT) 2024, [paper]
Achieved SOTA fast eigenvalue estimation for massive matrices by introducing and leveraging a novel graph sparsification framework. Proved tight lower bounds, optimizing the trade-off between computational efficiency and accuracy.

4. **Moments, Random Walks, and Limits for Spectrum Approximation**
with Yujia Jin, Christopher Musco, and Aaron Sidford
Conference on Learning Theory (COLT) 2023, [paper]
Characterized the noise tolerance for stable recovery of distributions via the method of moments. Constructively proved that near-identical moment profiles can still hide large statistical distances.

5. **Regularized Spectral Methods for Clustering Signed Networks**
with Mihai Cucuringu, Deborah Sulem, and Hemant Tyagi
Journal of Machine Learning Research (JMLR) 2021, [paper]
Developed scalable spectral algorithms for robust clustering in large-scale signed networks. Proved theoretical recovery guarantees under signed stochastic block models

for general k-way clusters.

6. **On Euclidean k-Means Clustering with α-Center Proximity**
with Amit Deshpande, and Anand Louis
Conference on Artificial Intelligence and Statistics (AISTATS) 2019, [paper]
Designed sampling-based clustering algorithms with provable guarantees, leveraging stability of data. Established NP-hardness for improving approximation ratios.

7. **Approximation Algorithms for Cost-Balanced Clustering**
with Amit Deshpande, Anand Louis, and Deval Patel
Preprint 2019, [paper]
Devised sampling-based approximation algorithms for clustering under balance constraints to ensure uniform cluster weights. Optimized k-means objectives while preventing cluster collapse in skewed datasets.

Ongoing Projects

8. **Fast Schatten p-norms from rational approximations**
with Isabel Detherage, and Nicholas West
Developed a state-of-the-art randomized algorithm for estimating Schatten-p norms by combining explicit rational approximations to the square-root function with variance reduction and fast solvers for positive semidefinite linear systems.

9. **SLQ v/s KPM for Spectral Density Estimation**
with Isabel Detherage, and Nicholas West
Stochastic Lanczos Quadrature (SLQ) and Kernel Polynomial Method (KPM) are the two most common techniques in practice to estimate eigenvalues of a matrix. Established stronger guarantees for SLQ, showed SLQ to be strictly better than KPM, and proposed a new method for practitioners.

10. **Spectral Density Estimation for General Massive Matrices**
with Natalia Hajlasz, Christopher Musco, and Jonathan Weare
Developing numerical routines to approximate spectra for structured massive sparse matrices (e.g., 10^7+ dimensions). Established sublinear time algorithms for general matrices.

11. **Untangled Spectrum Estimation**
with Ainesh Bakshi, Christopher Musco, and Xinyu Tan
Improved copy complexity for learning the spectrum of a mixed quantum state under unentangled measurements, moving closer to the conjectured optimal dependence on the accuracy parameter. The approach combines spectral bucketing and profile likelihood estimation with Chebyshev moment matching.

12. **Python Package for Spectral Density Estimation**
with Anil Damle, Christopher Musco, and Ibrohim Nosirov
Building a high-performance Python library for spectral density estimation using variance-reduced stochastic Lanczos quadrature.

Teaching

Graph Visualization Algorithms 2024 Head TA; **Algorithmic Machine Learning and Data Science 2023** Head TA; **Deep Learning, Theory and Practice 2019** TA; **Spectral Algorithms 2018** TA.

Selected Talks

- **Sharper Bounds for Chebyshev Moment Matching**: Stanford 2024, NYC graduate student TCS Day 2024, Yale student theory day 2025, COLT 2025.
- **Faster Spectral Density Estimation and Sparsification in the Nuclear Norm**: COLT 2024, Simons Institute UC Berkeley 2025.
- **Moments, Random Walks, and Limits for Spectrum Approximation**: DIMACS Rutgers 2023, IISc Bangalore 2023, COLT 2023, Stanford 2024, Brown 2024.
- **Euclidean k-Means with Center Proximity**: ICTS-TIFR 2019, IIIT Bangalore 2019, AISTATS 2019, INRIA Lille 2020.

Awards & Achievements

- Received the COLT 2024 Travel Grant.
- NYU CSE Dissertation Fellowship Fall 2023 - Summer 2024
- Selected for the 2022 Swedish Summer School on Theoretical Computer Science, KTH.
- NYU School of Engineering Fellowship Fall 2020 - Summer 2021