Aditya Gupta

Mercedes-Benz Research & Development, India

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Research Interests

Machine Learning ○ Natural Language Processing ○ Combinatorial Optimization ○ Data & Information Systems

Education

Indian Institute of Technology Bombay **[2020 - 2024]**
Bachelor of Technology (B.Tech) in Mechanical Engineering
○ Cumulative GPA: **9.09/10**, Department rank **16** out of 240 students
○ **Minor** (earned by completing 5 extra courses) in **Computer Science**

Publications

○ **Aditya Gupta**, Souvik Das, & Debasish Chatterjee. "On a probabilistic global optimizer derived from the Walker slice sampling" *submitted to SoftwareX, 2024*
○ **Aditya Gupta**, Souvik Das, & Debasish Chatterjee. "On the algorithmic construction of control Lyapunov functions for continuous control systems" *submitted to TMLR, 2024*
○ Ankit Halder, Sabyasachi Samantarey, Sahil Barbade, **Aditya Gupta**, & Sanjeeva Srivastava. "DrugProtAI: A guide to the future research of investigational target proteins" *submitted to Nature journal, 2024*

Work Experience

Mercedes-Benz R&D, India **[Present]**
○ Developing cloud-based microservices as part of the vehicle control platform's team in the R&D department
○ Working on the connected cars platform to enable users remotely control essential car features via the Mercedes Me app using Java based applications in conjugation with SpringBoot, all hosted over Microsoft Azure
○ Exploring host platforms such as temporal to handle complex microservices like the Mercedes Plug-and-Charge

Research Experience

SwiftNav: Probabilistic global optimizer **[Jan '24 - Sept '24]**
Guide: *Prof. Debashish Chatterjee, Department of Systems and Controls Engineering, IIT Bombay*
Introduction: *We developed a global optimization algorithm based on Markov hain Monte-Carlo (MCMC) sampling techniques. It leverages simulated annealing on a discrete search space for swift onvergence at the global optima*
○ Developed a custom annealing function on a discrete search space using MATLAB by leveraging MCMC samplers
○ Implemented Walker-slice algorithm over the Metropolis-Hastings sampler to predict transition probability in a Markov chain and expanded its scope by employing Gibbs sampling for multidimensional scaling
○ Ideated a novel "Adaptive Refinement" scheme to dynamically alter the grid size in order to enhance accuracy, and added support for parallel processing, utilizing multiple CPU cores simultaneously for faster calculation

Algorithmic construction of control Lyapunov functions **[Jan '24 - Sept '24]**
Guide: *Prof. Debashish Chatterjee, Department of Systems and Controls Engineering, IIT Bombay*
Introduction: *We utilized a computationally tractable algorithm (MSA Algorithm), coupled with SwiftNav which allowed us to algorithmically construct control Lyapunov functions (CLFs).*
○ Formulated the CLF construction problem as a CSIP and implemented MSA algorithm integrated with SwiftNav
○ Developed a robust library consisting of a mix of trigonometric and polynomial functions to represent CLFs
○ Examined CLFs to solve biological and chemical reactions, epidemic mitigation and spacecraft control problem

DrugProtAI: Protein druggability predictor **[July '24 - Oct '24]**
Guide: *Prof. Sanjeeva Shrivastava, Department of Biosciences and Bioengineering, IIT Bombay*
Introduction: *We developed a comprehensive knowledgebase used to evaluate the druggability potential of 20000+ human proteins, along with offering access to 2M+ publications on drug targets and multiple additional features*
○ Developed a global knowledgebase allowing researchers have access to protein druggability scores – the likeeliability of a protein being druggable along with 3D structure, functionalities, drug targets and ML model statistics
○ Part of a team that developed the novel Partition ensemble classifier (PEC) to handle class imbalance and utilizes XGBoost & Random Forest based ML models on 183 protein-specific properties for prediction scores

Optimal Sphere Packing in Higher Dimensions **[Aug '23 - Dec '23]**

Guide: *Prof. Avinash Bhardwaj, Department of Industrial Research and Operations Research, IIT Bombay*

<u>Introduction:</u> *The task is to find an arrangement where spheres achieve maximum density in higher dimensions*

