

Aayush Rajesh

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Research Interests

Information and Coding Theory, Communication Systems, Probability Theory, Signal Processing

Education

Indian Institute of Technology Bombay

Bachelor of Technology in Electrical Engineering

CPI: 9.88/10 (4th out of 203 students)

Honors in Electrical Engineering

Minor in Computer Science and Engineering

Mumbai, India
2020 - 2024 (Expected)

Scholastic Achievements

- Recipient of **Institute Academic Prize** for excellence in academic year (2021, 2023)
- Achieved **AP grade** for outstanding performance in Machine Learning and Biology courses (2021, 2023)
- Awarded **Urvish Medh Memorial Prize** and **Aditya Choubey Memorial Prize** for top performance (2021)
- Secured **All India Rank 78** in **JEE Advanced** out of 150 thousand candidates (2020)
- Achieved **All India Rank 115** in **JEE Main** out of 1 million candidates (2020)
- Awarded the **KVPY Fellowship** with an **All India Rank 677** by Govt. of India (2020)
- Among the top **331** students selected for **Indian National Astronomy Olympiad** (2019)

Publications

- H. K. P. Anilkumar, **A. Rajesh**, V. Narayanan, M. M. Prabhakaran and V. M. Prabhakaran, "Randomness Requirements for Three-Secret Sharing," *2023 IEEE International Symposium on Information Theory (ISIT)*, Taipei, Taiwan, 2023, pp. 252-257, doi: 10.1109/ISIT54713.2023.10206455

Research Experience

Byzantine-Resilient Gradient Coding

July 2023 - Present

Guides: Prof. Nikhil Karamchandani, Prof. Vinod Prabhakaran

Undergraduate Thesis

Gradient coding is a coding-theoretic framework to distribute the computation of a large gradient to multiple workers, some of which may be faulty. We study exact gradient coding in an adversarial setting

- Working on developing **low-replication** gradient coding protocols under byzantine errors given access to a gradient oracle for general data allocation, and analyzing bounds on their communication and computation requirements
- Proposed a scheme requiring **nearly half** the local computations than previously required under full communication
- Exploring the **trade-off** involved in required computation upon introducing communication constraints

Information-Theoretic Persuasion

May 2023 - Present

Guide: Prof. Michael Gastpar

École Polytechnique Fédérale de Lausanne

We are working on a project modeling persuasion using selective information revelation through the analysis of a rate-distortion setting on an indirect source observation

- Studying the actions of an agent attempting to persuade a worker to encode maximum information about the agent's objective by revealing **partial information** about the worker's objective
- Derived the optimal choice of linear **observation kernel** in the case of jointly Gaussian worker and agent objectives
- Working on quantifying the persuasion using **information inequalities** on the associated quantities and making remarks about the optimal choice of partial observation and encoding rate in the general case

Correlated Multi-Secret Sharing

Guide: Prof. Vinod Prabhakaran

May 2022 - February 2023

Tata Institute of Fundamental Research, Mumbai

- Worked on information-theoretic cryptography, specifically the analysis of 3-party **multi-secret sharing** schemes over all possible combinations of binary secrets
- Computed the optimal lower bound on **randomness complexity** of secret sharing in these scenarios and searched for secret sharing schemes with randomness requirements matching the calculated lower bounds
- Presented **combinatorial bounds** on randomness complexity in scenarios with loose information-theoretic bounds
- **Published** paper at International Symposium on Information Theory (ISIT) 2023

Technical Projects [↗](#)

Image Enhancement and Processing

Guide: Prof. Ajit Rajwade

August 2023 - November 2023

CS663: Digital Image Processing

- Implemented computationally efficient **mean shift**-based and PCA-based filtering techniques for image-denoising
- Designed a PCA-based face recognition system achieving peak recognition rate of **94.53%** on ORL database and **60%** on Yale database taking into account Lambertian reflectance model
- Implemented a **detail transfer** and denoising pipeline for digital photography using flash/no-flash image pairs

