Mudit Aggarwal

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EDUCATION

INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY — **NEW DELHI, INDIA**
Bachelor of Technology | Computer Science and Engineering — Expected May 2023

- Cummulative GPA: 9.18/10

PUBLICATIONS AND PREPRINTS

[1] Mudit Aggarwal and T Aaron Gulliver. A New Self-Shrinking Generator (submitted). 2022. URL: https://www.researchsquare.com/article/rs-2348688/v1, doi:10.21203/rs.3.rs-2348688/v1.

[2] Mudit Aggarwal and Samrith Ram. Generating Functions for Straight Polyomino Tilings of Narrow Rectangles. *J. Integer Seq.*, 26(1):Art. 23.1.4, 12, 2023. URL: https://cs.uwaterloo.ca/journals/JIS/VOL26/Ram/ram3.pdf.

RESEARCH EXPERIENCE

REED SOLOMON CODES AND THEIR VARIANTS | Undergraduate Thesis

Advisor: Dr. Anuradha Sharma — IIIT Delhi, India
August 2022 - Present

- Working on generalising and finding variants to Reed-Solomon Codes, particularly **Twisted RS Codes**, that can be used to detect and correct **Insertion-Deletion errors** during transmission.
- Aiming to use the variants being developed to give error correcting codes for **DNA Sequences**.
- Using techniques from **Algebraic Coding Theory**, as well as Combinatorics, Finite Fields, Number Theory, Modern Algebra, and Linear Algebra.

GENERATING FUNCTIONS FOR TILING RECTANGLES

Advisor: Dr. Samrith Ram — IIIT Delhi, India
May 2021 - November 2022

- Worked on finding **multivariate generating functions** for the number of ways to tile an $m \times n$ rectangle with an unlimited number of $k \times 1$ and $k \times k$ tiles, allowing for free rotations.
- Also worked on finding the generating functions for the number of tilings with constraints on the number of tiles.
- Using topics and techniques from **Combinatorics**, **Generating Functions**, **Recurrences**, and **Number Theory**.
- A paper [2] has been published in the Journal of Integer Sequences.

SHRINKING GENERATORS FOR CRYPTOGRAPHY | Mitacs Globalink Research Internship

Advisor: Dr. Aaron Gulliver — University of Victoria, Canada
May 2022 - November 2022

- Worked on finding new **Self-Shrinking Generators** for cryptography, while also generalising the notion of **LFSRs** by introducing **non-linearities** in them. This ensures **better security guarantees** in both theory and practice.
- Compared multiple types of such generators like LFSRs, Cellular Automata, Shrinking Generators, Modified Generators, etc. Additionally, analysing the security of these both **theoretically** as well as **practically**.
- A paper [1] has been submitted and is currently under review.

BOUNDED ARBORICITY GRAPH STREAMING

Advisors: Dr. Saket Saurabh & Dr. Akanksha Agrawal — IMSc Chennai & IIT Madras, India
Jan 2021 - May 2021 — (Remote)

- Worked with Sameep Dahal, Savit Gupta, and Agastya Vibhuti Jha on finding **small-space approximation algorithms** for graphs with a given bounded arboricity, in the streaming model.
- Proved results and small-space algorithms for **Vertex Cover**, **b-Matching**, and **Capacitative Matching** for weighted graphs under the streaming model, and unweighted graphs under the dynamic model.

SUNFLOWER LEMMA AND LIFTING THEOREMS

Advisor: Dr. Sajin Koroth — University of Victoria, Canada
May 2022 - September 2022

- Worked on improving the **gadget-size** guarantees of **lifting theorems** in communication complexity using the recent improvements in the **Erdos-Rado Sunflower Lemma**.

- Conversely, also used **randomised lifting theorems** and **decision tree complexity** to further the lower bounds on the size in the sunflower lemma.

WORKSHOPS

ALGORITHMS FOR BIG DATA AND ML | ACM Winter School 2020-21
Institute of Mathematical Sciences, Chennai

- The workshop was organised by **Dr. Saket Saurabh** and **Dr. Venkatesh Raman** on **Streaming Algorithms**.
- The main topics covered were: Chernoff bounds, Morris counter, Lower Bounds, AMS estimator, Sparse recovery, Johnson–Lindenstrauss lemma, Graph streaming and PAC learning.