○ Studied mathematical models to formulate spheres as **d-dimensional lattices** and maximize packing density
○ Examined Monte-Carlo approach for denovo lattice generation, implemented **Torquato-Jio** algorithm for optimal arrangement and compared its advantages against **Lubachevsky-Stillinger** algorithm in the given context
○ Exploring viability of Sphere Packing in **Cryptosystems** and its applications in **Computational Mathematics**

Proteomics Data Evaluation for Covid-19 Patients **[Nov'21-Mar'22]**

Guide: *Prof. Sanjeeva Shrivastava, Department of Biosciences and Bioengineering, IIT Bombay*

<u>Introduction:</u> *The project aimed to conduct research on available proteomics data, evaluate levels of protein markers across different organs and visualize their trend in infected patients*

○ Developed a global **search portal for COVID-19**, allowing researchers to look for proteomics data in patients
○ Conducted research on variation observed in proteomics data across various organs and studied their efficacy
○ Managed SQL-based local and global datasets while integrating real-time COVID-19 news and resources

International Exposure & Internships

Spaceport America (SA) Cup 2023 — New Mexico, USA **[June '23]**

World's largest intercollegiate rocketry competition with participation from 150+ institutions, 7000+ participants
○ Bagged 1st rank nationally, engaged with 6000+ students, exhibiting execution and technical expertise
○ Co-authored a technical report showcasing Rocket's planned flight and recovery plan, design and safety choices
○ Part of the team that achieved nominal liftoff, reaching an apogee of 8984 ft followed by a successful recovery

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Global Optimization Techniques for Market Mix Modelling **[May '23 - Jul '23]**

Machine Learning Internship, American Express India
○ Developed an **OLS based** optimization algorithm to tune hyperparameters in Market Mix Modelling- MMM
○ Implemented **Dual Annealing** and **Bayesian optimization** on novel Gaussian functions having **120+** variables
○ Enhanced benchmark results by**150 %** for all **3** classes of variables evaluated on **12** independent metrics
○ Ideated a concept of using **C-curve** transformation coupled with Dual Annealing for select class of variables

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Research, Analysis, and Capital Raising Support for Startups and MSMEs **[May '22 - Jul '22]**

Financial Analytics Internship, Opulence Business Solutions
○ Conducted research and combined data to **create strategic insights and suggestions** for a range of clients
○ Involved in **offering recommendations to investors** regarding funding for potential startups and MSMEs
○ Facilitated the establishment of business relationships between various enterprises and global investors

Technical Highlights

High Power Rocketry – IITB Rocket Team **[June '21 - June '24]**

Guide: *Prof. Neeraj Kumbhakarna, Department of Mechanical Engineering, IIT Bombay*

An IN-SPACe recognized team of 30+ students working on design and development of high-power rockets for SA Cup

Senior Design Engineer — Airframe Subsystem
○ Ideated structural design for the rocket's avionics part using **Solidworks**, and examined its stability under pressure
○ Conducted **Finite Element Analysis** on various potential designs, utilizing **ANSYS Structural & Fluent**
○ Designed and manufactured quality-assured **GFRP** rocket body and **CF** fins ans simulated drag in **OpenRocket**

Optimization of Public Transport Selection **[Jan '23 - May '23]**

Guide: *Prof. Avinash Bhardwaj, Department of Industrial Research and Operations Research, IIT Bombay*

Aimed at optimizing travel in a transportation network consisting multiple objectives and real-world applicability
○ Developed a **time-based** algorithm optimizing travel across **25** locations in Mumbai via **4** transport modes
○ Evaluated deterministic scenarios through **Linear Programming**, added support for stochasticity by implementing RL-powered MDP algorithms and effectively showcased NSGA-II (GA) for custom user-preffered enhanement
○ Developed an **interactive UI** displaying the optimal path with route instructions under multiple objectives

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Automatic Segmentation of Abdominal Organs **[Jan '24 - May '24]**

Guides: *Prof. Kshitij Jadhav, KCDH, IIT Bombay | Prof. Ganesh Ramakrishnan, CSE, IIT Bombay*

Aimed at segmenting abdominal organs – liver, kidneys, and spleen given their CT/MRI images in a 3D format
○ Implemented Meta's Segment-anything model (SAM), modified to use with medical images (SAMed-mod) with LORA loss function and enhanced the training data with fine-tuned pre-processing steps for robust results

