Mudit Aggarwal

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EDUCATION

THE UNIVERSITY OF BRITISH COLUMBIA   VANCOUVER, CANADA
Master of Science | Mathematics   2023 - Present
- Advisor: Dr. Andrew Rechnitzer
- Cummulative Percentage: 86.3/100

INDRAPRASTHA INSTITUTE OF INFORMATION TECHNOLOGY   NEW DELHI, INDIA
Bachelor of Technology | Computer Science and Engineering   2019-2023
- Cummulative GPA: 9.21/10
- Recieved Dean's Award for Academic Excellence

PUBLICATIONS AND PREPRINTS

[1] **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.

[2] **Mudit Aggarwal** and T Aaron Gulliver. A New Self-Shrinking Generator (submitted to *J. Cryptogr. Eng.*). 2022.

RESEARCH EXPERIENCE

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.
- A paper [1] has been published in the Journal of Integer Sequences.

INTERACTIVE CAPACITY OF A BINARY ERASURE CHANNEL
Advisor: Dr. Manuj Mukherjee   IIIT Delhi, India
March 2023 - Present
- Working on improving the lower bounds for the interactive capacity of a noisy binary erasure channel.
- Provided an updated coding scheme and a new way of error analysis of protocols using Markov Chains to model error patterns for stochastic errors.
- A manuscript is currently being written.

RANDOM WALKS ON SCHREIER COSET GRAPHS
Advisor: Dr. Andrew Rechnitzer   UBC, Canada
September 2023 - Present
- Working on asymptotics of generating functions arising from random walks on Schreir Coset Graphs.

REED SOLOMON CODES AND THEIR VARIANTS | Undergraduate Thesis (A)
Advisor: Dr. Anuradha Sharma   IIIT Delhi, India
August 2022 - May 2023
- Worked 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.
- Additionally, worked on finding MDS and LCD codes, useful in preventing side-channel and fault injection attacks using Orthogonal Direct-Sum masking.

SHRINKING GENERATORS FOR CRYPTOGRAPHY | Mitacs Globalink Research Internship
Advisor: Dr. Aaron Gulliver   UVic, 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, analyzing the security of these both **theoretically** as well as **practically**.
- A paper [2] 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 **randomized lifting theorems** and **decision tree complexity** to further the lower bounds on the size in the sunflower lemma.

WORKSHOPS

SIGNAL PROCESSING, COMMUNICATIONS AND NETWORKS | JTG/IEEE Summer School 2023
Indian Institute of Science, Bengaluru
- The speakers were **Dr. Gautam Kamath**, **Dr. Nilanjana Datta**, and **Dr. Rashmi Vinayak**.
- The talks included Differential Privacy, Quantum Information Theory, quantum data compression, quantum state discrimination, manipulation of entanglement, and Coding Theory for Distributed Systems.

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 ASSISTANTSHIPS | IIIT Delhi, India
- Abstract Algebra 1
  Instructor: Dr. Krishanu Roy　　　　　　　　　　　　　　January 2023 - May 2023
- Multivariate Calculus
  Instructor: Dr. Satish Kumar Pandey　　　　　　　　　　August 2022 - December 2022
- Combinatorics and Applications
  Instructor: Dr. Samrith Ram　　　　　　　　　　　　　　January 2022 - May 2022
- Abstract Algebra 1
  Instructor: Dr. Anuradha Sharma　　　　　　　　　　　　January 2022 - May 2022
- Discrete Mathematics
  Instructor: Dr. Samrith Ram　　　　　　　　　　　　　　August 2021 - December 2021

S-CUBE WORLD | Sᴛᴜᴅᴇɴᴛ Mᴇɴᴛᴏʀ ᴀɴᴅ Cᴏɴᴛᴇɴᴛ Cʀᴇᴀᴛᴏʀ
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.

VOLUNTEER EXPERIENCE

VOLUNTEERS.COVIHELP | Cᴏ-Fᴏᴜɴᴅᴇʀ
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 (2X)
Sᴛᴜᴅᴇɴᴛ Mᴇɴᴛᴏʀsʜɪᴘ Pʀᴏɢʀᴀᴍ, IIIT Dᴇʟʜɪ
September 2022 - June 2023 and August 2021 - May 2022
- Selected as a student mentor for the Student Mentorship Program at IIIT Delhi.
- Acted as a mentor for 4 mentees, helping them adjust to college life, and tacking the paradigm shift it accompanies.
- Served as their first point of contact for any scenario.
- Held weekly to biweekly meetings discussing their mental health, how they cope with the changes, etc.

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.

