Saksham Rathi

Curriculum Vitae

Department of Computer Science,
Indian Institute of Technology Bombay
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Education

2022 - 2026 **Indian Institute of Technology Bombay** *Bachelor's of Technology*
Pursuing majors in Computer Science and Engineering (CSE) along with honors and minor in Machine Intelligence and Data Science (CPI - **9.65**/10)

2020 - 2022 **Disha Delphi Public School, Kota** *Senior Secondary Education*
Secured **99.0%** in CBSE Class 12th Board Examination

2008-2020 **Delhi Public School, Kota** *Primary and Secondary Education*
Secured **98.6%** in CBSE Class 10th Board Examination

Research Experience and Internships

Current **Software Engineering Internship**
Citadel, London

2024 **Applied Scientist Internship**
Amazon, Bangalore

(a) Worked on Amazon's Large Language Model **Olympus** and improved its instruction following ability
(b) Implemented **Classifier-free Guidance** method to enhance focus on key parts of user queries and system prompts, optimizing the balance between conditional and unconditional probabilities using a hyper-parameter
(c) Evaluated the performance of Olympus and some open source models on various single and multi-turn datasets

2024-25 **Compressive Lognormal Regression**
Indian Institute of Technology Bombay. Guide: Prof. Ajit Rajwade.

(a) Improving on the current viral load estimators used in compressed sensing pool testing methods for **RT-PCR**
(b) Utilizing **Bayesian inference** to estimate distributions of infected samples and errors in their testing parameters
(c) Using **combinatorial group testing** and compressed sensing to improve upon algorithms for deconvoluting pooled tests

Academic Achievements

2022 Secured **All India Rank 18** in **Joint Entrance Examination Advanced** among 250,000 selected students

2023 Awarded the **Institute Academic Prize** for being among the **top 20** out of 1400 students in first year

2023, 25 Achieved **10** Semester Performance Index **(SPI)** by scoring a perfect grade in two of the Spring Semesters

2020 Awarded the **NTSE Scholarship** after a two-tier merit-based procedure by NCERT, Government of India

2021, 22 Recipient of the **Kishore Vaigyanik Protsahan Yojana**, a coveted fellowship by the Department of Science and Technology, Government of India by securing **All India Ranks 24** and **33** in the SX and the SA streams

2022, 25 Secured the **Advanced Performer** (AP) grade, awarded to the top 1% of students, in both the Advanced Machine Learning and Calculus courses

2022 Secured **All India Rank 321** in Joint Entrance Examination Main among 900,000 students

Olympiads and Competitions

2022 Among the **top 26** students to clear the Indian National Astronomy Olympiad (INAO) and selected to attend the **Orientation-Cum-Selection Camp** for **International Astronomy Olympiad** (IOAA)

2024, 25 Was among the **top 50** at Limestone Data Challenge conducted by **Tower Research Capital**, India in collaboration with the Finance Club, IIT Bombay amongst 200+ participating candidates across all academic years

2020 Selected among the **top 40** students to clear the Indian National Junior Science Olympiad (INJSO) and selected to attend the **Orientation-Cum-Selection Camp** for **International Junior Science Olympiad** (IJSO)

2022 Among the top 300 students selected for the **Indian National Physics Olympiad** conducted by HBCSE

2018 Selected among the top 300 students for the **Indian National Mathematics Olympiad**, HBCSE

Key Projects

Spring 2025 **Analyzing Selfish Mining and Eclipse Attack in a P2P Cryptocurrency Network**
Guide: Prof. Vinay Ribeiro | Course Project: Blockchains, Cryptocurrencies and Smart Contracts
Developed a **P2P blockchain** network simulator with **100+** nodes to demonstrate how coordinated attackers

can manipulate block propagation through combined Selfish Mining and Eclipse Attack strategies
Conducted comprehensive analysis showing attack effectiveness at various adversary thresholds **(5%-100%)**, revealing that malicious control of >50% network nodes results in complete blockchain takeover
Designed and implemented a **trust-based** countermeasure system that reduced malicious block acceptance by 95%, effectively neutralizing attacks even with 40% malicious nodes present

