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Farhan Ali

Curriculum Vitae

Education

2021–Present **Bachelor of Technology in Computer Science and Engineering**,
Indraprastha Institute of Information Technology Delhi, New Delhi, India, Cumulative GPA: 9.37/10

- Recieved Dean's List for Academic Performance for AY 21-22 and AY 22-23
- Recieved Distinguished Dean's List for TA Performance for AY 23-24

Research Interests

- Complexity Theory
- Quantum Computation
- Cryptography
- Discrete Mathematics

Research Experience

Lattice Cryptography

April 2024 – Present **Fine-grained Hardness of Lattice Problems**,
Undergraduate Thesis, Summer Semester 2024 - Present,
Advisor: Dr. Rajendra Kumar (IIT Delhi)
Co-Advisor: Dr. Debajyoti Bera

- Currently working on trying to find new hardness results for CVP in ℓ_2 norm, by using non-standard problems to reduce from, such as Set Cover and Label Cover
- Additionally, working on trying to find new subexponential time reductions based on Label Cover to various approximation problems
- Furthermore, trying to find new directions on unsolved problems related to CVP in ℓ_2 norm

Quantum Compexity Theory

June 2024 – August 2024 **Quantum Boolean Circuit Complexity**,
Independent Project, Summer Semester 2024, IIIT Delhi, India,
Advisor: Dr. Debajyoti Bera (IIIT Delhi), Sagnik Chatterjee (IIIT Delhi)

- Reviewed the following papers for hardness results on PARITY in circuit classes such as:
  - "On the Pauli Spectrum of QAC^0" by Shivam Nadimpalli, Natalie Parham, Francisca Vasconcelos, Henry Yuen
  - "Parity vs. AC^0 with Simple Quantum Preprocessing" by Joseph Slote
  - "The power of shallow-depth Toffoli and qudit quantum circuits" by Alex Bredariol Grilo, Elham Kashefi, Damian Markham, Michael de Oliveira
- Worked on trying to improve existing separations between classical and quantum depth circuits for PARITY
- **Grade recieved: A**

Parameterized Algorithms and Complexity

May 2023 – August 2023 **Separation Problems in Special Graph Classes**,
Summer Undergraduate Research Fellow (SURF) 2023, IIIT Delhi, India,
Advisor: Dr. Diptapriyo Majumdar (IIIT Delhi)

- Worked on trying to find parameterized algorithms faster than $\mathcal{O}(2^k \mathrm{poly}(n))$ and polynomial kernels of size smaller than $\mathcal{O}(k^3\ell^7)$ for different variants of MULTICUT in interval and proper interval graphs.
- Found new results for the UNRESTRICTED MULTICUT variation of the problem :
  1. Developed a FPT algorithm that runs in $\mathcal{O}(2^k \mathrm{poly}(n)$ time for interval graphs
  2. Developed a polynomial kernel of size $\mathcal{O}(k^2\ell^5)$ for connected interval graphs

August 2023 – December 2023 **Cuts and Separation Problems in Special Graph Classes**,
Undergraduate Research, Monsoon Semester 2023, IIIT Delhi, India,
Advisor: Dr. Diptapriyo Majumdar (IIIT Delhi)

- Reviewed existing literature for the parameterized complexity of MULTICUT and ODD CYCLE TRANSVERSAL in planar graphs
- Worked on trying to find a polynomial kernel for MULTICUT variants on planar graphs
- Additionally, worked on trying to improve existing deterministic polynomial size kernels for ODD CYCLE TRANSVERSAL
- **Grade recieved: A**

Technical Skills

Languages: Python, C, C++, Java, Bash, Assembly, Javascript, HTML, CSS, Matlab, GNU Octave, LaTeX, Beamer, SageMath

Technologies: Linux, Git, Figma, Numpy, Pandas, Matplotlib, Qiskit, D-Wave, Pennylane

Co-curriculars

Technical Event Involvement

2022, 2023 and 2024 **Organising team for Simon Marais Math Competition**, *International Undergraduate Mathematics Competition*
Held preparation sessions for interested undergraduates, organized and invigilated exam

June 2023 – August 2023 **Events Organizing Team Member of Esya'23**, *Annual Tech Fest at IIIT Delhi*,
Events: Perplexicon, ZPT (Zero Prerequisite Tournament) and Prosort Euler
Prepared event handouts and questions, organized and held all events

December 2023 **Panelist in Joy of Theory**
Session organised by CSE and ECE faculty, for encouraging undergraduates to take part in theory research

Club Involvement

2022–2024 **Club Head of Évariste**, *Mathematics and Theoretical CS Club at IIIT Delhi*
- Selected as a freshman
- Organized regular monthly events such as Zero-Prerequisite Competitions, Speed Proving Tournaments and Theory Talks
- Helped prepare handouts and questions for most events conducted

Social Event Involvement

July 2023 - December 2023 **Self Growth Activity**, *The 65th Square (Chess Club at IIIT Delhi)*
- Learnt the basics of Chess and took part in online and offline tournaments
- Practiced using puzzles on lichess.org

January 2024 - May 2024 **Community Work Activity**, *Bachpan Bachao Foundation, Badarpur, New Delhi*
Taught English, Mathematics and Environmental Science to underprivileged children from Grade 1 and Grade 2 in Badarpur, New Delhi

Relevant Coursework

Reading Groups and Courses

Interactive Coding Theory

Spectral and Algebraic Graph Theory

Theory of Probability

Graduate Courses

Lattices in Computer Science *(at IIT Delhi)* (Ongoing)

Data Science (Ongoing)

Introduction to Functional Analysis (Ongoing)

Information Theory (A)

Introduction to Quantum Computing (A)

Cryptography *(at IIT Delhi)* (A-)

Algorithms Under Uncertainty (A-)

An Introduction to Quantum Information Theory (A-)

Advanced Linear Algebra (B)

Point Set Topology (Audit)

Teaching Assistantships

Real Analysis-I
(Nominated for TA award)

Theory of Computation
(Nominated for TA award)

Undergraduate Courses

Modern Algorithm Design (Ongoing)

Theory of Computation **(A+)**

Introduction to Programming **(A+)**

Real Analysis-I **(A+)**

Abstract Algebra-I **(A+)**

Number Theory **(A+)**

Probability and Statistics **(A+)**

Algorithm Design and Analysis (A)

Differential Equations (A)

Linear Algebra (A)

Discrete Mathematics (A-)

Data Structures & Algorithms (B)

The above information is accurate as of November 1, 2023