ALGORITHMS AND LOWER BOUNDS | ACM Winter School 2021-22
IIT Madras and CMI, Chennai

- The workshop was organised by **Dr. Akanksha Agrawal** and **Dr. G. Philip** on **Algorithmic Lower Bounds**.
- The main topics covered were: Fast Fourier Transform, Linear Decision Trees, Polynomial Methods, Complexity Conjectures, and Reductions.

AWARDS

- Dean's Award for Academic Excellence — IIIT Delhi
  Awarded for excellent academic performance.
- OnlyMyHealth HealthCare Heroes Award 2022 — Dainik Jagran
  Awarded by Dainik Jagran to **Volunteers.Covihelp**, for exemplary social work during the Covid-19 Pandemic, using digital resources to help people.
- SchoolTime Achievement Award — The Global Times
  Awarded for exemplary and lasting contribution to The Global Times, a student-run newspaper in the Amity Group of Schools and Universities.

TEACHING EXPERIENCE

TEACHING ASSISTANT | FUNCTIONAL ANALYSIS
Instructor: Dr. Satish Kumar Pandey
January 2023 - Present — Winter Semester, 2023

TEACHING ASSISTANT | COMBINATORICS AND APPLICATIONS
Instructor: Dr. Samrith Ram
January 2022 - May 2022 — Winter Semester, 2022

TEACHING ASSISTANT | DISCRETE MATHEMATICS
Instructor: Dr. Samrith Ram
September 2021 - December 2021 — Monsoon Semester, 2021

TEACHING ASSISTANT | ABSTRACT ALGEBRA I
Instructor: Dr. Anuradha Sharma
January 2022 - May 2022 — Winter Semester, 2022

TEACHING ASSISTANT | MULTIVARIABLE CALCULUS
Instructor: Dr. Satish Kumar Pandey
August 2022 - December 2022 — Monsoon Semester, 2022

S-CUBE WORLD | Student Mentor and Content Creator
July 2020 - August 2020 | IIITD Incubation Center

- Designed quality study material and modules for school students, for a community of the students by the students.
- Created presentations for relevant paths and exams as a student mentor.

VOLUNTEERING EXPERIENCE

VOLUNTEERS.COVIHELP | Co-Founder
`https://www.volunteerscovihelp.org/`

- Co-Founded and actively worked for the Volunteers.Covihelp organisation during the second wave of the deadly covid-19 pandemic in India.
- The organisation had **24x7 manned helplines** on Facebook, Instagram, Whatsapp, and Twitter. The helplines provided seekers with self-verified information on leads for oxygen cylinders, blood and plasma donors, RT-PCR tests, hospital beds, medicines, etc.
- The organisation had **300+ volunteers**, and successfully resolved **1700+ cases**.
- Also **raised Rs. 25000+** through multiple fundraiser events to donate to patients and for setting up of OPDs.

- Personally worked on **100+ cases**, trained the volunteers, and helped set up the organisation systems on Discord, Google Forms, Airtable, etc.
- **Awarded the HealthCare Heroes Award 2022 in the Digital Healthcare category**
  (Details for the same can be found **here**)

STUDENT MENTOR
Student Mentorship Program, IIIT Delhi
September 2022 - Present

- Selected as a student mentor for the Student Mentorship Program at IIIT Delhi.
- Acting as a mentor for 4 mentees, helping them adjust to college life, and tacking the paradigm shift it accompanies.
- Serving as their first point of contact for any scenario.
- Holding weekly to biweekly meetings discussing their mental health, how they cope with the changes, etc.

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PROJECT ROSHNI: BOOK DONATION
IIIT Delhi | Member

- Collected, organised, curated, and purchased books for donation to underprivileged kids in government schools during Diwali 2019.
- Donated and distributed over 500 books in government schools across New Delhi.

RELEVANT COURSEWORK

READING COURSES
- **Combinatorics and Representation Theory** — A
  Advisor: Dr. Samrith Ram — Monsoon Semester, 2022
  - Studied an assortment of topics from **Combinatorics** and **Representation Theory**, using multiple texts.
  - Main topics covered were Snake Oil, WZ Pairs, Gosper's Algorithm, Pólya-Redfield Theorem, Cycle Index, Symmetric Functions, Partitions, Weighted Objects, and Tableaux.
  - Some texts used were *Generatingfunctionology* by Wilf, *A = B* by Zeilberger, Wilf, Petkovšek, *A Course in Enumeration* by Aigner, and *Bijective Combinatorics* by Loehr.

