KUSHAGRA GUPTA

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EDUCATION

IIT Kanpur
Dept. of Mathematics and Statistics, GPA: 9.1/10 — *Expected Graduation: June 2021*

Delhi Public School, Jaipur
Science and Mathematics, 95.6% — *CBSE AISSCE 2017*

RELEVANT COURSEWORK

Markov Chain Monte Carlo	Bayesian Inference	Probability Theory
Bayesian Econometrics	Stochastic Processes	Linear Algebra
Econometrics	Numerical Analysis and Scientific Computing	
Probability and Statistics	Data Structures and Algorithms	Real Analysis

∗: In progress

PUBLICATIONS

- **Gupta, K.**, Vats, D. Estimating Monte Carlo variance from multiple Markov chains, arXiv

PROJECTS

Estimating Monte Carlo Variance from Multiple Markov Chains *Research Project*
- Prof. Dootika Vats, IIT Kanpur

- Proposed a multivariate replicated batch means (RBM) estimator to estimate asymptotic covariance matrix.
- Established strong consistency of RBM under weak conditions on the mixing rate of the process.
- Extended large-sample bias and variance results to multivariate setting under significantly weaker conditions.
- Obtained a novel result in closed form expression for asymptotic covariance matrix for a 2-variable Gibbs sampler.
- Demonstrated superiority of RBM over other class of methods for finite sample properties.

Bayesian Inference on 3 parameter Weibull Distribution *KVPY project*
- Prof Debasis Kundu, IIT Kanpur

- Developed algorithm for parameter estimation of 3-Weibull distribution using bayesian inference, achieving MSE of 0.007 as compared to 0.015 for general Bayesian methods for 25 data points.
- Improved performance of existing bayesian based algorithm for parameter estimation of both 2-Weibull and 3-Weibull distribution using numerical optimization techniques, reducing running time to less than 30 seconds from more than 5 minutes.
- Implemented MCMC sampling methods using Metropolis-Hasting and Gibbs-Sampling methods.

Interval Regression using Bayesian Inference *Undergraduate Project*

- Developing a new paradigm for Bayesian Inference by extending set arithmetic for interval-valued variables.
- Implemented SOTA approaches covering convex optimization, swarm minimization, linear programming and Information Theory for Interval Regression.
- Extending existing Bayesian Quantile Regression to cover problems involving continuous and partially observed variables.

Multi-Agent Reinforcement Learning using latent code *Research Project*

- Working on multi-agent self-play in atari games in collaborative and competetive settings
- Currently working on using variational autoencoders to disentangle multiple near optimal policies extracted using latent code.
- Initial results on the model gave win probability of 72%, which is close to 80% SOTA values, and much better than human score of 40% in multi-agent CTF.

Multi-Class Image Segmentation on extremely small datasets *ML Competition*

Inter IIT Tech Meet, IIT Bombay

- Designed and implemented a U-Net architecture for image segmentation of high quality satellite images by using context-based representations.
- Improved existing accuracy from 84% to 91% on just 25 images by developing new algorithm based on 9 U-Nets using 'one vs all' classification approach.
- Won the silver medal in the competition. Currently working on designing custom U-Nets for each class in the multi-class classification.
- Used localized optimization of parameters with high frequency to break bottleneck of small dataset.

Fully Homomorphic Encryption Library *Research Project*

- Programming Club, IIT Kanpur

- Implemented a C++ FHE library based on GSW encryption system using libtorch with CUDA to enable parallel computation with Automatic Differentiation.
- The only University in India to develop a fully homomorphic encryption crpytography; one of only 2 homomorphic schemes to make multiplication homomorphic without re-linearization or bootstrapping.
- 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 in Kivi Capital, Gurgaon

- Designed trading strategies by combining multiple technical indicators from diverse time-frames to capture market trends. Achieved intra-day returns close to 80 basis points per trade.
- Increased the return of some existing strategies for futures and options by close to 60% by designing custom exit conditions.
- Conducted a comprehensive study of candlestick trading patterns for medium frequency trading of futures and options. Suggested improvements doubled the sharpe when combined with basic technical indicators.
- Designed and implemented a framework for technical analysis of custom candlestick charts of any time duration.

SOTA Online Recommendation Engine based on Implicit Feedback *May 2018 - November 2018*

Machine Learning Intern in New York Office, IIT Kanpur

- Implemented state of the art algorithm for online collaborative filtering based on Fast Matrix Factorization for Online Recommendation with Implicit Feedback, achieving NDCG close to 0.8 after only 2 online iterations.
- Integrated element-wise Alternating Least Squares (eALS) based incremental update strategy for online learning to tackle cold-start problem, reducing time from 21 minutes to 72 seconds and achieving hit ratio of more than 0.5 after only 1 user interaction.
- Developed online collaborative filtering based deep learning algorithm recommender based on AutoEncoder using tensorflow.

Toxic Comments Detection *June 2018 – July 2018*

Machine Learning Intern in New York Office, IIT Kanpur

- Implemented Bidirectional LSTM based model for flagging hate-speech on comments based on six metrics.
- Further improved the performance by using ELMO word representation to introduce contextualized word-embedding, increasing performance of baseline model by 6.8%.

ACHIEVEMENTS AND ACCOLADES

- **Coordinator Programming Club**- Conducted lecture series, projects, reading-groups, hackathons and winter-camps on machine learning and mathematics topics.
- **Coordinator, Stamatics** - Head of the student body, dept of Mathematics and Statistics. Responsible for conducting colloquium and lectures.
- Part of the **Probabilistic Machine Learning and Inference group, IIT Kanpur**, headed by Prof. Piyush Rai.
- Awarded **A* (for exceptional academic performance)** in Econometrics, Real Analysis, General Relativity and Mechanics and Introduction to Literature.
- **Kishore Vigyan Protsahan Yojana(KVPY)** fellow in 2016 and 2017, **National Talent Search Examination(NTSE)** scholar 2015
- Cleared level 1 of Physics and Chemistry International olympiads in **National Physics (NSEP) and Chemistry Olympiads (NSEC)**,
- **Student's representative to Departmental UG Committee, Mathematics** - Responsible for representing mathematics UG students in the university academic committee.
- **Mentored more than 150 students** for projects on Language Models, Optimization Techniques, cryptoML and reinforcement learning under Programming Club and Stamatics, IIT Kanpur.
- **Silver medal** in Inter IIT Tech Meet in Machine Learning.
- JEE mains **rank 157** among 15 lakh candidates and JEE advanced **rank 768** among 1.72 lakh candidates

TECHNICAL SKILLS

Interests - Bayesian statistics | Deep learning | Trading strategies | Debating
Languages - R | Python | C++ | Matlab | Golang **Frameworks used -** Pytorch | Keras | Libtorch | Tensorflow | Scikit-learn
Softwares/Libraries used - OpenAI gym | Gensim | NLTK | Pandas | Scipy | Kafka | BeautifulSoup | Couchbase | Docker | Locust | Numpy