

Aniket Das

PRE-DOCTORAL RESEARCHER, GOOGLE RESEARCH INDIA

EDUCATION	Indian Institute of Technology Kanpur <i>BTech in Electrical Engineering and BS in Mathematics (Double Major)</i> GPA : Overall 9.3/10 Mathematics 9.8/10	<i>Aug' 17 - May' 22</i> <i>8 Semesters</i>
	Aalto University, Finland <i>Year-long Academic Exchange in Aalto University School of Science</i> GPA : 4.8/5.0	<i>Jan' 20 - Jan' 21</i> <i>2 Semesters</i>

INTERESTS	Sampling Algorithms, Markov Chains, Applied Probability, High Dimensional Statistics
-----------	--

PUBLICATIONS	<i>Provably Fast Finite-Particle Variants of SVGD via Virtual Particle Stochastic Approximation</i> Aniket Das, Dheeraj Nagaraj [αβ] <i>Neural Information Processing Systems (NeurIPS) 2023 [Spotlight] [Paper]</i> <i>Oral Presentation at Optimal Transport and Machine Learning Workshop @ NeurIPS 2023</i>
	<i>Utilising the CLT Structure in Stochastic Gradient based Sampling : Improved Analysis and Faster Algorithms</i> Aniket Das, Dheeraj Nagaraj, Anant Raj [αβ] <i>Conference On Learning Theory (COLT) 2023 [Paper]</i>
	<i>Near-Optimal Heteroscedastic Regression with Symbiotic Learning</i> Dheeraj Baby, Aniket Das, Dheeraj Nagaraj, Praneeth Netrapalli [αβ] <i>Conference On Learning Theory (COLT) 2023 [Paper]</i>
	<i>Sampling without Replacement Leads to Faster Rates in Finite-Sum Minimax Optimization</i> Aniket Das, Bernhard Schölkopf, Michael Muehlebach <i>Neural Information Processing Systems (NeurIPS) 2022 [Paper]</i>
	<i>NeurInt - Learning Interpolation by Neural ODEs</i> Avinandan Bose*, Aniket Das*, Yatin Dandi, Piyush Rai <i>Workshop on Deep Learning and Differential Equations @ NeurIPS 2021 [Spotlight] [Paper]</i>
	<i>Jointly Trained Image and Video Generation using Residual Vectors</i> Yatin Dandi, Aniket Das, Soumye Singhal, Vinay P. Namboodiri, Piyush Rai <i>IEEE/CVF Winter Conference on Applications of Computer Vision (WACV), 2020 [Paper]</i>
	<i>TorchGAN: A Flexible Framework for GAN Training and Evaluation</i> Avik Pal*, Aniket Das* <i>Journal of Open Source Software (JOSS) [Paper]</i>
	[αβ] : indicates alphabetical ordering * : indicates equal contribution

EXPERIENCE	Google Research India <i>Pre-Doctoral Researcher, Machine Learning and Optimization (MLO)</i>	<i>July '22 - Present</i>
	<ul style="list-style-type: none"> - Working on sampling, spin systems, high dimensional statistics and stochastic optimization - Published two papers at COLT 2023 on SGLD and minimax optimal heteroscedastic regression, and one spotlight paper at NeurIPS 2023 on finite particle convergence of SVGD. 	

Max Planck Institute for Intelligent Systems, Tübingen

Advisors : *Michael Muehlebach* and *Bernhard Schölkopf*

July '21 - Dec '21

- Remotely worked on stochastic minimax optimization and gradient flows for constrained optimization
- Paper on sampling without replacement for minimax optimization published at NeurIPS 2022

Tata Institute of Fundamental Research, Bombay

Advisor : *Sandeep Juneja*

Apr '21 - Jun '21

- Remotely worked on instance-dependent lower bounds for PAC learning in Markov Decision Processes and structured stochastic bandits

SELECTED PROJECTS

Rapid Convergence of Finite-Particle SVGD using Virtual Particles

Advisor : *Dheeraj Nagaraj*, Google Research [NeurIPS'23 Spotlight + OTML'23 Oral]

- Developed computationally efficient variants of **Stein Variational Gradient Descent (SVGD)** with *provably fast convergence in the finite-particle regime*
- Obtained the *first known gradient oracle complexity* for any SVGD-type algorithm that enjoys *polynomial scaling in dimension and error tolerance*
- Demonstrated a *double exponential improvement* over prior state-of-the-art
- Developed a novel and highly general technique for designing stochastic approximations in the space of measures that admit an *exact finite-particle implementation*
- Applied techniques from Optimal Transport, Geometry, Dynamical Systems and Functional Analysis.
- Accepted as a **Spotlight Paper** at *Neural Information Processing Systems (NeurIPS) 2023*.
- Also accepted for an **Oral Presentation** at the *Optimal Transport and Machine Learning (OTML) Workshop, NeurIPS 2023*

