

Mudit Aggarwal

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EDUCATION

INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY

BACHELOR OF TECHNOLOGY | COMPUTER SCIENCE AND ENGINEERING

NEW DELHI, INDIA

EXPECTED MAY 2023

- Cumulative GPA: 9.21/10
- Received Dean's Award for Academic Excellence

PUBLICATIONS AND PREPRINTS

- [1] **Aggarwal, Mudit** and T Aaron Gulliver. A New Self-Shrinking Generator (submitted). 2022.
- [2] **Aggarwal, Mudit** and Samrith Ram. Generating functions for straight polyomino tilings of narrow rectangles (submitted). 2022. URL: <https://arxiv.org/abs/2206.04437>, doi:10.48550/ARXIV.2206.04437.

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 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 Genome 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 - Present

- Working 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 working on finding the generating functions for number of tilings with constraints on the number of tiles.
- Using topics and techniques from **Combinatorics, Generating Functions, Recurrences, and Number Theory**.
- A preprint of the same is available as [2]

SHRINKING GENERATORS FOR CRYPTOGRAPHY | Mitacs Globalink Research Internship

ADVISOR: DR. AARON GULLIVER

UNIVERSITY OF VICTORIA, CANADA

May 2022 - Present

- Working 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.
- Comparing 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 | DISCRETE MATHEMATICS

INSTRUCTOR: DR. SAMRITH RAM

September 2021 - December 2021 (Monsoon Semester, 2021)

- Responsible for a group of **~90** students; my duties included taking weekly recitation/tutorial sessions, clearing doubts, and grading papers (assignments, quizzes, and exams).
- Took recitations, where I taught the students, clarified their doubts regarding course content, and did live problem-solving related to the course.
- Graded papers for all the 90 students, as well as made rubrics for the same.

TEACHING ASSISTANT | ABSTRACT ALGEBRA I

INSTRUCTOR: DR. ANURADHA SHARMA

January 2022 - May 2022 (Winter Semester, 2022)

- Responsible for a group of **~20** students; my duties included taking weekly recitation/tutorial sessions, clearing doubts, and grading papers (assignments, quizzes, and exams).
- Took recitations, where I taught the students, clarified their doubts regarding course content, and did live problem-solving related to the course.
- Graded papers for all 80+ students in the course, as well as made rubrics for the same.

TEACHING ASSISTANT | MULTIVARIABLE CALCULUS

INSTRUCTOR: DR. SATISH KUMAR PANDEY

August 2022 - December 2022 (Monsoon Semester, 2022)

- Responsible for a group of **30** students; my duties included taking weekly recitation/tutorial sessions, clearing doubts, and grading papers (assignments, quizzes, and exams).
- Took recitations, where I taught the students, clarified their doubts regarding course content, and did live problem-solving related to the course.
- Graded papers for all 30 students, as well as made rubrics for the same.

TEACHING ASSISTANT | COMBINATORICS AND APPLICATIONS

INSTRUCTOR: DR. SAMRITH RAM

January 2022 - May 2022 (Winter Semester, 2022)

- My duties included clearing doubts and grading papers (assignments, quizzes, and exams).
- Took sessions where I clarified doubts regarding course content, grading, and exams.

- Graded the exams for the course.

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 6 mentees, helping them adjust to college life, and tackling 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

• DIFFERENTIAL GEOMETRY WITH TOPOLOGY

Advisor: Dr. Shilpak Banerjee

A
Summer Semester, 2021

- Studied **Point-Set Topology** from *Topology* by Munkres.
- Covered **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, Manifolds, Orientability of Surfaces, Isometries.

• COMBINATORICS AND REPRESENTATION THEORY ²

Advisor: Dr. Samrith Ram

Monsoon Semester, 2022

- Studying an assortment of topics from **Combinatorics** and **Representation Theory**, using multiple texts in the area.
- Main topics covered: Snake Oil, WZ Pairs, Gosper's Algorithm, Pólya-Redfield Theorem, Self-Complementary Patterns, Cycle Index, Symmetric Functions, Partitions, and Tableaux.

- Some texts used are *Generatingfunctionology* by Wilf, $A = B$ by Zeilberger, Wilf, Petkovšek, *A Course in Enumeration* by Aigner, and *Bijjective Combinatorics* by Loehr.

- **ADVANCED LINEAR ALGEBRA** ¹

Advisor: Dr. Samrith Ram

Winter Semester, 2022

- Studied **Linear Algebra** from *Linear Algebra* by Hoffman & Kunze.
- Covered **Linear Algebra** from *Linear Algebra Done Right* by Axler.
- Main topics included: Vector Spaces, Basis, Fields, Maxtrix Systems, Dual Spaces, Functionals, Cyclic Decompositions, Jordan Form, Canonical Forms, Inner Product Spaces.

GRADUATE COURSES

- **ABSTRACT ALGEBRA II** A
Instructor: Dr. Sneha Chaubey Winter Semester, 2022
- **CALCULUS ON \mathbb{R}^n** A
Instructor: Dr. Kaushik Kalyanaraman Winter Semester, 2022
- **INTRODUCTION TO FUNCTIONAL ANALYSIS** A
Instructor: Dr. Satish Kumar Pandey Winter Semester, 2022
- **THEORY OF MODERN CRYPTOGRAPHY** A
Instructor: Dr. Donghoon Chang Winter Semester, 2022
- **APPLIED CRYPTOGRAPHY** B-
Instructor: Dr. Subhabrata Samajder Monsoon Semester, 2021
- **TOPICS IN NUMBER THEORY** ² Monsoon Semester, 2022
Instructor: Dr. Anuradha Sharma
- **APPROXIMATION ALGORITHMS** ² Monsoon Semester, 2022
Instructor: Dr. Syamantak Das
- **COMMUNICATION COMPLEXITY** ¹ Summer Semester, 2022
Instructor: Dr. Sajin Korothe

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. Sneha 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** ¹

Instructor: Dr. Samrith Ram

Winter Semester, 2021

- **MULTIVARIATE CALCULUS** ¹

Instructor: Dr. Shilpak Banerjee

Monsoon Semester, 2021

- **NUMBER THEORY** ¹

Instructor: Dr. Sneha Chaubey

Monsoon Semester, 2020

Footnotes: ¹ Course audited with instructor's permission ² Course ongoing as of writing

SELECTED 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, and 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** scale-able 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.

INTERESTS AND CO-CURRICULARS

ACADEMIC INTERESTS

- **MATHEMATICS:**
Combinatorics ● Abstract Algebra ● Linear Algebra ● Discrete Mathematics ● Graph Theory
- **PROGRAMMING:**
SageMath ● Julia ● LaTeX ● Beamer ● Python ● C++ ● C ● Java

CO-CURRICULAR ACTIVITIES

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 **SGFI Nationals** in Lawn Tennis (2016)
- Representative for Lawn Tennis in the Sports Council of IIITD. Also represented the institute at numerous tournaments.

Chess

- Club Coordinator for the Chess Club in college.
- Played numerous Intra and Inter-college tournaments, winning multiple prizes.

WRITING

- **The Global Times:**
Won multiple awards in contribution to **The Global Times**, a student-run newspaper, 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.