# Avinandan **Bose**

INCOMING GRADUATE RESEARCH ENGINEER · SINGAPORE MANAGEMENT UNIVERSITY

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## Education

**Indian Institute of Technology Kanpur(IITK)** *Kanpur,Uttar Pradesh*

Bachelor of Technology in Computer Science and Engineering *July.2018 - PRESENT(Expected Dec.2021)*

- Cumulative Performance Index(CGPA): **9.31/10.0** (After six semesters)
- Academic Excellence Award (20-19,20,21) : Awarded to top 10 percentile students based on annual academic performance
- CLASS OF 1990 SCHOLARSHIPS (2018) : Awarded to top three freshmen

## Research Interests

1. Multi Agent Reinforcement Learning
2. Decision Making under Uncertainty
3. Game Theory and Behavioural Models
4. Distributionally Robust Optimization

## Publications

### Rigorously Reviewed Conference Publications

**Multiscale Generative Models: Improving Performance of a Generative Model Using Feedback from Other Dependent Generative Models** *Feb, 2022*

Chen Changyu,**Avinandan Bose**, Shih-Fen Cheng, Arunesh Sinha

In Proceedings of *36th Association for Advancement in Artifical Intelligence (**AAAI**) Conference*, **Acceptance rate : 15%**

**NeurInt : Learning to Interpolate using Neural ODEs** *Dec, 2021*

**Avinandan Bose**, Aniket Das, Yatin Dandi, Piyush Rai *[Paper][Extended Version]*

**Oral Spotlight** at *The Symbiosis of Deep Learning and Differential Equations **(DLDE) NeurIPS** Workshop*

### Under Review

**Conditional Expectation based Value Decomposition for Scalable On-Demand Ride Pooling** *Apr, 2022*

**Avinandan Bose**, Pradeep Varakantham *[Reviews][Paper]*

Under Review at International Conference on Learning Representations (**ICLR**)

**Change Point Analysis of Topic Proportions in Temporal Text Data** *2022*

**Avinandan Bose**, Soumendu Sundar Mukherjee *[Preprint]*

Under Review at *Journal of Computational and Graphical Statistics(**JCGS**)*

### In Preparation

**Distributional Robusteness in Discrete Choice Models** *2022*

**Avinandan Bose**, Mai Ahn Tien, Arunesh Sinha

In Preparation to be submitted at International Conference on Machine Learning (**ICML**)

## Work Experience

**Visiting Undergraduate Researcher, School of Information Systems** *Singapore Management University*

Prof. Pradeep Varakantham, Prof.Arunesh Sinha, Prof.Mai Ahn Tien *May.2021 - Dec.2021*

- Paper on a hierarchial system of GANs to learn from feedback through other dependent GANs (Accepted AAAI 22).
- Paper on Conditional Expectation based Value Decomposition for Scalable Ride Pool Matching (Submitted ICLR 22).
- Working paper on Distributional Robustness in Stackelberg Games with Quantal Response.
- Offered Research Engineer Position, starting Jan. 2022.

**Research Assistant, Dept of Computer Science and Engieering** *IITK*

Prof.Piyush Rai *Dec.2020 - Mar.2021*

- Paper on non-parametric generative models for images using Second Order Neural ODEs (Accepted DLDE NeurIPS 21 Workshop).

**Research Assistant, Interdisciplinary Statistical Research Unit** *Indian Statistical Institute, Kolkata*

Prof.Soumendu Sundar Mukherjee *Dec2019,May.2020- Oct.2020*

- Paper on Change Point Analysis of Topic Proportions in Temporal Text Data (Submitted JCGS)

## Selected Projects

**Conditional Expectation based Value Decomposition for Scalable On-Demand Ride Pooling** *Singapore Management University*

Advisor : Prof. Pradeep Varakantham [Paper] *May.2021-Oct.2021*

- Developed a novel mechanism based on computing values in the form of conditional expectations through joint conditional probabilities for capturing dependencies on other agents actions without increasing the complexity of training or decision making.
- Mechanism can also be easily extended to Centralized Execution Fully Cooperative Large Scale Multi Agent Reinforcement Learning Tasks.
- Outperformed the current State of the Art Model by upto 9.76%.

