Rohan Goyal

CONTACT INFORMATION

Chennai Mathematical Institute
H1 SIPCOT IT Park, Siruseri, Chennai

rohang@cmi.ac.in
www.goyal-rohan.github.io

RESEARCH INTERESTS

I am widely interested in Theoretical Computer Science. My main interests lie in Extremal and Algebraic Combinatorics, Coding Theory and Pseudorandomness along with applications to other areas but I am widely interested in almost all aspects of theory including computational algebra, algorithm design, computation for society, automata theory, games on graphs etc.

EDUCATION

Chennai Mathematical Institute, Chennai, India — September 2021-April 2024
B.Sc.(Honours) in Mathematics and Computer Science
CGPA: 9.55/10.00, **CS GPA:** 10.0/10.0 — July 2023

Detailed Coursework and Courses TAed towards the end of the document.

HONORS AND AWARDS

- Deputy Leader India, **European Girls Mathematics Olympiad 2023** Indian team — 2022
- Bronze Medal at **International Mathematical Olympiad (IND1)** — 2021
- Iranian Geometry Olympiad Advanced 2021: Silver Ruler, Advanced Category, 1st in India — 2021
- Asian Pacific Mathematical Olympiad, Bronze Medal — 2020
- Indian National Mathematical Olympiad: Qualified for National Camp
  India Rank 2 in 2021 — 2020, 2021
- International Collegiate Programming Competition Regionals — 2023
- Simon Marais Mathematics Competition: Topped CMI, Top 20 overall — 2022
- Kishore Vigyanik Pratyogita Yojana, All India Rank 87 and receive INSPIRE scholarship — 2020
- Sriram Scholarship: Complete Tuition Fee waiver for attending CMI — 2021-2024
- Asian Pacific Linguistics Olympiad, Unofficial Honourable Mention — 2021
- Qualified Panini Linguistics Olympiad and wrote Indian team selection tests — 2021
- Participated in Virtual Maths Beyond Limits Camp 2020 usually conducted in Poland. I also returned as a volunteer in 2021 for Olympic Training. — 2020
- Qualified Zonal Informatics and Computing Olympiads — 2020
- Qualified National Talent Search Examination and was awarded an NTSE scholarship. — 2019-20

INTERNSHIPS, RESEARCH PROJECTS

Tata Institute of Fundamental Research, Navy Nagar, Mumbai, India

Intern — May 2023 - present, (concluded August 2023 officially)
Worked under Professor Prahladh Harsha.

- Read Anup Rao's Sunflowers: Soil to Oil paper and presented recent results on the Sunflower Conjecture. (on a break)
- Looked at some problems in secret sharing and some algorithms (with Prof. Akshayram and Rathnakar).
- Read and presented Amnon Ta-Shma's paper on local testability of multiplicity codes.
- Read notes and papers on high dimensional expanders and sampling algorithms using HDXs.
- Read notes, and DELLM21 paper on CCC codes (constant rate, distance and locality) and tried to improve bounds.(ongoing work)
- Were able to find a near linear time algorithm for list decoding multiplicity codes (ongoing work, with Prof. Mrinal Kumar and Ashutosh Shankar)

IIT Bombay

Reading Project May 2022 - July 2022
Worked under Professor Rohit Gurjar.

- Read Michael Kim's lecture notes and Nitin Saxena's 2009 survey on Polynomial Identity Testing. I also looked at some ROABPs and other methods of computation and depth reduction techniques.

CMI

Research Internship (Planned) January 2024 -
Working on problems in matchings and fair division with Prof. Prajakta Nimbhorkar.

Writing and Publications

Preprints

- *Fast list-decoding of univariate multiplicity and folded Reed-Solomon codes*
  with Prahladh Harsha, Mrinal Kumar and Ashutosh Shankar.

Olympiad Writing

I have written many articles and handouts during the time I was preparing for Mathematical Olympiads. Most of them can be found on my blog. Some selected ones are:

- Polynomials, February 2021 [pdf]
- Chip Firing Games, September 2020 [slides] [pdf]
- Combinatorial Nullstellensatz, May 2020 [pdf]
- Circumcircle-Excircle Configuration, October 2020 [pdf]

Talks and Presentations

Sunflower Conjecture, CMI Student Seminar Sep, 2023

Combinatorial Nullstellensatz TIFR STCS Student Seminar Aug, 2023

Games on Graphs with Imperfect Information, Games on Graphs Course May, 2023

Saks-Zhou 1999, $\mathsf{BP_HSPACE}(S) \subset \mathsf{DSPACE}(S^{3/2})$, Complexity 2 Course [Report] Dec, 2022

Conferences and Workshops attended

- Workshop on Algebra and Computation 2023, attended via Zoom
- STCS Day 2023, TIFR
- Chennai-Tirupati Intercity Number Theory Conference 2023
- FSTTCS 2022, Pre Conference workshop on "Algorithms under Uncertainty".
- FSTTCS 2022

Olympiad Projects and Outreach

Indian Mathematical Olympiad Program 2021-present
I am involved in various roles in the Indian Mathematical Olympiad Program. Some of these are:

- Deputy Leader for India at EGMO 2023
- Paper Setting, Grading, Problem Proposing: IMO TSTs: 2023| EGMO TSTs 2021, 2022, 2023| INMO 2023, 2024
- Teaching, Training: EGMOTC 2022, 2023|IMOTC 2023|INMOTCs 2022, 2023|EGMO PDC 2022, 2023|IMO PDC 2022, 2023

Championship of Mathematical and Logical Games [Post by Ghislain Fourny, ETH] 2022
Conducted the Qualifying, Regional and National stages of the Championship of Mathematical and Logical Games in India for the first time. We had over 3000 participants and took 16 students across to EPFL, Switzerland for the International finals. We did not charge any participants at any stage and were completely sponsored by Inshorts Ltd. Organized under "Indian Federation of Mathematical Games" which I co-founded.

