RAKSHITHA

Senior Undergraduate | Department of Mathematics
Indian Institute of Technology (IIT) Delhi, New Delhi, India - 110016
✉ E-mail | LinkedIn | GitHub | Website

EDUCATION

Bachelor of Technology, Mathematics and Computing **(CGPA - 9.3/10)**
Indian Institute of Technology (IIT) Delhi, New Delhi, India (Sept 2021 - Present)

Class XII, Karnataka State Board **(Percentage - 100%)**
The Learning Center, Mangalore, India (Jun 2021)

SCHOLASTIC HONOURS AND ACHIEVEMENTS

Summer Undergraduate Research Award (SURA) Research grant and award by the Industrial R&D Unit (IIT Delhi) for results obtained in the project *"Data Envelopment Analysis for the Performance of Various Geographical Regions in Fighting COVID-19"*.(2023)
Mittal Renaissance Scholarship Awarded by Alumni Relations Office (IIT Delhi) for participation in research activities, involvement in social and community activities, contribution to co-curricular activities, demonstration of leadership, and academic performance. (2023)
Endowment Merit Fellowship Awarded by the Alumni Relations Office and Undergraduate Section (IIT Delhi) to recognize academic merit and consistency, covering tuition fees for three out of four years of undergraduate study. (2022, 2023, 2024)
Semester Merit Awards Awarded by Undergraduate Section (IIT Delhi) in multiple semesters for being among top 7% in the institute.
Joint Entrance Examination (JEE) Secured an All India Rank (AIR) of 299 among 1.5 million candidates in JEE Mains, and was ranked among the top 10 female candidates. Secured an AIR of 751 in JEE Advanced among 150,000 appearing candidates. (2021)
Kishore Vaigyanik Protsahan Yojna (KVPY) Fellowship Awarded by the Dept. of Science and Technology, Govt of India for securing an AIR of 100 in KVPY-SX and AIR of 421 in KVPY-SA. Also offered admission to Indian Institute of Science (IISc). (2020, 2021)
Mathematics Olympiad Qualified the Regional Mathematics Olympiad by being among top 600 candidates nation-wide. (2018, 2019)

PUBLICATIONS

Bhaskar, U., Kumar, G., Pandit, Y., & Rakshitha (2024). *EF1 Allocations for Identical Trilean and Separable Single-Peaked Valuations*. (Under review at AAAI'25 - Cleared Phase1) [Arxiv]

RESEARCH EXPERIENCE

Capacitated Facility Location (CFL) for k-Coloured Clients (June'23 - Present)
Supervisor: Prof. Naveen Garg, Dept. of Computer Science, IIT Delhi Project Presentation
- Proposed a new variant of CFL where each client demands one service from a predefined set of k distinct services and each facility location has capacities for each type of service, aiming to develop (local search) algorithms and prove their approximation guarantees.
- Literature Review: Approximation guarantees for k-median problem. Approximation guarantees for Uncapacitated Facility Location using greedy, primal-dual, local search algorithms. Approximation guarantees for Capacitated Facility Location using local search algorithms.
- Obtained an $O(k)$-approximation guarantee for local search, independent of input-size. Currently investigating approaches to establish guarantees independent of k, noting that no counterexample has been found where the approximation ratio is worse than a constant.

Relaxed Envy-Freeness for Trilean and Separable Single Peaked Valuations (Oct'23 - Sept'24)
Supervisor: Prof. Umang Bhaskar, School of Technology and Computer Science, Tata Institute of Fundamental Research (TIFR)
- Proposed two new classes of valuation functions - trilean and separable single peaked functions - for the fair division (indivisible items) problem. Aimed to extend knowledge on the existence of relaxed envy-free allocations for these classes, and develop algorithms.
- Literature Review: Cycle-elimination based EF1 algorithms for monotone, doubly monotone valuations, greedy round-robin algorithms for additive valuations. Cut-choose protocol for arbitrary two-agent settings. Algorithms for ex-ante EF and ex-post EF1 allocations.
- Developed algorithms to find EF1 (Envy-freeness upto one item) allocations for three agent separable single peaked valuation and identical trichotomous valuation. Disproved the generic existence of EFX (upto any item) allocations for the two valuation classes.
- Briefly worked on the existence of ex-ante EQ (Equitable) and ex-post EQ1 (Equitable upto one item) allocation.

Exploring Problems in Computational Social Choice and Their Tractability (Jan'24 - May'24)
Supervisor: Prof. Ashutosh Rai, Department of Mathematics, IIT Delhi Project Report
- Literature Review: Foundational problems in Stable Matching, Auctions, Fair Division (Indivisible setting and Cake Cutting), Voting, Participatory Budgeting. Review of notions of fairness including Equitability (EQ), Nash Social Welfare (NSW), Pareto Optimality (PO).
- Worked on finding fixed-parameter tractable (FPT) and slicewise polynomial (XP) algorithms for fair division instances where each agent has a binary additive valuation and the valuation of each agent for the entire set of items is k, the parameter.
- Tried set theoretic approaches, bipartite-graphs, flow-based approaches. Solved the problem for special cases $k = 2$ and $k = 3$.

