Aditya Gupta

Senior Undergraduate, Department of Mechanical Engineering, IIT Bombay, India
+91-90018-00994 • adigupta2602@gmail.com • Aditya-Gupta26

Research Interests

Artificial Intelligence ○ Systems and Networking ○ Computer System Architecture ○ Data and Information Systems

Education

Indian Institute of Technology Bombay **[2020 - 2024]**
Bachelor of Technology with Honors in Mechanical Engineering;
Minor degree in Computer Science and Engineering

(1) Cumulative GPA: **9.08/10**
(2) **Ranked 16th** in the Department of Mechanical Engineering amongst **223** students

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Neerja Modi School - Jaipur **[2005 - 2020]**

(1) Intermediate, Central Board of Secondary Education: **98.20%** *[2020]*
(2) Matriculation, Central Board of Secondary Education: **92.80%** *[2018]*
(3) Recipient of **KVPY-SX** Scholarship *(2020)* and **NTSE** Scholarship *(2018)*

Research Experience

1) Optimal Sphere Packing in Higher Dimensions **[Aug '23 - Present]**
Guide*: Prof. Avinash Bhardwaj, Department of Industrial Research and Operations Research, IIT Bombay*
Introduction: *The problem asks how to arrange congruent balls as densely as possible without overlap between their interiors, the task is to find the maximal possible density in higher dimensions*

- Studied mathematical models to formulate spheres as **d-dimensional lattices** and maximize packing density
- Implemented the **Torquato-Jio** algorithm to solve for the densest packing and conducted a comprehensive examination of its advantages when compared to the **Lubachevsky-Stillinger** algorithm in the given context
- Examined **Monte Carlo** approach for generating dense lattices denovo and its use with the Metropolis algorithm
- Exploring viability of Sphere Packing in **Cryptosystems** and its applications in **Computational Mathematics**

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2) Robust Optimization for Machine Learning **[Jun '23 - Present]**
Guide*: Prof. Debashish Chatterjee, Department of Systems and Controls Engineering, IIT Bombay*
Introduction: *To delve deep into an entirely novel approach for robust optimization in the convex regime and to explore specific applications of convex semi-infinite programs, via a newly developed "targeted sampling technique"*

- Conducted vast research on **robust optimization** and formulation of **Convex Semi-Infinite Problem** (CSIP)
- Studied texts on **Markov Chain & Hamiltonian Monte Carlo**, and their integration with simulated annealing
- Developing software to implement a **Finite Impulse Response (FIR) filter** via CSIP programming routines
- Implementing the Novel **MSA Algorithm** using **targeting sampling** as an advantage over traditional methods

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3) Proteomics Data Evaluation for Covid-19 Patients **[Nov'21-Mar'22]**
Guide*: Prof. Sanjeeva Shrivastava, 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

Industrial Work Experience

1) 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

2) 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

1) High Power Rocketry – IITB Rocket Team **[June '21 - Present]**
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

Bagged **1st position** nationally and **66th position** among **150+** teams at the Spaceport America Cup, 2023

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**

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2) Optimization of Public Transport Selection **[Jan '23 - May '23]**
Guide*: Prof. Avinash Bhardwaj, Department of Industrial Research and Operations Research, IIT Bombay*
Aimed at presenting a thorough approach to optimizing travel in a transportation network considering multiple objectives, time-dependent behavior, stochastic effects, reliability 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 with AMPL**, handling a variable set of 320
- Structured the problem as an **MDP**, employing **Policy Iteration** and **Value Iteration** to tackle stochasticity
- Effectively showcased the use of **NSGA-II** evolutionary genetic algorithm for **time-dependent** enhancement
- Developed an **interactive UI** displaying the optimal path with route instructions under multiple objectives

Key Technical Projects

1) Predicting Progression of Parkinson Disease using Machine Learning **[Aug '23 - Present]**
Guide: Prof. Kshitij Jadhav, Koita Centre for Digital Health, 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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2) Hyper Spectral Satellite Image Clustering **[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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3) Genre-based Song Clustering **[Mar '23 - Apr '23]**
Guide: Prof. Abir De, Computer Science and Engineering, IIT Bombay
- Trained a Fuzzy C-Means Clustering model on a dataset with 30k+ data entries and 11 independent features
- Evaluated performance using Calinski-Herbasz & Silhouette scores; determining the optimal genre count