- **Differential Geometry with Topology** — A
  Advisor: Dr. Shilpak Banerjee — Summer Semester, 2021
  - Studied **Point-Set Topology** from *Topology* by Munkres.
  - Covered sections on **Differential Geometry** from *Elementary Differential Geometry* by Pressley.
  - Also covered the required multivariable calculus and multivariable analysis prerequisites.
  - Main topics included: Topology, Basis for topology, Metric Spaces, Connectedness, Compactness, Homeomorphisms, Curves and Surfaces, Parameterisations and Reparameterisations, Manifolds, Orientability of Surfaces, and Isometries.

- **Advanced Linear Algebra** — Audit
  Advisor: Dr. Samrith Ram — Winter Semester, 2022
  - Studied **Linear Algebra** from *Linear Algebra* by Hoffman & Kunze, and *Linear Algebra Done Right* by Axler.
  - Main topics included: Vector Spaces, Basis, Fields, Maxtrix Systems, Dual Spaces, Functionals, Cyclic Decompositions, Jordan Form, Canonical Forms, and Inner Product Spaces.

GRADUATE COURSES
- **Introduction to Functional Analysis** — A [Class Rank 1]
  Instructor: Dr. Satish Kumar Pandey — Winter Semester, 2022
- **Abstract Algebra II** — A
  Instructor: Dr. Sneha Chaubey — Winter Semester, 2022
- **Calculus on $\mathbb{R}^n$** — A
  Instructor: Dr. Kaushik Kalyanaraman — Winter Semester, 2022
- **Approximation Algorithms** — A
  Instructor: Dr. Syamantak Das — Monsoon Semester, 2022

- Theory of Modern Cryptography — A
  Instructor: Dr. Donghoon Chang — Winter Semester, 2022
- Topics in Number Theory — B
  Instructor: Dr. Anuradha Sharma — Monsoon Semester, 2022
- Applied Cryptography — B-
  Instructor: Dr. Subhabrata Samajder — Monsoon Semester, 2021
- Information Theory — Ongoing
  Instructor: Dr. Manuj Mukherjee — Winter Semester, 2023
- Randomised Algorithms — Ongoing
  Instructor: Dr. Rajiv Raman — Winter Semester, 2023
- Lattices in Computer Science — Ongoing
  Instructor: Dr. Subhabrata Samajder — Winter Semester, 2023
- Measure and Probability Theory — Audit
  Instructor: Dr. Subhajit Ghosechowdhury — Winter Semester, 2023
- Algebraic Coding Theory — Audit
  Instructor: Dr. Anuradha Sharma — Winter Semester, 2023
- Introduction to Quantum Computing — Audit
  Instructor: Dr. Debajyoti Bera — Winter Semester, 2023
- Communication Complexity — Audit
  Instructor: Dr. Sajin Koroth — Summer Semester, 2022

UNDERGRADUATE COURSES

- Discrete Mathematics — A+ [Class Rank 1]
  Instructor: Dr. Samrith Ram — Monsoon Semester, 2020
- Real Analysis II — A [Class Rank 1]
  Instructor: Dr. Satish Kumar Pandey — Monsoon Semester, 2021
- Abstract Algebra I — A
  Instructor: Dr. Sneha Chaubey — Winter Semester, 2021
- Probability and Statistics — A
  Instructor: Dr. Sanjit K. Kaul — Winter Semester, 2020
- Differential Equations — A
  Instructor: Dr. Ashish Kumar Pandey — Winter Semester, 2021
- Theory of Computation — A
  Instructor: Dr. Debajyoti Bera — Winter Semester, 2021
- Data Structures and Algorithms — A
  Instructor: Dr. Subhabrata Samajder — Winter Semester, 2020
- Digital Circuits — A
  Instructor: Dr. Sneh Saurabh — Monsoon Semester, 2019
- Linear Algebra — A-
  Instructor: Dr. Acushla Saraswat — Monsoon Semester, 2019
- Real Analysis I — A-
  Instructor: Dr. Debika Banerjee — Monsoon Semester, 2020
- Analysis and Design of Algorithms — A-
  Instructor: Dr. Syamantak Das — Winter Semester, 2021
- Basic Electronics — A-
  Instructor: Dr. Vivek Bohara — Winter Semester, 2020
- Modern Algorithm Design — B
  Instructor: Dr. Syamantak Das — Monsoon Semester, 2021
- Signals and Systems — B
  Instructor: Dr. Pravesh Biyani — Monsoon Semester, 2020
- Combinatorics and its Applications — Audit
  Instructor: Dr. Samrith Ram — Winter Semester, 2021
- Multivariate Calculus — Audit
  Instructor: Dr. Shilpak Banerjee — Monsoon Semester, 2021
- Number Theory — Audit
  Instructor: Dr. Sneha Chaubey — Monsoon Semester, 2020