**Distributional Robusteness in Discrete Choice Models** *Singapore Management University*

Advisor : Prof. Arunesh Sinha and Prof. Mai Ahn Tien *May.2021-Dec.2021*

- Discrete Choice Models are class of non-convex fractional problems. Prior works have only developed approaches to reach a stationary point in nonconcave-convex max-min relaxed versions or global optimum in a special cases with convex risk functions.
- Reformulated the problem as a Mixed Integer Second Order Cone Program guaranteed to find the global optimum.
- Derived theoretical bounds on converging to the global optimum when using approaches to scale up such as clustering and stratified sampling.
- Applied to robustifying Stackelberg Security Games, Fairer Facility Location and Cost Planning.

**Multiscale Generative Models: Improving Performance of a Generative Model Using Feedback from Other Dependent Generative Models** *Singapore Management University*

Advisor : Prof. Arunesh Sinha and Prof. Shih-Fen Cheng *May.2021-Sept.2021*

- Modelled a system of multiple interacting generative Models (GANs) trained in a hierarchical setup where a higher level GAN is conditioned on the output of several lower level GANs.
- Achieved training a newly arrived lower level GAN on very limited data through feedback from the pre-trained system of dependent GANs.

**NeurInt : Learning to Interpolate using Neural ODEs** *Dept of CSE,IITK*

Advisor : Prof. Piyush Rai [Paper] *Dec.2020-Mar.2021*

- Developed a generative model for images that learns a distribution of smooth continuous-time interpolation trajectories for a given source-target pair and generates images by subsampling random interpolation curves drawn from the trajectory distribution.
- Parameterised the conditional distribution of interpolation trajectories with Probabilistic Second Order Neural ODEs and formulated the resultant model as a modified Generative Adversarial Network with a nonparametric data-dependent prior for the latent code
- Benchmarked against appropriate GAN and Bidirectional GAN baselines that employ a fixed latent code prior and obtained significant improvements in image generation and interpolation

**Change Point Analysis of Topic Proportions in Temporal Text Data** *Interdisciplinary Statistical Research Unit,ISI, Kolkata*

Advisor : Soumendu Sundar Mukherjee [Paper] *Dec.2019,May.2020-Oct.2020*

- Proposed and developed a novel efficient temporal topic model with provisions for change points to capture offline changes in topic proportions of large corpuses of temporal textual data robust to predicting false positives.
- Change Point Estimation is widely studied but has received very little attention in textual data, hence our work is among the very few available.
- Our method estimated literary era changes in 19th-20th century English Literature Data consisted with linguists works, and scientific trend changes in the field of High Energy Physics in agreement to the beliefs of the scientific community.
- Proposed work facilitates the automated detection of change points in large corpora without any domain knowledge. Our model also serves to explain changes through topic interpretability.

## Ongoing Research Projects

**Conditional Expectation based Value Decomposition for RL** *Singapore Management University*

Advisor : Prof. Pradeep Varakantham *Oct.2021-PRESENT*

- Proved that Conditional Expectation based Value Decomposition (CEVD) can capture a preference order over joint actions in Potential Games
- Currently working on implementing CEVD in cooperative games and benchmarking against appropriate value decomposition techniques.

## Other Projects

**Lock-Free Parallelized SGD for Matrix Factorization** *Dept of Electrical Engineering,IITK*

Advisor : Prof.Ketan Rajawat[CODE] [REPORT] *Jan.2020 - Apr.2020*

- Reviewed literature on Parallelized Stochastic Gradient Descent with particular focus on Matrix Factorization Tasks.
- Matrix Factorization datasets hardly ever have entries missing completely at random. Proposed a method to permute the rows and columns to identify and separate patches of high density from a seemingly sparse matrix.
- Developed a method to solve matrix factorization problems by combining ideas from HOGWILD and stratified SGD, which highly improved convergence rates on the permuted matrix in synthetic and real datasets.
- Worked on a theoretical analysis of convergence rates of the proposed method, and contrasted with existing methods.