Data Envelopment Analysis for the Performance of Various Geographical Regions in Fighting COVID-19 (Feb'23 - Sept'23)
Supervisor: Prof. Aparna Mehra, Department of Mathematics, IIT Delhi Project Repository
- Project aims to understand the theory behind the lesser-known primal-dual based Data Envelopment Analysis (DEA) used for analysis of efficiency and ranking of participating entities, and extend the use of DEA to the health sector (previously used in finance only).
- Defined the notion of "efficiency" by quantifying inputs and outputs of the health sector. Ranked the states of India according to exhibited efficiency during the COVID-19 pandemic. Used Pulp library of python to code CCR, BCC and SBM models for DEA.
- Used Inverse DEA to mathematically predict the need for an increase or decrease in certain resources for a better overall performance.
- Briefly investigated the possibility of incorporating stochasticity and feedback mechanisms into the predicitions of the inverse model.

INTERNSHIPS

Quantitative Researcher Intern, J.P Morgan Chase & Co. (May'24 - July'24)

- Used Q-KDB to retrieve time series market data, and run any primary pre-processing with efficient pre-computation.
- Used Regression (Linear, Lasso, LARS), ANNs, Boltzman Machines and GANs to predict the implied volatility for pricing warrants from Hong Kong market during low-liquidity and out-of-market hours. Achieved an average of 70% model scores on the test data.
- Carried out cross-market analysis for US, EU and HK names - to account for ADRs and sector wise correlations and improve prediction.
- Secured a Pre-Placement Offer (PPO) from the firm in recognition of the quality of work submitted during the internship.

COURSE PROJECTS

Simulating the Functioning of an Operating System (Fall, 2024-25)

Course: Operating Systems, Prof. Ashutosh Rai Project Repository

Built a Unix-based shell from scratch using fork, exec functionalities. Simulated an OS by implementing offline and online scheduling policies for shell-based commands, and by writing custom memory management functions like malloc, calloc and free. Simulated producer-consumer and reader-writer locks using synchronization primitives.

Numerical Methods for Solving Differential Equations (Fall, 2024-25)

Course: Computational Methods for Differential Equations, Prof. VVK Srinivas Project Repository

Wrote MATLAB codes for implementing Lax-Wendroff, Lax-Freidrich, Godunov, Roe methods for solving PDEs. Implemented FTCS, BTCS and Crank-Nikolson methods for solving parabolic PDEs. Implemented Euler, Taylor series and Range-Kutta methods to solve ODEs. Implemented linear and non-linear shooting methods and linear and non-linear finite difference methods for solving BVPs.

Building a Computer from Scratch (Fall, 2023-24)

Course: Computer Architecture, Prof. Saurabh Gandhi Project Repository

Designed the Micro architecture for a SimpleRISC CPU using logisim-evolution to perform arithmetic operations, load and store operations, branch instructions, call and return instructions. Also added a ROM Controller and a provision to accept keyboard-based input.

RELEVANT COURSEWORK

Computer Science: Data Structures, Analysis and Design of Algorithms, Theory of Computation, Approximation Algorithms, Quantum Information and Computing, Data Mining, Computer Architecture, Operating Systems, Matroid Theory*, Computational Social Choice*, Cryptography*, Machine Learning*

Mathematics: Discrete Mathematics, Probability and Stochastic Processes, Optimisation Theory, Game Theory, Linear Algebra, Statistical Methods, Differential Equations, Numerical Methods, Real and complex Analysis, Functional Analysis, Financial Mathematics, Coding Theory*

* courses to be done in Spring, 2024-25

TEACHING EXPERIENCE

Teaching Assistant - Analysis and Design of Algorithms (Junior Year Course) (Fall, 2024-25)

Instructor: Prof. Dalu Jacob, Department of Mathematics, IIT Delhi

- Engaged with students in weekly problem solving sessions and cleared doubts related to course material during office hours.
- Contributed to making of quizzes, practice problem sets and assignments for the course. Set up autograders on gradescope for the evaluation of coding assignments. Helped with evaluation and grading of exams, quizzes and written assignments.

MENTORSHIP AND OUTREACH

Teaching Volunteer, Project VIDYA, NSS, IIT Delhi: Volunteered to teach Science and Mathematics to high-school students from underprivileged economic background. Mentored these students to help them prepare for the standard examinations post high school.

Student Mentor, BSW, IIT Delhi: Engaged with a group of 6 first-year students to help them transition smoothly into college. Helped them understand course-based requirements, and cleared doubts pertaining to various activities and social engagements within campus.

Academic Mentor, Academic Support Group, IIT Delhi: Volunteered to mentor students from the college who were struggling with courses in Math and Computer Science (Specifically: Linear Algebra, Data Structures, Analysis and Design of Algorithms, Real Analysis).

Author, At Right Angles: Wrote several articles for *At Right Angles* - a magazine in Mathematics for educators and schoolteachers by Azim Premji University, explaining problems in Olympiad Mathematics (Specifically: Geometry, Number Theory) and provided guidance notes to approaching Olympiad problems.

EXTRA-CURRICULARS

Member, MathSoc, IIT Delhi: Engaged in activities and competitions of the Mathematics Society, ideated reading groups and student seminars.

Music Club, IIT Delhi: Ex-Director, Cadence-Western Acapella Society (May'23-Apr'24); Band leader for on-campus and external competitions.

Editor, Tech Ambit: Edited three articles for the digital Pan-IIT magazine on contemporary research and entrepreneurship developments.