

KUSHAGRA GUPTA

SENIOR UNDERGRADUATE, IIT KANPUR

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EDUCATION

- **Bachelor of Science** **Indian Institute of Technology, Kanpur**
MAJOR: Mathematics and Scientific Computing, GPA: 9.1/10
MINOR: English Literature *(expected) April 2021*
- **CBSE AISSCE (standardized 12th grade)** **Delhi Public School, Jaipur**
Science and Mathematics, 95.6 % *May 2017*

PUBLICATIONS

- Estimating Monte Carlo variance from multiple Markov chains** [arXiv]
Kushagra Gupta, Dootika Vats July 2020
Under Review: *Journal of Machine Learning Research* (JMLR)
- Proposed a multivariate replicated batch means (RBM) estimator of the limiting covariance of ergodic averages from parallel Markov chains and demonstrated its superior convergence and finite sample properties.
 - Proved strong consistency and obtained bias and variance of the estimator under weak mixing conditions.
 - Obtained the closed form asymptotic covariance matrix expression for bivariate normal Gibbs sampler.

RESEARCH PROJECTS

- **Inference for Deterministic Computer Models** **Ongoing**
- *Prof. Snigdhanu Chatterjee (University of Minnesota), Prof. Dootika Vats (IIT Kanpur)*
 - Proposed a method for verifying the identifiability of Lorenz'63 model, and extended it to identify the parent nonlinear differential equation from observed data.
 - Developed a linchpin MCMC strategy and variants of gradient based MCMC algorithms (HMC and MALA) for extremely slow mixing and high dimensional Markov chain.
- **Bayesian Inference on 3 Parameter Weibull Distribution** [details]
- *Prof. Debasis Kundu (IIT Kanpur)*
 - Statistically motivated the approximation of the log-concave posterior by a Gamma density based on moment conditions and explained the inconsistency and inefficiency in MLE estimation for certain cases.
 - Dramatically improved efficiency of the supervisor's posterior decomposition based inference algorithm.
- **Interval Regression using Bayesian Inference** [details]
- *Prof. Mohammad A. Rahman (IIT Kanpur), Prof. Dootika Vats*
 - Explored interval regression paradigms covering quantile regression (QR), meta-heuristic algorithms, information theory, convex analysis, and set arithmetic linear models.
 - Extended Bayesian QR to continuous and partially observed variables by modifying the quantile loss function.

PROGRAMMING PROJECTS

- **Multi-Class Image Segmentation on Extremely Small Datasets** [details]
- *Inter IIT Tech Meet, IIT Bombay (Silver Medal)*
 - Designed and implemented a U-Net architecture for image segmentation of high quality satellite images by using context-based representations and localized optimization of parameters with high frequency.
 - Developed a 'one vs all' algorithm with 9 U-Nets to improve accuracy on just 25 images.
- **Multi-Agent Reinforcement Learning using Latent Code** [details]
- *Dept. of Computer Science and Engineering, IIT Kanpur*
 - Created self-play algorithm for multi-agent atari games. Used variational autoencoders to disentangle multiple near optimal policies extracted with the help of latent code.
 - Achieved close to state of the art win probabilities in multi-agent CTF in collaborative and competitive settings.

- Fully Homomorphic Encryption Library** [details]
 - *Programming Club, IIT Kanpur*
 - Implemented a C++ Fully Homomorphic Encryption library with `libtorch` based on the generation scheme of Gentry, Sahai, and Waters, capable of parallel computation and Automatic Differentiation.
 - Extended current implementation of approximate eigenvector method for encryption to reach close to asymptotic fastest encryption based on learning with errors.

WORK EXPERIENCE

- Proprietary Trading Strategies** April 2020 - June 2020
 - *Quantitative Researcher, Kivi Capital, Gurgaon*
 - Designed trading strategies combining technical indicators from diverse time-frames to capture market trends.
 - Conducted a comprehensive study of candlestick trading patterns for medium frequency trading of futures.
- Online Recommendation Engine based on Implicit Feedback** [details]
 - *Machine Learning Intern, New York Office, IIT Kanpur*
 - Implemented state-of-the-art algorithm for online collaborative filtering based on Fast Matrix Factorization.
 - Implemented Bidirectional LSTM based model for flagging hate-speech on comments with ELMO embedding.

RELEVANT COURSEWORK

STATISTICS	Bayesian Inference, MCMC, Econometrics (A*), Stochastic Processes, Probability Theory, Inference*, Statistical Simulations and Data Analysis*, Time Series*, Machine Learning*
MATHEMATICS	Advanced Linear Algebra, Several Variable Calculus, Real Analysis (A*), ODE, PDE*
PROGRAMMING	Data Structures and Algorithms, Scientific Computing, Fundamentals of Computing
: in progress A: exceptional performance	

TECHNICAL SKILLS

LANGUAGES	R, Python, C/C++, Matlab, Stan, Golang
FRAMEWORKS	Pytorch, Keras, Libtorch, Tensorflow, Scikit-learn
SOFTWARES/LIBRARIES	rstan, mcmcse, sgmmcmc, Scipy, Pandas, Numpy, OpenAI gym, Gensim, NLTK

ACHIEVEMENTS AND ACCOLADES

- **Silver medals** in Inter IIT Technical Meet in Machine Learning and Data Science competitions.
- **All India Rank 157** among 1,500,000 in IIT Joint Entrance Examination (JEE) Mains.
- **National top 1%** in NATIONAL STANDARD EXAMINATION IN PHYSICS, level 1 of IPhO.
- **Statewise top 1%** in NATIONAL STANDARD EXAMINATION IN CHEMISTRY, level 1 of IChO.
- **Kishore Vigyan Protsahan Yojana (KVPY)** fellow in 2016 and 2017,
- **National Talent Search Examination (NTSE)** scholar 2015, awarded by Govt. of India.
- **State topper of Mathematics** in IAIS, organized by UNSW Australia.
- **Mentored more than 150 students** for projects on Language Models, Optimization Techniques, cryptoML and reinforcement learning.

EXTRACURRICULARS

LEADERSHIP	<i>Coordinitor, PROGRAMMING CLUB, IIT Kanpur</i> <i>Coordinator, MATHEMATICS AND STATISTICS SOCIETY, IIT Kanpur</i>
POSITIONS	<i>Member, PROBABILISTIC MACHINE LEARNING AND INFERENCE GROUP, Dept. of CSE, IIT Kanpur</i> <i>Student Nominee, DEPARTMENT UNDERGRADUATE COMMITTEE, IIT Kanpur</i>
TALKS	MARKOV CHAIN MONTE CARLO, Special Interest Group in Machine Learning, IIT Kanpur [slides] MACHINE LEARNING WINTER CAMP, Programming Club, IIT Kanpur [slides]
DEBATING	<i>Honourable Mention</i> in Parliamentary Debate, HINDU COLLEGE <i>Chair</i> of the ASIAN PARLIAMENTARY DEBATE, Cultural Festival IIT Kanpur
OTHER	<i>Core group member</i> of JOURNALISM CELL, IIT Kanpur and DEBATING SOCIETY, IIT Kanpur