Aditya Gupta

Mercedes-Benz Research & Development, India

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Research Interests

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

Education

Neerja Modi School Jaipur **[2005 - 2020]**
- Intermediate, Central Board of Secondary Education: **98.20%** *[2020]*
- Matriculation, Central Board of Secondary Education: **92.80%** *[2018]*

Indian Institute of Technology Bombay **[2020 - 2024]**
Bachelor of Technology (B.Tech) in Mechanical Engineering
- Cumulative GPA: **9.09/10**, Department rank **25** out of 177 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 for review to SoftwareX, 2024* [arXiv]
- Ankit Halder, Sabyasachi Samantarey, Sahil Barbade, **Aditya Gupta**, & Sanjeeva Srivastava. "DrugProtAI: A guide to the future research of investigational target proteins" *submitted for review to NAR, 2024* [bioRxiv]

Work Experience

Mercedes-Benz R&D, India **[Present]**
- Designing a novel architecture to enable end-to-end vehicle-app connectivity, as part of Mercedes connected cars
- Ideating execution of **CAT**-**M1** technology for optimizing shoulder-tap, and **MQTTv5** for robust connectivity
- Developing cloud-based microservices allowing remote access to **150+** vehicle features with **98%** success 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

Proteomics Data Evaluation for Covid-19 Patients [Website] **[Nov'21-Mar'22]**
Guide*: Prof. Sanjeeva Srivastava, Department of Biosciences and Bioengineering, IIT Bombay*
Introduction: *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

Optimal Sphere Packing in Higher Dimensions [Report] **[Aug '23 - Dec '23]**
Guide*: Prof. Avinash Bhardwaj, Department of Industrial Research and Operations Research, IIT Bombay*
Introduction: *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**

SwiftNav: Probabilistic global optimizer **[Jan '24 - Sep '24]**
Guide*: Prof. Debasish Chatterjee, Department of Systems and Controls Engineering, IIT Bombay*
Introduction: *We developed a global optimization algorithm based on Markov chain Monte-Carlo (MCMC) sampling techniques. It uses simulated annealing on a discrete search space for swift convergence 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 - Sep '24]**
Guide: *Prof. Debasish Chatterjee, Department of Systems and Controls Engineering, IIT Bombay*
<u>Introduction:</u> *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 construct CLFs
○ Examined CLFs to solve biological and chemical reactions, epidemic mitigation and spacecraft control problem

DrugProtAI: Protein druggability predictor [Website]   **[July '24 - Oct '24]**
Guide: *Prof. Sanjeeva Srivastava, Department of Biosciences and Bioengineering, IIT Bombay*
<u>Introduction:</u> *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 access to **protein druggability scores** – the probability 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

International Exposure & Internships

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

Global Optimization Techniques for Market Mix Modeling   **[May '23 - Jul '23]**
Machine Learning Internship, American Express India
○ Developed an **OLS based** optimization algorithm to tune hyperparameters in Market Mix Modeling- 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

Spaceport America (SA) Cup 2023 — New Mexico, USA [Website]   **[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

Technical Highlights

High Power Rocketry – IITB Rocket Team [Website]   **[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**

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
○ Modeled a simple game of Cricket as a **Markov Decision Problem**; implemented and utilized 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

Optimization of Public Transport Selection [Paper presentation]   **[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 **MDP** algorithms and effectively showcased **NSGA-II** (GA) for custom user-preferred enhancement
○ Developed an **interactive UI** displaying the optimal path with route instructions under multiple objectives

Hyper Spectral Satellite Image Clustering [Report]   **[Mar '23 - Apr '23]**
Guide: Prof. BK Mohan, Centre of Studies for Resource Engineering, IIT Bombay
- Employed **Expectation Maximization** and **Fuzzy C-Means Algorithm** for satellite image clustering and comparison
- Developed an **interactive interface** using **Tkinter** for image selection, parameter customization and display
- Created a model capable of categorizing images captured in **100+** wavelengths into user-defined clusters

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Predicting Progression of Parkinson Disease using Machine Learning [Report]   **[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 [Report]   **[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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Automatic Segmentation of Abdominal Organs [Report]   **[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

Key Academic Achievements

- 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]*
- Recipient of **KVPY-SX** Scholarship *[2020]* and **NTSE** Scholarship *[2018]*

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*   **[June '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

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

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Senior Technical Advisor — *IITB Rocket Team*   **[June '23 - June '24]**
- 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