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Aniket Das

Pre-Doctoral Researcher, Google Research India

Education

Indian Institute of Technology Kanpur *Aug' 17 - July' 22*
*BTech in **Electrical Engineering** and*
*BS in **Mathematics** (Double Major)*
GPA : *Overall* **9.3/10** *Mathematics* **9.8/10** *8 Semesters*

Aalto University, Finland *Jan' 20 - Jan' 21*
Year-long Academic Exchange in Aalto University School of Science
GPA : 4.8/5.0 *2 Semesters*

Research Interests

Sampling Algorithms, Markov Chains, Optimization, Statistical Learning Theory, High-Dimensional Probability

Publications

[$\alpha\beta$] **Aniket Das**, Dheeraj Nagaraj, Anant Raj "Utilising the CLT Structure in Stochastic Gradient based Sampling : Improved Analysis and Faster Algorithms" *Conference On Learning Theory (COLT) 2023* [Paper]

[$\alpha\beta$] Dheeraj Baby, **Aniket Das**, Dheeraj Nagaraj, Praneeth Netrapalli "Near-Optimal Heteroscedastic Regression with Symbiotic Learning" *Conference on Learning Theory (COLT) 2023* [Paper]

Aniket Das, Bernhard Schölkopf, Michael Muehlebach "Sampling without Replacement Leads to Faster Rates in Finite-Sum Minimax Optimization" *Neural Information Processing Systems (NeurIPS) 2022* [Paper]

[$\alpha\beta$] **Aniket Das**, Dheeraj Nagaraj "Provably Fast Finite-Particle Variants of SVGD via Virtual Particle Stochastic Approximation" [Preprint] [Under Review]

Avinandan Bose*, **Aniket Das***, Yatin Dandi, Piyush Rai "NeurInt - Learning Interpolation by Neural ODEs" *Neural Information Processing Systems (NeurIPS) 2021: Workshop on the Symbiosis of Deep Learning and Differential Equations (DLDE)* [Spotlight Paper]

Yatin Dandi, **Aniket Das**, Soumye Singhal, Vinay P. Namboodiri, Piyush Rai "Jointly Trained Image and Video Generation using Residual Vectors" *Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (WACV), 2020* [Paper]

Avik Pal*, **Aniket Das*** "TorchGAN: A Flexible Framework for GAN Training and Evaluation" *Journal of Open Source Software (JOSS)* [Paper]

[$\alpha\beta$] : *indicates alphabetical ordering* $*$: *indicates equal contribution*

Experience

Google Research India
Pre-Doctoral Researcher, Machine Learning and Optimization (MLO) *July '22 - Present*

- Working on problems in sampling, high-dimensional statistics and stochastic optimization
- Results on Stochastic Gradient Langevin Dynamics and minimax-optimal Heteroscedastic Regression published at COLT 2023.

Max Planck Institute for Intelligent Systems, Tübingen
Dr. Michael Muehlebach and Dr. Bernhard Schölkopf *May '21 - Dec'21*

- Worked on stochastic minimax optimization and gradient flows for constrained optimization
- Result on sampling without replacement for minimax optimization published at NeurIPS 2022

Tata Institute of Fundamental Research, Bombay
Prof. Sandeep Juneja *Apr '21 - Jul'21*

- Worked on instance-dependent lower bounds for PAC learning in Markov Decision Processes and structured stochastic bandits
- Investigated approximate best policy identification in large Markov Decision Processes via value function approximation

Selected Projects

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 guarantees for Stochastic Gradient Langevin Dynamics (SGLD) and Random Batch Method (RBM) for simulating Interacting Particle Dynamics
- Designed the Covariance Correction procedure to enable provably faster convergence of SGLD and RBM without added computational complexity
- Applied techniques from stochastic calculus, high dimensional probability and optimal transport
- Work is published at *Conference on Learning Theory (COLT), 2023*

Minimax Optimal Heteroscedastic Regression
Advisors : Dheeraj Nagaraj and Praneeth Netrapalli, Google Research ***[COLT'23 Paper]***

- Established tight (modulo log factors) non-asymptotic upper and lower bounds for the sample complexity of heteroscedastic linear regression.
- Derived fast rates for linear regression and phase retrieval under the multiplicative noise (or noisy covariate) model
- Developed a novel adaptation of Assouad's Lemma for heavy-tailed settings which applies even when the mutual information between two problem instances is infinite
- Utilised techniques from high dimensional statistics, random matrix theory 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-tight rates for GDA and PPM with Random Reshuffling, Single Shuffling and Incremental Gradient for solving finite-sum strongly monotone variational inequalities.
- Developed an algorithm which combines without-replacement sampling with alternating updates to converge faster than with-replacement sampling for nonconvex-nonconcave minimax optimization.
- Utilised techniques from game theory, variational inequalities and stochastic optimization
- Work is published at *Neural Information Processing Systems (NeurIPS),2022*

Rapid Convergence of Finite-Particle SVGD using Virtual Particles
Advisor : Dheeraj Nagaraj, Google Research ***[Preprint]***

- Developed computationally efficient variants of Stein Variational Gradient Descent with provably fast convergence in the finite-particle regime
- Proposed a novel stochastic approximation in the space of measures to the dynamics of population-limit SVGD that admits an exact finite-particle implementation
- Obtained fast finite-particle convergence rates that demonstrate a double-exponential improvement over prior state-of-the-art
- Applied techniques from optimal transport, geometry, dynamical systems and functional analysis.

Near-Optimal Streaming Heavy Tailed Stochastic Optimization
Advisors : Dheeraj Nagaraj and Arun Suggala, Google Research

- Rigorously analyzed the popular clipped SGD heuristic for heavy-tailed Stochastic Convex Optimization (SCO) in the streaming setting
- Proved that clipped SGD nearly achieves the optimal sub-Gaussian statistical rate for heavy-tailed 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$^{\Lambda}$, Toolkit for Theoretical Computer Science$^{\Pi}$,
Probability Statistics & ML	Optimization in ML$^{\Lambda}$, Kernel Methods and Learning Theory$^{\Lambda}$, Advanced Probability Theory$^{\Pi}$, Markov Chains and Mixing Times$^{\Pi}$, Probabilistic ML, State Space Models$^{\Lambda}$
Mathematics	Real Analysis, Complex Analysis, Functional Analysis$^{\Lambda}$, Topology, Measure Theory$^{\Lambda}$, Differential Geometry, Dynamical Systems$^{\Lambda}$, Ordinary Differential Equations, Partial Differential Equations$^{\Lambda}$, Linear Algebra, Abstract Algebra, Numerical Methods

Λ *: credited at Aalto University* Π *: audited at Tata Institute of Fundamental Research*

Service

2023	**Reviewer**	NeurIPS 2023
2021	**Reviewer**	AISTATS 2022
2021	**Reviewer**	NeurIPS 2021 DLDE Workshop
2019-20	**Co-ordinator**	Special Interest Group in Machine Learning, IIT Kanpur
2019-20	**Project Mentor**	Programming Club, IIT Kanpur
2021	**Project Mentor**	Stamatics (Math Club), IIT Kanpur