Autumn 2023 **Socket-Based Trading Engine with Arbitrage Detection**
Guide: Prof. Ashutosh Gupta | Course Project: Data Structures and Algorithms
Devised trading strategies utilizing **sockets** and **threads** to enhance market responsiveness and execution efficiency
Developed a **dynamic market** platform that intelligently matches traders based on optimal prices, enhancing overall market performance and has robust measures to identify and prevent **arbitrage** opportunities
Implemented **median trading** and **statistical arbitrage**, to exploit market anomalies and drive consistent returns

Spring 2025 **Approximate Nearest Neighbour Search via Group Testing**
Guide: Prof. Ajit Rajwade | Course Project: Advanced Image Processing
Implemented a novel **FLINNG** algorithm combining Locality Sensitive Hashing with distance-sensitive Bloom filters to optimize nearest neighbor search operations
Designed and evaluated a **parameterized search index** achieving $O(N^(1/2 + \gamma))$ query time complexity, demonstrating significant performance improvements over traditional approaches
Conducted comprehensive performance analysis across multiple metrics (**precision, recall, F1 score**) to validate theoretical guarantees and practical efficiency of the proposed method

Summer 2023 **Modeling Economic Systems with Reinforcement Learning**
Web and Coding Club | Seasons of Code
Formulated and implemented various economic problems as **Markov Decision Processes** in the Gym framework
Employed a combination of **Bandit** algorithms and **Reinforcement Learning** algorithms, known for their adaptability and learning capabilities, to address complex matching markets, auction dynamics, and allocation problems
Modeled **stock exchange** as a **double auction**, which incorporated market sentiment and the individual objectives of users and conducted simulations involving a diverse group of over **100** participants to assess the model's efficacy

Spring 2025 **Automated Index Creation in a Database**
Guide: Prof. Sudarshan | Course Project: Database and Information Systems
Developed an automatic indexing system for PostgreSQL that dynamically creates and removes indices based on query patterns, reducing execution time by **40%** in tests
Implemented adaptive indexing policies using weighted **attribute frequencies** and PostgreSQL's query planner to optimize database performance without manual DBA intervention
Created a real-time query monitoring interface with custom data structures that tracks attribute access patterns and applies cost-aware filtering through the **hypopg** extension

Summer 2023 **Working with Low Level Systems**
Guide: Prof. Biswabandan Panda | Course Project: Digital Logic and Computer Architecture
Utilized the **champsim** simulator to implement and analyze **stream** and **IP stride prefetchers**, while evaluating the effectiveness of **LRU**, **FIFO**, **LFU** and **BIP** replacement policies based on IPC and accuracy metrics
Designed a **VHDL** circuit which encodes **musical chords**, achieving conversion of 8-bit binary notes into chords
Implemented **Heap Sort**, **Merge Sort** and Binary Search algorithms in the **MIPS** and **x86** Assembly Language

Summer 2024 **Mathematics of Derivative Pricing**
Maths and Physics Club | Summer of Science
Achieved proficiency in **mathematical models** used in derivative pricing through comprehensive coursework
Acquired knowledge about Derivatives such as **Futures** and **Options**, with a focus on trading strategies
Gained in-depth understanding of **Black-Scholes model**, **Binomial model**, and **Greeks** for risk management

Spring 2025 **Building Decentralized Exchange**
Guide: Prof. Vinay Ribeiro | Course Project: Blockchains, Cryptocurrencies and Smart Contracts
Engineered a complete Automated Market Maker (AMM) **DEX** system using **Solidity**, implementing the constant product meechanism with ERC-20 token support, liquidity pool management, and LP token minting/burning mechanisms
Developed an **arbitrage** detection smart contract that automatically identifies profitable trading opportunities between DEXes, factoring in swap fees and minimum profit thresholds
Analyzed key metrics like Total Value Locked (**TVL**), **reserve ratios**, **slippage** impact, and trading volumes while documenting security measures against front-running attacks

