Raavi Gupta

Final Year Undergraduate
Electrical Engineering, IIT Bombay

Education

Indian Institute of Technology Bombay *Mumbai, India*
Bachelor of Technology in Electrical Engineering with Honors *[2020 - 2024]*
Minor in Artificial Intelligence and Data Science *[2021 - 2024]*

- **CGPA - 9.13/10 (top 10% in a batch of 200+)**

Research Interests

Large Language Models, Optimization, Natural Language Processing, Generative AI

Publications

R. Gupta, S. Chattopadhyay, P. Paruchuri, and D. Chatterjee, **Algorithmic construction of lyapunov functions for continuous vector fields via convex semi-infinite programs**, doi: arXiv preprint, 2023 (*Submitted to Systems & Control Letters*)

Academic Achievements

- Conferred with the **undergraduate research award** (URA 01) for exemplary work in junior year *[2023]*
- Selected for the **MITACS Globalink fellowship** for pursuing **undergraduate research** in Canada *[2022]*
- Secured All India Rank **817** in **Joint Entrance Examination Advanced** amongst **1.5M** candidates *[2020]*
- Awarded the **KVPY Fellowship** with All India Rank **385** by Indian Institute of Science, Bangalore *[2020]*
- One of the **45** chosen for International Mathematical Olympiad Training Camp from 13k students *[2019]*
- Among **8** students selected to represent India at **European Girls' Mathematical Olympiad** *[2019]*
- Among **77 students nationwide** to represent India at Asian Pacific Mathematics Olympiad *[2019]*
- Recipient of the **National Talent Search Examination** Scholarship conferred by NCERT *[2018]*

Research Projects

Attribution and Hallucination of Large Language Models *[Mar. 2023 - Present]*
Prof. Ganesh Ramakrishnan, CSE, IITB | Bachelor's Thesis | Adobe India

- Studying the causes to **mitigate hallucinations** and provide attribution in Large Language models (LLMs)
- Conducting experiments across model checkpoints of **Pythia** (LLM) to study the effect across training
- Surveyed literature on ways to tackle hallucinations by tuning the **encoder** and **decoder** of transformer

Algorithmic Construction of Lyapunov Functions *[May 2022 - Present]*
Prof. Debasish Chatterjee, Systems & Control Engineering, IITB | Research Project

- Devised a novel method to algorithmically construct **Lyapunov functions** for nonlinear vector fields
- Outperformed the SOTA `SOSTOOLS` library in handling **non-polynomial** continuous vector fields
- Synthesized Lyapunov functions for **5-d systems** and black box model predictive control systems

Research & Development Head [TDR] *[Jan. 2021 - Jul. 2022]*
Dr. Leena Vachhani, Systems & Control Engineering, IITB | AUV-IITB
*AUV-IITB is a student team working on the development of **unmanned underwater vehicles**, capable of performing naval missions, competing annually at AUVSI, **RoboSub, San Diego***

- Implemented **Simultaneous Localization and Mapping Algorithm** using Extended Kalman Filter to map vehicle's 2-d trajectory using data from localization sensors including IMU and Doppler Velocity Log
- Upgraded the present electronics architecture to **ARM®-based** for enhanced performance and reliability
- Conducted **comprehensive testing** of the complete vehicle system to execute tasks in RoboSub

Internships

Enhancing Credit risk model using Large Language Models (LLMs) *[May 2023 - Jul. 2023]*
Piramal Capital and Housing Finance Limited | Machine Learning Intern
*Received a **pre-placement offer** as ML Engineer based on internship performance*

- Achieved **20.4% increment** in categorization with 3-stage pipeline: rule engine, company extractor & LLM
- Web scraped **0.8M+** companies' domain information to optimize cost and enhance robustness in pipeline
- Compared **5+** open-sourced LLMs and selected **LLaMA-7b** for compatibility with Indian data

Development of Target Redemption Forward pricer *[Nov. 2022 - Dec. 2022]*
FinIQ Consulting | Quantitative Analyst Intern

- Designed a **pricing model** for low-volatility **Target Redemption Forward** structured products
- Implemented the **Black-Scholes** method for option pricing using **geometric Monte Carlo** simulations
- Implemented a **neural network** based **BackSolve** of derivative pricing to maximize payoff in FCN products

Key Technical Projects

Cocktail Party Problem [Report] [Presentation] *[Jan. 2022 - Apr. 2022]*
Prof. Abir De, CSE, IITB | Course Project: Introduction to Machine Learning

- Utilized **Deep Clustering** for achieving speaker-independent **speech separation** with LibriMix dataset
- Employed **Short Time Fourier Transform** to process raw signals and generate spectrograms
- Used **Deep Neural Networks** to learn embeddings integrated with a model architecture featuring two **Bidirectional Long Short-Term Memory** layers for audio source separation

Bandit View on Noisy Optimization [Report] [Presentation] *[Jan. 2023 - Apr. 2023]*
Prof. Ganesh Ramakrishnan, CSE, IITB | Course Project: Optimization in Machine Learning

- Utilized **7 bandit algorithms** to optimize black-box nonlinear functions using **4 sampling strategies**
- Implemented **Hierarchical Optimistic Optimization** and **Simultaneous Optimistic Optimization** for multi-dimensional functions and benchmarked their performance in terms of time and accuracy

Analyzing Stein's unbiased risk estimate [Report] [Presentation] *[Jan. 2023 - Apr. 2023]*
Prof. Satish Mulleti, EE, IITB | Course Project: Advanced Topics in Signal Processing

- Implemented **SURE** as a mean-squared error estimator for **4** denoising algorithms with unknown signals
- Devised **SURE** implementation techniques for **non-differential median blurring** denoising algorithm
- Implemented **3 efficient divergence calculation methods** to reduce computational complexity