CLT Analysis of Stochastic-Gradient Based Sampling

Advisor : *Dheeraj Nagaraj*, Google Research

[COLT'23 Paper]

- Developed novel non-asymptotic Central Limit Theorems to analyze the interaction between the stochastic approximation noise and diffusion noise in stochastic-gradient based sampling algorithms
- Obtained state of the art convergence rates for **Stochastic Gradient Langevin Dynamics (SGLD)** under *minimal isoperimetric assumptions*
- Analyzed the **Random Batch Method (RBM)** for simulating Interacting Particle Dynamics and derived state of the art trajectory-level guarantees under minimal assumptions
- Derived the first known convergence rates for the Covariance Correction heuristic and proved that it enables faster convergence of SGLD and RBM without added computational complexity
- Applied techniques from Stochastic Calculus, Markov Chains and Optimal Transport
- Work is published at *Conference on Learning Theory (COLT), 2023*

Minimax Optimal Heteroscedastic Linear Regression

Advisors : *Dheeraj Nagaraj* and *Praneeth Netrapalli*, Google Research

[COLT'23 Paper]

- Developed a computationally efficient **Alternating Minimization** algorithm for heteroscedastic linear regression that exhibits *minimax optimal sample complexity* (modulo log factors).
- Designed provably efficient algorithms for *linear regression and phase retrieval under the multiplicative noise (or noisy covariate) model*
- Utilised the spectral properties of rank-deficient Wishart matrices to design a *novel adaptation of LeCam's method which is robust to infinite mutual information quantities*
- Applied techniques from High Dimensional Statistics, Random Matrices and Information Theory.
- Work is published at *Conference on Learning Theory (COLT), 2023*

Sampling without Replacement for Finite-Sum Minimax Optimization

Advisors : [Michael Muehlebach](#) and [Bernhard Schölkopf](#), MPI-IS [NeurIPS'22 Paper]

- Analyzed stochastic gradient minimax optimization algorithms that sample the data points *without replacement* and demonstrated that they lead to faster convergence than uniform sampling.
- Derived *near-optimal rates for GDA and PPM with Random Reshuffling, Single Shuffling and Incremental Gradient* for solving finite-sum strongly monotone variational inequalities
- Used *alternating updates* and without-replacement sampling to design an algorithm that outperforms sampling with replacement for *nonconvex-nonconcave problems satisfying a two-sided PL inequality*
- Provably demonstrated the effectiveness of *data ordering attacks* on finite-sum minimization and minimax optimization by deriving *near-optimal rates under the Adversarial Shuffling model*.
- Utilised techniques from Game Theory, Variational Inequalities and Stochastic Optimization
- Work is published at *Neural Information Processing Systems (NeurIPS), 2022*

Near-Optimal Streaming Heavy Tailed Stochastic Optimization

Advisors : [Dheeraj Nagaraj](#) and [Arun Sai Suggala](#), Google Research

- Rigorously analyzed the popular clipped SGD heuristic for *Heavy-tailed Stochastic Convex Optimization (HT-SCO)* in the streaming setting
- Proved that clipped SGD nearly achieves the *optimal sub-Gaussian statistical rate* for HT-SCO under smoothness and strong convexity
- Applied techniques from Stochastic Optimization and Heavy-tailed Statistics
- Currently working on extending our analysis to problems without strong convexity

RELEVANT COURSEWORK

Computer Science	Introduction to Programming, Data Structures and Algorithms, Advanced Algorithms, Toolkit for Theoretical Computer Science ^{II} ,
Probability Statistics & ML	Optimization in ML, Kernel Methods and Learning Theory, Advanced Probability Theory ^{II} , Markov Chains and Mixing Times ^{II} , Probabilistic ML, State Space Models
Mathematics	Real Analysis, Complex Analysis, Functional Analysis, Topology, Measure Theory, Differential Geometry, Dynamical Systems, Ordinary Differential Equations, Partial Differential Equations, Linear Algebra, Abstract Algebra, Numerical Methods

^{II} : Audited Remotely at Tata Institute of Fundamental Research (TIFR), Mumbai

TALKS

Sampling Through the Lens of Optimization : Recent Advances and Insights

MSR-IISc Theory Seminar 2023 [Upcoming]

Utilising the CLT Structure in Stochastic Gradient-Based Sampling

Conference on Learning Theory 2023

Near-Optimal Heteroscedastic Regression with Symbiotic Learning

Conference on Learning Theory 2023

SERVICE

Reviewer	JMLR, NeurIPS 2023, AISTATS 2022, NeurIPS 2021 DLDE Workshop
Co-ordinator	Special Interest Group in Machine Learning, IIT Kanpur
Project Mentor	Programming Club, IITK and Stamatics (Math Club), IITK