Other Projects

Autumn 2024 **Image Compression**
Guide: Prof. Ajit Rajwade | Course Project: Digital Image Processing
Implemented multiple image compression algorithms including **JPEG-inspired DCT** with quantization, run-length encoding, and advanced **PCA** techniques
Implemented and enhanced **Edge-Based** Image Compression with **Homogeneous Diffusion**, reducing artifacts in uniform intensity regions through artificial segmentation
Conducted performance analysis across diverse image datasets, evaluating **RRMSE vs BP**P metrics to quantify compression efficiency while preserving visual quality

Autumn 2024 **Audio Network Communication**
Guide: Prof. Vinay Ribeiro | Course Project: Computer Networks
Utilized **frequency based** bit transmission with robust error correction through **CRC** algorithm capable of detecting and correcting upto **2-bit** errors
Implemented a modified **CSMA-CA** protocol with **RTS/CTS** mechanism for collision avoidance and included specialized handling for **broadcast** messages
Built a **multi-threaded** architecture with one thread managing message buffering and another handling the communication protocol, complete with exponential backoff strategy for collision management and clock synchronization via NTP

Spring 2024 **Saliency-Guided GMM Image Segmentation**
Guide: Prof. Suyash Awate | Course Project: Medical Image Computing
Implemented **Gaussian Mixture Model** (GMM) with **Saliency Map** for accurate image segmentation
Achieved better accuracy and reduced computational cost over Markov Random Field and mean template based GMM

Summer 2023 **Option Pricing Models**
Finance Club | Finsearch
Engaged in **Stock Markets** and **Options Trading**, with a focus on understanding diverse Option Strategies
Implemented the **Black-Scholes** model, the **Binomial** model, and **Monte Carlo** simulations using Python libraries
Evaluated the precision and **performance** of the Black-Scholes Model by applying it to **real-world** data sourced from the National Stock Exchange (**NSE**) markets and achieved a high accuracy by optimizations

Spring 2025 **Simulation of a P2P Cryptocurrency Network**
Guide: Prof. Vinay Ribeiro | Course Project: Blockchains, Cryptocurrencies and Smart Contracts
Implemented a simulator modelling transaction generation, message propagation with realistic network latencies and Proof-of-Work (PoW) mining using exponential distributions
Analyzed blockchain tree evolution to assess the impact of node speed and CPU power on mining success and fork resolution

Summer 2023 **Exploring Reinforcement Learning**
Maths and Physics Club | Summer of Science
Completed an extensive **reading project** on Reinforcement Learning (main reference: **Sutton & Barto**)
Investigated Dynamic Programming, Monte Carlo Methods, n-step bootstrapping, **Temporal Difference** learning and **on-policy** methods with their applications and **implemented** all the algorithms in Python

Spring 2023 **Python Web Crawler**
Guide: Prof. Kameswari Chebrolu | Course Project: Software Systems Lab
Designed a sophisticated Web Crawler equipped with the ability to **recursively extract** all the hyperlinks of a webpage and generating a comprehensive **graph** showcasing various link types, with user-defined recursion levels
Harnessed the power of **Python libraries** to visualize this wealth of data, resulting in an interpretable representation

Winter 2022 **Alien Invasion Game**
Self Project
Developed a **customized** version of Alien Invasion Game with **pygame** aiming for an engaging gameplay experience
Added layers of excitement and depth to the gaming experience by allowing the players to shoot advancing extraterrestrial invaders, encountering three **unique types**, each with individually tailored point rewards
Enhanced gameplay by introducing escalating difficulty **levels**, with each new level increasing game speed and point rewards for aliens and implemented a **high-score** tracking system that saved and retrieved player high scores

Positions of Responsibility

2025 **Teaching Assistant** | Discrete Structures, IIT Bombay
Instructor: Prof. Akshay S

2025 **Teaching Assistant** | Operating Systems, IIT Bombay
Instructor: Prof. Mythili Vutukuru
Collaborated with the professor in creating labs, exams and autograders

2024-25 **DAMP Mentor** | Department Academic Mentorship Programme, IIT Bombay CSE
Selected via a rigorous procedure of SoP, Peer Reviews, and Interviews to be part of a team of 37 out of 90 applicants
Guiding sophomores on academic and extra-curricular decisions and helping them navigate their curriculum

