Sayak Chakrabarti

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Education

Indian Institute of Technology, Kanpur 2017-2022 *(expected)*
Integrated B. Tech- M.Tech in Computer Science and Engineering CPI: 8.8/10.0

South Point High School, Kolkata 2017
All India Senior School Certificate Examination, CBSE Board Score: 93.2 %

Publications

- Aditya Gulati, **Sayak Chakrabarti**, Rajat Mittal, On algorithms to find p-ordering, *to appear in 7th Annual International Conference on Algorithms and Discrete Applied Mathematics, 2021* [arXiv]
- Soumendu Sundar Mukherjee, **Sayak Chakrabarti**, Graphon Estimation from Partially Observed Network data, *arXiv preprint* **arXiv:1906.00494** [arXiv]

Academic Achievements

- *2020* **Research Fellowship** at Max Planck Institute of Software Systems
- *2017* Secured **All India Rank** of **181** in **Joint Entrance Exam, Advanced** among 200,000 candidates
- *2017* Secured **All India Rank** of **287** in **Joint Entrance Exam, Main** among 1.2 million candidates
- *2017* Secured **Rank 10** in **West Bengal Joint Entrance Examination** among 150,000 candidates
- *2017* Qualified **Indian National Physics Olympiad (INPhO)**, among 34 students to be selected from India, and attended **Orientation cum Selection Camp (OCSC Physics)**
- *2016* Qualified **Indian National Mathematical Olympiad (INMO)**, among 30 students to be selected from India
- *2015* Secured **All India Rank 115** in **Kishore Vaigyanik Protsahan Yojana (KVPY)** among 100,000 candidates

Research Experience

Root Finding of Polynomials Aug 2020 – Present
Prof. Nitin Saxena, *Dept. of Computer Science and Engineering, IIT Kanpur* *Kanpur, India*

- Studied **algebraic geometry** and the complexity of **Hilbert's Nullstellensatz**
- Reviewed literature on algorithms to **factorize polynomials** in fields and upto modulo p^4, and calculate **basic irreducible factors** modulo prime powers
- Currently working on finding a **root of a system of bivariate polynomials** modulo primes using algebraic and algebraic geometric techniques

Root Sets, p-ordering and Factorization Aug 2019 – Present
Prof. Rajat Mittal, *Dept. of Computer Science and Engineering, IIT Kanpur* *Kanpur, India*

- Learnt about **Root sets** of polynomials modulo prime powers, their behaviours and some properties
- Studied the work done on **factorization** modulo primes and **lifting** these to modulo prime powers
- Attempted to find a method of factorization of polynomials using **representative roots** such that the factorization gives maximum linear factors modulo a prime power
- Solved this problem upto degree 3 and attempted to lift to higher degree polynomials
- Discovered algorithms to find **p-ordering** of subsets of integers, also represented in succinct form

Continuous Skolem Problem for arbitrary dimensions May 2020 – July 2020
Prof. Jöel Ouaknine, *Max Planck Institute of Software Systems* *Saarbrücken, Germany*

- Remotely worked on the **continuous Skolem problem** for higher dimensions in Prof. Ouaknine's research group under the supervision of Dr. Eike Neumann and Dr. Engel Lefaucheux
- Learnt about **Real Algebraic Geometry** with an emphasis on Semi-algebraic sets and their decomposition
- Studied the work done upto dimension 8 and attempted to extend it to arbitrary dimensions using **Schanuel's conjecture** and **Leon Ehrenpreis' conjecture**
- Attempted to prove the decidability of **zeroes of exponential polynomials** for low codimension cases
- Devised a parameterization of a semi-algebraic set which contains the zeroes of the given function

- Extended a proposition from "Real Algebraic Geometry" by Bochnak, Coste and Roy to show that the parameterized semialgebraic set can be extended to $\bar{0}$

Graphon Estimation Dec 2018 – Present

Prof. Soumendu Sundar Mukherjee, *Interdisciplinary Statistical Research Unit, ISI Kolkata* *Kolkata, India*

- Learnt about Graphons that are symmetric measurable function $f : [0, 1]^2 \to [0, 1]$ used to denote network edge probability of a dense graph
- Learnt about **graphon estimation methods** including Universal Singular Value Thresholding, Stochastic Blockmodel Approximation, Matrix Completion, Neighbourhood Smoothing etc.
- Extended the **Neighbourhood Smoothing** technique for graphon estimation proposed in "Estimation of Network Edge Probabilities by Neighbourhood Smoothing" by Zhang et al.
- Used the **extended Neighbourhood Smoothing** algorithm on partially revealed graphs to estimate the underlying graphon with high accuracy, both on simulated networks from standard graphon functions and real networks
- Estimated graphons using various existing alternative methods and compared those against the proposed algorithm

Selected Projects

Linear Cryptanalysis on Logic Locking May 2019 – Oct 2019

Prof. Pramod Subramanyan, *Dept. of Computer Science and Engineering, IIT Kanpur*

- Learnt about various Logic Locking techniques
- Reviewed literature on **SAT-attack** on Logic Lockings
- Attempted to break logic locking encryption by using Linear Cryptanalysis
- Used Genetic algorithm and MaxSAT solvers to improve linear approximation of for encrypted circuits
- Tested proposed attack on various benchmark circuits

Breaking Cryptosystems | *Course Project, Modern Cryptology* Jan 2019 – Apr 2019

Instructor: Prof. Manindra Agarwal, *Dept of Computer Science and Engineering, IIT Kanpur*

- Solved a Dungeon and Dragons based game where in each stage a cryptosystem was to be broken to advance to next stage
- Broke **Substitute cipher, Block Substitution Cipher, Substitution Permutation Cipher, DES Cryptosystem** (using Differential Cryptanalysis)**, SASAS Cipher** (AES-like cryptosystem)**, RSA Cyptosystem** (with low public exponent, using Coppersmith's attack)

Relevant Coursework

Algebraic Number Theory, Computational Number Theory and Algebra, Geometric Topology, Modern Cryptology, Discrete Mathematics, Data Structures & Algorithms, Algorithms II, Theory of Computation, Randomized Methods in Computational Complexity*, Arithmetic Geometry* ** - ongoing courses*

Technical Skills

Programming: Python, C/C++, R, Haskell, Verilog, PHP **Tools:** LaTeX, Bash, Git, MySQL
Libraries: Pytorch, Tensorflow, Keras, Numpy, OpenCV

Extra-Curricular Activities

Volunteer | *Shiksha Sopan* Aug 2019 – Mar 2020

- Volunteered to teach English at a school under Shiksha Sopan, an NGO providing education to underprivileged children

Project Mentor | *Association for Computing Activities* Jan 2019 – Apr 2019

- Guided a group of first year students in topics of Theoretical Computer Science

Academic Mentor | *Counselling Services* Aug 2018 – Apr 2019

- Helped students facing academic problems by conducting doubt clearing sessions and one-to-one mentorship regarding courses on Mathematics

Stuident Guide | *Counselling Services* Jul 2018 – Apr 2019

- Helped 4 freshmen students get used to campus life and quickly adjust to college environment