PROGRAMMING PROJECTS

QUADROTOR DRONE SIMULATOR

Cyborg: Robotics Club at IIITD

April 2020 - June 2020

- Worked with Devansh Gupta to create a quadrotor simulator using **Numpy** and **Matplotlib** in Python.
- It takes quadrotor parameters (size and dynamics) and the way-points for its path from editable text files.
- Uses **Euler-Newtonian** rigid body dynamics, and a multi-loop **PID** controller to simulate the motion of the given quadrotor and give plots for the motion of the same along with the errors.

LINE FOLLOWER

Electroholics: Electronics Club at IIITD

January 2020 - February 2020

- Worked with Madhur Kumar to create a PID-based Line Following Robot.
- The Robot is built using an Arduino, takes values of the PID constants as inputs, and follows a black line.
- The robot was featured as an entry in the Robotics Competition at Breeze 2020 (at Shiv Nadar University).

COLOUR SWITCH

Advanced Programming: Course Project

November 2020 - December 2020 — Monsoon Semester, 2020

- Worked with Agamdeep Bains to create a **JavaFX** based PC rendition of the popular mobile game **Colour Switch** completely from scratch. Instructor: **Dr. Vivek Kumar**.
- Created the infinite version of the game, with additional functionalities including multiple saves and in-game boosts.

CACHE SIMULATOR

Computer Organisation: Course Project

April 2020 - May 2020 — Winter Semester, 2020

- Simulated L1 and L2 caches in python, with options for Direct as well as n-Associative mappings, implemented using bit-string operations. Instructor: **Dr. Prabhaker Mateti**.
- The simulator allows for reading and writing to the cache, with hits and misses also reported to the user.

SMART ROOM PROTOTYPE

Prototyping Interactive Systems: Course Project

October 2019 - December 2019 — Monsoon Semester, 2019

- Worked with Agamdeep Bains and Aryan Behal to create a prototype of a low cost smart room, as an alternative to the current expensive solutions available in the market. Instructor: **Dr. Aman Parnami**.
- Created a **gesture controlled** scaleable prototype, using **Computer Vision** based devices that could be kept in the room. The Computer Vision processes ran on **Raspberry Pi** modules embedded in the devices themselves.

PROFICIENT IN: SageMath ● Julia ● LaTex ● Beamer ● Python ● C++ ● C ● Java

CO-CURRICULARS

CLUB INVOLVEMENT

As President

- Évariste:
  Mathematics and Theoretical CS Club of IIIT Delhi.
- Electroholics:
  Electronics Club of IIIT Delhi.
- The 65th Square:
  Chess Club of IIIT Delhi.

As Core Member

- Cyborg:
  Robotics Club of IIIT Delhi.
- LitSoc:
  Literary/Debating/Pop-Culture Society of IIIT Delhi.
- PhiloSoc:
  Philosophy Society of IIIT Delhi.

SPORTS

- Lawn Tennis
  Played **nationals** in 2016, and also represented the institute in multiple tournaments.
- Chess
  Played **zonals** multiple times, and also represented the institute in multiple tournaments.

WRITING

- The Global Times
  Wrote for The Global Times, a student-run newspaper, for over 8 years in school. Won multiple awards for contribution including awards like **SchoolTime Achievement**, Best Article, etc.
- IIIT Delhi
  Contributed articles to **Kaleidoscope**, IIIT Delhi's college magazine. Also organised **Haiku** and **Content Writing** events at Odyssey 2020.