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4) Intelligent Agents and Reinforcement Learning Agents **[Jul '22 - Nov '22]**
Guide: Prof. Shivaram Kalyanakrishna, Computer Science and Engineering, 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

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5) PID-controlled Spring System with Noise Filtering **[Oct '22 - Nov '22]**
Guide: Prof. Prasanna Gandhi, Mechanical Engineering, IIT Bombay
- Developed a **MATLAB** script with animations to regulate displacement in a constrained two-mass spring system
- Implemented **PID** control over the problem to satisfy multiple constraints including overshoot and settling time
- Designed a custom PID control with 2nd order **low-pass** filter with provision to tackle external noise

6) Bitcoin Price Prediction **[Feb '22 - Apr '22]**
- Analyzed historical bitcoin data to predict future prices, employing Python tools and libraries for data processing
- Designed a **NN-based regression model** in the refined data-set using **Keras (TensorFlow) and Sklearn**

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7) Image Recognition **[Apr '22 - June '22]**
- Implemented **MobileNetV2** neural network using **TensorFlow 2.0** and trained the network to classify alpacas
- Achieved an increase an accuracy from **89% to 95%** by fine-tuning final layers of the 53-layer deep NN

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8) Techster Texter | Android App Development **[Apr '21 - July '21]**
- Conceived and brainstormed the concept of a **real-time chat application** for both **Android and web** platforms, implementing core chat functionality, the ability to create groups and seamless member addition features
- Implemented user authentication using **GitHub OAuth** and designed a user friendly UI with assistive features
- Added **screen time**, **profile photo window**, and integrated **Firebase** and **Android Studio** for real-time sync

Teaching & Mentorship Experience

1) Teaching Assistant — *Engineering Drawing and Graphics* **[Mar '22 - July '23]**
Prof. B Ravi, Mechanical Engineering, IIT Bombay
Selected based on technical proficiency to guide students in the subject
- Reviewed problem sets and examinations provided to 600+ freshmen across departments over an entire semester
- Prepared detailed solutions and mentored freshmen by solving course related doubts in weekly lab sessions

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3) 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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3) D-CAMP Mentor — *Department Academic Mentorship Program* **[Jun '23 - Sep '23]**
A mentorship programme to assist junior students in application procedures and interview preparations for internships
- 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

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

Extracurricular Activities

- Awarded for exceptional performance in STEM-SCIENCE Workshop **['17]**
- Attended workshops on Cryptocurrencies and Blockchain development by Terra and Solana **['22]**
- Stood 2nd at annual Tech Exhibition held at IIT Roorkee showcasing Rocket's technical capabilities **['23]**
- Participated in the Summer Band Showcase, Symphony Club – IIT Bombay **['21]**
- Bagged 1st prize at Sports Commentary Competition at Aavhan – Sports Fest of IIT Bombay **['21]**
- Completed year-long training for Hindustani Classical Vocals under NSO- Vocals **['21]**

Relevant Coursework & Technical Skills

CS/AI/ML Courses	Computer Programming, Computer Networks, DSA, Reinforcement Learning, Design and Analysis of Algorithms, Statistical Machine Learning, Satellite Image Processing
Online courses & MOOCs	Android App Development (CentraleSupelec), Machine Learning (Stanford University), Deep Learning and neural networks , Improving Deep Neural networks (DeepLearning.AI), Aerospace Materials and Structures (Delft University)
Learning & Computers	C++, Python, Java, MATLAB, HTML, CSS, PHP, SQL, Wolfram Mathematica
Frameworks and Libraries	NumPy, Pandas, Matplotlib, Sklearn, BeautifulSoup, Tkinter, Plotly, TensorFlow
Software Tools	Octave, SolidWorks, ANSYS, OpenRocket, AutoCAD, Git, Linux, Wireshark