2024 **Teaching Assistant** | Data Analysis and Interpretation, IIT Bombay
Instructor: Prof. Sunita Sarawagi
Instructed sophomore students, offering guidance and support both during tutorials and doubt solving sessions
Collaborated with the professor in creating weekly quizzes, exams, assignments, practice problems, tutorial notes and grading

2024 **Teaching Assistant** | Software Systems Lab, IIT Bombay
Instructor: Prof. Kameswari Chebrolu
Instructed a cohort of 50 freshman students, offering guidance and support both during tutorial and lab hours
Collaborated with the professor in creating labs, exams, autograders, quizzes, practice problems and tutorial notes

2024 **Mentor** | Seasons of Code, IIT Bombay
Web and Coding Club
Instructed a group of 25 students for Competitive Programming and provided them the appropriate resources and problems for Dynamic Programming, Sorting, Greedy, Graphs, Trees, Range and String Algorithms

2023 **Teaching Assistant** | Calculus, IIT Bombay
Instructor: Prof. Ravi Raghunathan
Guided and instructed a group of 40 freshmen students enrolled in a semester-long calculus course
Actively collaborated with the professors to ensure the seamless and effective execution of the course

2023 **Mentor** | Winter in Data Science, IIT Bombay
Analytics Club
Provided mentorship to a team of 10 students for a **data analysis** project involving **Python** and **MATLAB**, guiding them in presenting results on a personal website through HTML, JavaScript, and CSS integration

Coursework

Computer Science Data Structures and Algorithms[§], Design and Analysis of Algorithms, Digital Logic Design and Computer Architecture[§], Computer Networks[§], Programming Paradigms[§], Implementation of Programming Languages[§], Database and Information Systems[§], Logic and theory for Computation, Operating Systems[§], Software Systems Lab[§], Computer Programming and Utilization[§], Computing and Science[§], Applied Algorithms, Game Theory and Algorithmic Mechanism Design, Blockchains, Cryptocurrencies and Smart Contracts

Matematics Discrete Structures, Calculus, Linear Algebra, Differential Equations, Mathematical Structures for Control

Data Science Data Analysis and Interpretation, Optimization, Medical Image Computing, Artificial Intelligence and Machine Learning[§], Digital Image Processing, Advanced Image Processing, Advanced Machine Learning

Others Organic and Inorganic Chemistry[§], Physical Chemistry[§], Classical and Quantum Physics, Makerspace, Management, Philosophy, Biology, Economics, Design Thinking for Innovation, Development of Mathematics in India, Physiology, Environmental Studies, Entrepreneurship

[§] *along with a lab component*

Technical Skills

Programming Languages C++, Python, HTML, CSS, Git, JavaScript, VHDL, MIPS, Sed, Awk, Shell, Bash

Software Tools LaTeX, Qiskit, GitHub, Autodesk Fusion 360, Arduino, Pygame

Data Science Matplotlib, MATLAB, NumPy, Keras, TensorFlow, PyTorch, SciPy, Pandas

Verbal Debate, Group Discussion

Extracurriculars

2024 Received the **Excellence** in **CSE Teaching Assistantship** Award for the Software Systems Lab course

2025 Awarded special recognition for outstanding dedication and contribution to the **DAMP** program

2023 Engineered a manually controlled **robot**, imbued with the ability to navigate through a diverse array of obstacles while participating in the prestigious **XLR8** Competition, the Robotics Club of IIT Bombay

2019 Secured **third rank** in Rajmata Gayatri Devi National Inter-School **Verbattle Debate** Competition

2025 Acknowledged for my contributions as a **Department Academic Mentor** in the CSE department

2019 Appointed as the **Prime Minister** during a **Model United Nations** session, which serves as a platform aimed at fostering political discourse and encouraging the exchange of thoughtful ideas of international affairs

2023 Completed a one-year course in **Weightlifting** under National Sports Organization, IIT Bombay

2019 Secured **First Rank** in **Science Quiz** organised by Defence Laboratory, Jodhpur on National Science Day

2019 Secured **First Rank** in **Science Quiz** organised by Career Point World School on National Science Day