Student Alcohol Consumption Analysis [Report] *[Aug. 2021 - Nov. 2021]*
Prof. Amit Sethi, EE, IITB | Course Project: Programming for Data Science

- Applied **PCA** and performed **EDA** to survey the effect of student's **daily habits** with **alcohol intake**
- Performed χ^2 **test of independence** to analyze features and studied heat-maps among others
- Obtained **87**% accuracy using **Random Forests** in determining the extent of student's alcohol consumption

Radio-frequency identification [Report] *[Jan. 2023 - Apr. 2023]*
Prof. Siddharth Tallur, EE, IITB | Course Project: Electronic Design Lab

- Developed a 125kHz wave-generating RFID detector interfacing ATtiny85 for data retrieval from tags
- Designed an **impedance matching circuit** to **maximize power transfer** between reader IC and antenna
- **Programmed** the reader IC to facilitate communication between the **antenna** and the μ**controller**

Viterbi Decoding Algorithm [Presentation] *[Aug. 2022 - Nov. 2022]*
Prof. Nikhil Karamchandani, EE, IITB | Course Project: Error Correcting Codes

- Explored Viterbi Algorithm's for **hidden state sequence** estimation in n-th order **Markov processes**
- Applied the algorithm to decode **rate 1/3** convolutional codes thus optimising spread-out input data bits

Multicycle RISC Processor Design [Report] *[Jan. 2022 - Apr. 2022]*

Prof. Virendra Singh, EE, IITB | Course Project: Microprocessors

- Designed and simulated a 16-bit multi-cycle processor, capable of executing **17 instructions**, comprising an **ALU**, **8 registers**, **instruction** and **data memory**, **shifter**, **counter** and **sign-extender**, among others
- Developed and optimized **level-2 flow charts** for the finite state machine controller in the processor
- Simulated RTL of the processor for **end-to-end testing** and **verification** of hardware design

Number Theoretic Transform on FPGA *[May 2022 - Jul. 2022]*

Prof. Saravanan Vijayakumaran, EE, IITB | Research Project

- Analyzed protocols for **Interactive Zero Knowledge** of a polynomial for **zk-SNARK**
- Implemented **Elliptic Curve Digital Signature Algorithm** over a 256-bit prime field
- Accelerated **NTT** computation with **lowest latency**, adjusted by power consumption on an FPGA

Optimal Policy for playing last wicket in cricket [Report] *[Aug. 2022 - Nov. 2022]*

Prof. S. Kalyanakrishnan, CSE, IITB | Course Project: Foundations of Intelligent & Learning Agents

- Computed optimal policy using Value Iteration, Howard's Policy Iteration, and Linear Programming
- Planned and decoded an optimal action of a batter at the last wicket to maximize probability of winning

Technical Skills and Key Courses

- **Machine Learning**: Probability and Random Processes, Programming for Data Science, Intro to Machine Learning, Optimization in Machine Learning, Advanced Topics in Signal Processing
- **Computer Science**: Foundations of Learning and Intelligent Agents, Fundamentals of Digital Image Processing*, Markov Chains and Queuing Systems, Online Learning and Optimisation, Game and Information*
- **Miscellaneous**: Error Correcting Codes, Communication Systems, An Introduction to Cryptography
- **Libraries**: Keras, Numpy, OpenCV, Pandas, PyTorch, SciPy, Scikit-learn, Tensorflow
- **Programming**: Python, MATLAB, C/C++, VHDL, ARM, Arduino, AVR, LaTeX

Leadership Positions

Teaching Assistant (TA) | *Department of Mathematics* *[Jul. 2022 - Jan. 2023]*

- Mentored **over 120** freshmen for the span of 4 courses including **Calculus** and **Differential Equations**
- Conducted tutorials for **problem-solving** and **cleared conceptual doubts** through personal interaction
- Curated a blog for Department Academic Mentorship Program detailing the experiences of a TA

Department Placement Coordinator | *Institute Placement Team* *[Jul. 2023 - Present]*

- Facilitated dissemination of information to **200+** students for institute and department-level activities
- Responsible for **conducting** preparatory **mock tests** for **5+ profiles** aligning with the students' interests
- Verified resumes of the batch ensuring accuracy, integrity and adherence to the institute guidelines

Subgroup Head, Experiences | *Department Academic Mentorship Program* *[Jun. 2022 - Present]*

- Leading a team of **23 mentors** in acquiring resources for internship blogs, semex experiences among others
- Leveraging institute resources to **provide guidance** to a student under **academic rehabilitation**
- **Guided 7 sophomores** in their **academic** and **extracurricular** pursuits through personalized mentorship

Institute Student Mentor | *Student Mentorship Program* *[Jun. 2023 - Present]*

- Part of **148 member** team, chosen after a rigorous procedure involving peer reviews and an interview
- Responsible for **mentoring 12 freshmen** in **academic**, **extracurricular** and **personal development**

Extracurriculars

- Performed in **Annual Insync Dance Show** with **1500+ audience** by Insync Club, IIT Bombay *[2022, 2023]*
- Secured **2nd** position in **Institute Hockey League** among 8 teams by Hockey Club, IIT Bombay *[2023]*
- Guided **8 freshmen** in XLR8, the flagship event of Electronic and Robotics Club, IIT Bombay *[2022, 2023]*
- Completed one year long **NCC** training at the NCC Unit of 2 Maharashtra Engineers Regiment *[2020-2021]*
- Editor of department newsletter serving **1000+ students** and **100+ faculty** *[2022-2023]*
- Completed a course on **Flute** in Summer School of Cult organized by Roots Club, IIT Bombay *[2022]*
- **Interests and Hobbies:** Solving jigsaw puzzles, tennis, reading fiction, adventure sports & horse riding