- Trained the model using CHAOS dataset, consisting of CT Scan/MRI based 3D DICOM images and analyzed its performance with varying number of images to identify optimal dataset size for best results

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Predicting Progression of Parkinson Disease using Machine Learning   **[Aug '23 - Dec '23]**
Guide: Prof. Kshitij Jadhav, Koita Centre for Digital Health (KCDH), IIT Bombay
- Forecast evolution of Parkinson's Disease (PD) across a 4 year timeframe within a 3-D progression framework
- Performed dimensionality reduction using **Non-Negative Matrix Factorization** (NMF) and implemented unsupervised machine learning using **Gaussian Mixture Models** to break down the patient group into subtypes
- Trained the PPMI dataset using **Random Forests** (RF) algorithm, followed by 5 fold cross validation technique

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Flexible and Extendable 2D Manipulator   **[Sep '23 - Dec '23]**
Guide: Prof. Ramesh Singh, Mechanical Engineering, IIT Bombay
- Built a near-continuum robotic arm intended for hard-to-reach places, healthcare systems and for maintenance
- Designed the arm to bend at various radii of curvature along its length, offering adaptability in navigation
- Developed a web app for mobiles, and desktops to control the robotic arm by leveraging Wi-Fi technology

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Intelligent Agents and Reinforcement Learning Agents   **[Jul '22 - Nov '22]**
Guide: Prof. Shivaram Kalyanakrishnan, Computer Science and Engineering (CSE), IIT Bombay
- Implemented Thompson Sampling, KL-UCB and UCB algorithms; studied effects on **Multi-Armed bandits** problem
- Modelled a simple game of Cricket as a **Markov Decision Problem**; implemented and utilised Value Iteration and Howard's Policy Iteration to derive the **optimal policy** and compared the effectiveness of the algorithms
- Developed a controller for autonomous driving using **Sarsa**, **Q- Learning** and **Policy search** algorithms

Key Academic Achievements

- Intermediate, Central Board of Secondary Education: **98.20%** *[2020]*
- Matriculation, Central Board of Secondary Education: **92.80%** *[2018]*
- Recipient of **KVPY-SX** Scholarship *(2020)* and **NTSE** Scholarship *(2018)*
- Secured All India Rank 831 in JEE Advanced out of 200,000+ students *(2020)*
- Secured All India Rank 462 in JEE Mains out of 1,200,000+ students *(2020)*

Teaching & Mentorship Experience

Teaching Assistant — *Engineering Drawing and Graphics*   **[Mar '22 - July '23]**
Prof. B Ravi, Mechanical Engineering, IIT Bombay
- Reviewed problem sets and prepared solutions for 600+ freshmen across departments over an entire semester

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Department Academic Mentor — *Student Mentorship Program*   **[May '22 - May '23]**
Selected out of 140+ applicants through interviews and peer reviews to build a support system for 240+ students
- Mentored **6 sophomores** to ensure a smooth transition in their academic and social life at IIT Bombay
- Part of a team responsible for ideating design and managing course reviews on the official Mechanical website

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D-CAMP Mentor — *Department Academic Mentorship Program*   **[Jun '23 - Sep '23]**
- Provided guidance to **5 third-year students** to equip them for internship roles in mechanical core engineering
- Effectively aided their preparation by providing important resources leading to selection in top-tier organizations

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Outreach Program — *SSSO Organization*
- Volunteered to create medical reports of underprivileged patients for an organization offering free heart operations

Leadership Experience

1) Senior Technical Advisor — *IITB Rocket Team*   **[Jun '23 - Present]**
- Interviewed & mentored 6 juniors from a pool of **100+** UG applicants based on rigorous selection criterion
- Offered mentorship by optimizing design, engineering practices, safety protocols for successful project execution

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2) Events & PR Coordinator — *Entrepreneurship Cell, IIT Bombay*   **[Jan '22 - Apr '22]**
- Directed diverse campaigns to enhance outreach and eventual footfall within a team exceeding 100 members
- Conducted research and prepared a database to connect with startups and VCs for the annual E-Summit event