COURSEWORK (AT UBC)

- Mᴇᴀsᴜʀᴇ Tʜᴇᴏʀʏ ᴀɴᴅ Iɴᴛᴇɢʀᴀᴛɪᴏɴ   A
  Instructor: Dr. Stephen Gustafson   Winter Term 1, 2023
- Pʀᴏʙᴀʙɪʟɪᴛʏ Tʜᴇᴏʀʏ   A
  Instructor: Dr. Omer Angel   Winter Term 1, 2023
- Fɪᴇʟᴅs ᴀɴᴅ Gᴀʟᴏɪs Tʜᴇᴏʀʏ   A
  Instructor: Dr. Sujatha Ramdorai   Winter Term 1, 2023
- Tᴏᴘᴏʟᴏɢʏ   A-
  Instructor: Dr. Jim Bryan   Winter Term 1, 2023
- Dɪsᴄʀᴇᴛᴇ Mᴀᴛʜᴇᴍᴀᴛɪᴄs   Oɴɢᴏɪɴɢ
  Instructor: Dr. Jozsef Solymosi   Winter Term 2, 2024
- Cᴏᴍᴘʀᴇssᴇᴅ Sᴇɴsɪɴɢ   Oɴɢᴏɪɴɢ
  Instructor: Dr. Yaniv Plan   Winter Term 2, 2023
- Fᴜɴᴄᴛɪᴏɴᴀʟ Aɴᴀʟʏsɪs   Aᴜᴅɪᴛ
  Instructor: Dr. Pablo Shmerkin   Winter Term 2, 2023
- Cᴏᴍᴘʟᴇx Aɴᴀʟʏsɪs   Aᴜᴅɪᴛ
  Instructor: Dr. Zinovy Reichstein   Winter Term 2, 2023
- Rᴇᴀʟ Vᴀʀɪᴀʙʟᴇs 2   Aᴜᴅɪᴛ
  Instructor: Dr. Joshua Zahl   Winter Term 2, 2023
- Mᴀᴛʜᴇᴍᴀᴛɪᴄs Tᴇᴀᴄʜɪɴɢ Tᴇᴄʜɴɪǫᴜᴇs   Oɴɢᴏɪɴɢ
  Instructor: Dr. Costanza Piccolo   Winter Term 2, 2023
- Rᴇᴘʀᴇsᴇɴᴛᴀᴛɪᴏɴs ᴏꜰ Fɪɴɪᴛᴇ Gʀᴏᴜᴘs   Rᴇᴀᴅɪɴɢ Sᴇᴍɪɴᴀʀ
- Dɪsᴄʀᴇᴛᴇ Mᴀᴛʜ ᴀɴᴅ Dɪsᴄʀᴇᴛᴇ Gᴇᴏᴍᴇᴛʀʏ   Rᴇᴀᴅɪɴɢ Sᴇᴍɪɴᴀʀ

COURSEWORK (AT IIITD)

GRADUATE COURSES

- INFORMATION THEORY   A+ [CLASS RANK 1]
  Instructor: Dr. Manuj Mukherjee   Winter Semester, 2023
- INTRODUCTION TO FUNCTIONAL ANALYSIS   A [CLASS RANK 1]
  Instructor: Dr. Satish Kumar Pandey   Winter Semester, 2022
- RANDOMISED ALGORITHMS   A [CLASS RANK 1]
  Instructor: Dr. Rajiv Raman   Winter Semester, 2023
- 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
- LATTICES IN COMPUTER SCIENCE   A-
  Instructor: Dr. Subhabrata Samajder   Winter Semester, 2023
- TOPICS IN NUMBER THEORY   B
  Instructor: Dr. Anuradha Sharma   Monsoon Semester, 2022
- APPLIED CRYPTOGRAPHY   B-
  Instructor: Dr. Subhabrata Samajder   Monsoon Semester, 2021
- MEASURE AND PROBABILITY THEORY   AUDIT
  Instructor: Dr. Subhajit Ghosechowdhury   Winter Semester, 2023
- ALGEBRAIC CODING THEORY   AUDIT
  Instructor: Dr. Anuradha Sharma   Winter Semester, 2023
- COMMUNICATION COMPLEXITY   AUDIT
  Instructor: Dr. Sajin Koroth   Summer Semester, 2022

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.
- TOPOLOGY AND DIFFERENTIAL GEOMETRY   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.
- PROBABILISTIC METHOD IN COMBINATORICS   AUDIT
  Advisor: Dr. Rajiv Raman   Summer Semester, 2023
    - Studied **Probabilistic Method** and its applications to combinatorics from *Probabilistic Method* by Alon & Spencer.
- SPECTRAL AND ALGEBRAIC GRAPH THEORY   AUDIT
  Advisor: Dr. Manuj Mukherjee   Summer Semester, 2023
    - Studied **Spectral and Algebraic properties** of graphs from *Spectral and Algebraic Graph Theory* by Spielman.
    - Main topics included: Perron-Frobeinus theorem, Courant Fischer theorem, Laplacians, Interlacing

Eigenvalues, Cayley Graphs, Payley Graphs, Wigderson Matrices, Cheeger's Inequalities, and Expanders.
- **Information Theory and Combinatorics**   Audit
  Advisor: Dr. Manuj Mukherjee   Summer Semester, 2023
    - Studied applications of **Information Theoretic** quantities and arguments to Combinatorics.
    - The texts used were *Entropy and Counting* by Radhakrishnan; and notes on *Information Theory in CS* by Braverman.

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
- **Fields and Waves**   Audit
  Instructor: Dr. Sayak Bhattacharya   Winter Semester, 2021

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.