ANIKET DAS

Google AI Research, RMZ Infinity
Bangalore, Karnataka, India
ketd@google.com | 1998.aniket.das@gmail.com
Website | Google Scholar | LinkedIn

PRE-DOCTORAL RESEARCHER, GOOGLE RESEARCH

EDUCATION

Indian Institute of Technology Kanpur　　　　　　*Jul' 17 - May' 22 (8 Semesters)*
BTech. in **Electrical Engineering**
Second Major in **Mathematics & Scientific Computing**
Overall GPA : 9.3/10　Mathematics GPA : 9.8/10

Aalto University　　　　　　　　　　　　　　　*Jan' 20 - Dec' 20 (2 Semesters)*
Academic Exchange in Aalto University School of Science
GPA　:　4.78/5

INTERESTS

Sampling Algorithms, Markov Chains, Probability, High Dimensional Statistics, Optimization

---

PUBLICATIONS

1. **Provably Fast Finite-Particle Variants of SVGD via Virtual Particle Stochastic Approximation**
   Aniket Das, Dheeraj Nagaraj　　　　　　　　　　　　　　　　　　　**[$\alpha\beta$]**
   Spotlight *at Neural Information Processing Systems 2023*　　　　**[NeurIPS'23]**
   Oral *at Optimal Transport and Machine Learning Workshop, NeurIPS 2023*

2. **Utilising the CLT Structure in Stochastic Gradient based Sampling : Improved Analysis and Faster Algorithms**
   Aniket Das, Dheeraj Nagaraj, Anant Raj　　　　　　　　　　　　　**[$\alpha\beta$]**
   Conference On Learning Theory 2023　　　　　　　　　　　　　　　**[COLT'23]**

3. **Near Optimal Heteroscedastic Regression with Symbiotic Learning**
   Dheeraj Baby, **Aniket Das**, Dheeraj Nagaraj, Praneeth Netrapalli　　　**[$\alpha\beta$]**
   Conference On Learning Theory 2023　　　　　　　　　　　　　　　**[COLT'23]**

4. **Sampling without Replacement Leads to Faster Rates in Finite-Sum Minimax Optimization**
   Aniket Das, Bernhard Schölkopf, Michael Muehlebach
   Neural Information Processing Systems 2022　　　　　　　　　　　**[NeurIPS'22]**

5. **NeurInt - Learning Interpolation by Neural ODEs**
   Avinandan Bose*, **Aniket Das***, Yatin Dandi, Piyush Rai
   Spotlight *at DL & Differential Equations Workshop, NeurIPS 2021*　　**[DLDE'21]**

6. **Jointly Trained Image and Video Generation using Residual Vectors**
   Yatin Dandi, **Aniket Das**, Soumye Singhal, Vinay P. Namboodiri, Piyush Rai
   Winter Conference on Applications of Computer Vision, 2020　　　　**[WACV'20]**

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

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

EXPERIENCE

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

❖ 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 [Remote]
Internship Advisors : Michael Muehlebach and Bernhard Schölkopf *July '21 - Dec '21*

❖ 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, Mumbai [Remote]
Internship Advisor : Sandeep Juneja *Apr '21 - Jun '21*

❖ 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 SVGD that exhibits **polynomial scaling in dimension and error tolerance**. Obtained a **double exponential speedup** over prior works.
❖ 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 Wasserstein Gradient Flows, Differential Geometry and Functional Analysis
❖ Accepted as a ***Spotlight Paper*** at ***Neural Information Processing Systems (NeurIPS) 2023***. Selected for ***Oral Presentation*** at ***Optimal Transport & Machine Learning Workshop, 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 Theory
❖ 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 statistically and computationally efficient algorithms for **linear regression and phase retrieval under the multiplicative noise 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 Gradient Descent Ascent and Proximal Point Method** under without-replacement sampling for finite-sum strongly monotone variational inequalities
❖ Combined **alternating updates** and without-replacement sampling to outperform sampling with replacement for **nonconvex-nonconcave problems** satisfying a two-sided PL inequality

- ❖ Rigorously 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 Nonconvex 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   ***[In Preparation]***

- ❖ 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 High Dimensional Statistics
- ❖ Currently working on extending our results to problems without strong convexity

RELEVANT COURSEWORK		
	Computer Science	Introduction to Programming, Data Structures and Algorithms, Advanced Algorithms, Toolkit for Theoretical Computer Science†,
	Probability Statistics & ML	Advanced Probability Theory†, Markov Chains and Mixing Times†, Optimization in ML, Kernel Methods and Learning Theory, Statistical Signal Processing, State Space Models Probabilistic Modelling & Inference, ML for Signal Processing
	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

$\dagger$: *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   [Slides] [Video]

Utilising the CLT Structure in Stochastic Gradient-Based Sampling
Conference on Learning Theory 2023   [Slides]

Near-Optimal Heteroscedastic Regression with Symbiotic Learning
Conference on Learning Theory 2023   [Slides]

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

AWARDS AND HONORS

Academic Excellence Award, IIT Kanpur
KVPY Scholarship, Govt. of India