**Online Bayesian Tensor Completion for Traffic Estimation** *Dept of Electrical Engineering,IITK*

Advisor : Prof.Ketan Rajawat[REPORT] *Aug.2019 - Nov.2019*

- Proposed a model for online prediction of estimated time of arrival for cab services via Online Variational Bayesian Subspace Filtering.

## Honors & Awards

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|---|---|---|
| 2018 | **All India Rank 104,** Joint Entrance Examination Advanced 200,000 candidates | *India* |
| 2018 | **All India Rank 554,** Joint Entrance Examination Main 1.5 million candidates | *India* |
| 2017 | **All India Rank 68,** KVPY Scholarship Indian Institute of Science and Government of India | *Bangalore,India* |
| 2018 | **All India Rank 1,** West Bengal Joint Entrance Examination | *West Bengal,India* |
| 2018 | **Gold Medal,** Indian National Physics Olympiad (Top 35 in the nation) | *Mumbai,India* |
| 2015 | **Gold Medal,** Indian National Junior Science Olympiad (Top 35 in the nation) | *Mumbai,India* |
| 2017 | **3rd in State, National Top 1 %,** National Standard Examination in Physics | *India* |
| 2017 | **3rd in State, National Top 1 %,** National Standard Examination in Chemistry | *India* |
| 2017 | **2nd in State, National Top 1 %,** National Standard Examination in Astronomy | *India* |
| 2016 | **3rd in State, National Top 1 %,** National Standard Examination in Astronomy | *India* |
| 2016 | **State Top 1 %,** National Standard Examination in Physics | *India* |
| 2014 | **State Top 1 %,** National Standard Examination in Junior Science | *India* |
| 2016 | **Scholar,** National Talent Search Examination | *India* |

## Skills

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|---|---|
| **Languages** | Python, R, C,C++ |
| **Deep Learning Frameworks** | PyTorch, Tensorflow, Keras, TorchGAN |
| **Data Science Libraries** | NumPy,SciPy,Pandas,Scikit-Learn,Gensim |
| **Optimization Softwares** | Gurobi, CPLEX |
| **Utilities** | Linux Shell Utilities,Git,Vim,LaTeX,MATLAB |

## Course Work

**Advanced Graduate Level Courses at IITK**

Convex Optimization in Signal Processing and Communication A
Decision Theory and Bayesian Analysis A
Topics in Probabilistic Modelling and Inference@
Introduction to Machine Learning A
Stochastic Processes
Quantum Computing A
Game Theory and Mechanism Design i
Statistical Simulation and Data Analysis i
Algorithmic Game Theory i

**Other Relevant Courses**

Real Analysis and Multivariate Calculus A*
Probability and Statistics A
Fundamentals of Programming A*
Theory of Computation A
Linear Algebra and Ordinary Differential Equations
Data Structures and Algorithms A
Discrete Mathematics for Computer Science A
Advanced Algorithms
Partial Differential Equations A
Mathematical Economics A

*A* : Grade for exceptional performance(Top 1%)*
*@ : audit*
*i : in progress*

## Activities

**Reviewer** *NeurIPS*

DLDE Workshop *2021*

**Coordinator** *IIT Kanpur*

Special Interest Group in Machine Learning(SIGML) *May. 2020 - Nov. 2021*

**Project Mentor** *IIT Kanpur*

Association of Computing Activities(ACA) *Jan.2020-Apr.2020*

**Secretary** *IIT Kanpur*

Programming Club *Mar. 2019 - Mar. 2020*