Sophie Fellowship [Web] 2021-present
Co-Founded Sophie Fellowship to provide more resources and guidance to talented students interested in participating in International and National Mathematical Olympiads. The team consists of various IMO and EGMO medalists. I am now not actively teaching, and am only in an advisory role due to my increased involvement with the official Indian program. I have also taught many of the sessions.

Online Math Club [Web and Blog] [YouTube] 2021-Present
I was the Co-Director for Online Math Club (OMC) and am currently in an advisory role. We take public lectures on topics in Mathematics(Olympiad and introductory college material) accessible to high schoolers weekly(used to be twice a week) and share them on YouTube later. We have collected over 100 lectures on various different topics in Mathematics. I have also taught many of these sessions.

STEMS [Web] [YouTube] 2021-Present
At CMI, we annually conduct exams in Mathematics, Computer Science and Physics for high school students and undergraduates. We then call the highest performing students to CMI for a 3-day camp where we have many renowned speakers in the three subjects. I was the Math head in 2021, overall head in 2022 and am in an advisory role this year.

Unofficial IMOTC and CAMP [Web] [YouTube] 2020-2021
We unofficially organized online camps in 2020 and 2021 for students qualified in the national Olympiad camp and some other students due to the cancellation of the official program due to CoViD situation. I took over 20 lectures in the two camps and many lectures were uploaded on YouTube. Students continued the program into 2022 and conducted it with our guidance. I have also taught many of the sessions.

Individual Instruction [OTIS web] 2020-Present
I take lectures for Mathematical Olympiads for some students from across the world mostly through OTIS. I have been fortunate to work with extremely talented students. Many of them have performed well in contests as well and qualified for the national camps and teams for IMO and EGMO.

Miscelleneous Talks and Activities
I often take some talks on Olympiads or elementary topics. For example, I have taken sessions on elementary number theory for Mathematical Initiatives in Nepal and for Informatics Olympiad training in India via CodeChef and Unacademy. I have also taken some talks on triangle inequality, parity and such for students from 5th to 8th grade for DhiMath, RAM and other organizations.

COURSEWORK

Mathematics Core

- Algebra 1 (Linear Algebra) — Semester 1, Fall 2021
- Algebra 2 (Group Theory) — Semester 2, Spring 2022
- Algebra 3 (Rings and Field Theory) — Semester 3, Fall 2022
- Analysis 1 (Analysis on $\mathbb{R}$) — Semester 1, Fall 2021
- Analysis 2 (Analysis on $\mathbb{R}^n$) — Semester 2, Spring 2022
- Analysis 3 (Generalized Metric Spaces and Fourier Analysis) — Semester 3, Fall 2022
- Calculus (Calculus on Manifolds) — Semester 3, Fall 2022
- Complex Analysis — Semester 4, Spring 2023
- Differential Equations — Semester 4, Spring 2023
- Topology (Point Set and Algebraic Topology) — Semester 4, Spring 2023
- Introduction to Probability Theory — Semester 2, Spring 2022

Computer Science Core

- Introduction to Programming in Haskell — Semester 1, Fall 2021
- Advanced Programming in Python — Semester 2, Spring 2022

- Discrete Mathematics — Semester 2, Spring 2022
- Design and Analysis of Algorithms — Semester 3, Fall 2022
- Theory of Computation — Semester 3, Fall 2022
- Programming Language Concepts (Concurrency, Lambda Calculus) — Semester 4, Spring 2023

Computer Science Graduate Electives

- Complexity Theory 1 [Course-Page] — Semester 2, Spring 2022
- Complexity Theory 2 (Pseudorandomness and PCPs) — Semester 3, Fall 2022
- Games on Graphs [Course-Page] — Semester 4, Spring 2023
- Algebra and Computation (Polynomial and Group Computation) — Semester 4, Spring 2023
- Timed Automata [Course-Page] — Semester 5, Fall 2023
- Advanced Algorithms [Course-Page] [my Class-Notes] — Semester 5, Fall 2023
- Algorithmic Coding Theory 2 (half semester) — Semester 5, Fall 2023
- Combinatorial Optimization (planned) — Semester 6, Spring 2024

TA

Courses TAed:

- Complexity Theory 1 — Semester 4, Spring 2023
- Discrete Mathematics — Semester 4, Spring 2023
- Theory of Computation — Semester 5, Fall 2023
- Discrete Mathematics — Semester 6, Spring 2024
- Expander Graphs and applications — Semester 6, Spring 2024

MISCELLENEOUS

A happy and proud moment: A student I worked with actively joined MIT as an undergraduate in Fall 2023. I then received an extremely kind letter from the MIT admissions department saying that I had been named by the student as an especially influential teacher in his development and congratulated me! [The letter]

Languages: Haskell, Python, Java, C++, LaTeX, SageMath

Hobbies

- Drama Club, CMI: I regularly attend Drama Club meetings in CMI.
- Chess: I used to participate in chess tournaments actively in middle school am FIDE rated. Currently, I mostly play bullet and blitz chess online and solve puzzles.
- Badminton and Go: I play Badminton regularly. I was also actively learning Go and intend to restart playing.
- Music: I love all kinds of music (except metal and the same family) and always appreciate recommendations!
- Film and TV: Same as music!(change metal to horror) Always appreciate recommendations!
- Potterhead: I am a Hufflepuff and my patronus is a Newfoundland :P.