EEG Data Acquisition System

Guides: Prof. Siddharth Tallur, Prof. Laxmeesha Somappa

January 2023 - April 2023

EE344: Electronic Design Lab

- Created schematic design for an EEG data acquisition system based on an extensive analysis of devices used for **bio-potential measurements** and their constraints
- Implemented a **modular design** capable of acquiring and displaying 4-channel EEG data for analysis
- Designed a **4-layer PCB** complete with 24-channel data acquisition analog front-end, daisy-chained ADCs, power supply regulators, and peripheral interfacing with the on-board microcontroller
- Among groups awarded **Best Project Award** for performance in project demonstration and presentation

Autoencoders for Denoising and Colorization

Guide: Prof. Amit Sethi

January 2023 - April 2023

EE769: Introduction to Machine Learning

- Studied **CNN-based autoencoder** architectures for the application of correcting errors in digital images
- Designed a denoising autoencoder trained on **MNIST dataset** capable of reconstructing test images corrupted by Gaussian noise and burst erasures by compressing into a coded format
- Explored colorization capabilities and limitations of autoencoders on **CIFAR-10** and **Intel** image datasets

Learning in Constrained MDPs

Guide: Prof. Vivek Borkar

January 2023 - April 2023

EE736: Introduction to Stochastic Optimization

- Conducted a literature review on the development of optimal learning algorithms in a constrained MDP setting
- Presented an analysis of the performance of a **sub-linear** regret algorithm with cost constraints

Reinforcement Learning

Guide: Prof. Shivaram Kalyanakrishnan

August 2022 - November 2022

CS747: Foundations of Intelligent and Learning Agents

- Implemented **regret minimizing** algorithms such as UCB, KL-UCB, and Thompson Sampling in various multi-armed bandit instances and compared their performance with theoretical expectations
- Modelled a situation within the game of cricket as an MDP, and used various methods like **policy iteration** and evaluation to solve for an optimal policy
- Developed an autonomous obstacle-avoidance algorithm based on action-value **function approximation** methods

Introduction to Polar Codes

Guide: Prof. Nikhil Karamchandani

August 2022 - November 2022

EE605: Error Correcting Codes

- Conducted a literature review on polar codes, building on the knowledge of classical error control coding
- Gave a presentation covering **channel polarization**, and the use of polar codes as a modern coding technique

CISC and RISC Processor Design

Guide: Prof. Virendra Singh

January 2022 - May 2022

EE309: Microprocessors

- Developed an on-paper design of a microcoded CISC Processor using Hardware Flowchart Method
- Designed and implemented a 16-bit multicycle RISC Processor in VHDL with a **Turing-complete** instruction set architecture of 17 instructions
- Extended the design to a 6-stage **pipelined** architecture and tested both on an Altera MAX V CPLD
- Optimized performance of pipeline by introducing **hazard mitigation** techniques such as data forwarding

Key Positions Held

Teaching Assistant

Served as an undergraduate teaching assistant for a batch of **40+** students, with the responsibility of conducting weekly problem-solving sessions, academically mentoring students, and preparing and correcting examination solutions over the duration of the following courses:

Year	Course	Instructor
Autumn 2023	EE605: Error Correcting Codes	Prof. Nikhil Karamchandani
Spring 2022	MA106: Linear Algebra	Prof. S. Sivaramakrishnan
Autumn 2021	MA109: Calculus-I	Prof. Sourav Pal

Department Academic Mentor

Department of Electrical Engineering, IIT Bombay

June 2022 - May 2023

- Selected from among **100+ applicants** on the basis of interviews and extensive peer reviews
- Tasked with mentoring **8** sophomores in the department in managing their academic workload and extracurriculars
- Involved in the development of a new department mentor program **website** for student support resources

Technical Skills

Languages	C++, Python, VHDL, Assembly, SQL
Software	Eagle, GNU Radio, Quartus, Keil μ Vision, MATLAB, Ngspice, \LaTeX

Relevant Coursework

Communication Theory and Systems	Information and Coding Theory, Error Correcting Codes, Communication Networks, An Introduction to Number Theory and Cryptography, Digital Image Processing, Signal Processing
Probability and Statistics	Introduction to Stochastic Optimization, Estimation and Identification, Foundations of Intelligent and Learning Agents, Markov Chains and Queueing Systems, Probability and Random Processes
Computer Science	Discrete Structures, Design and Analysis of Algorithms, Data Structures and Algorithms, Logic for Computer Science, Computer Programming and Utilization
Mathematics	Calculus, Linear Algebra, Differential Equations, Complex Analysis
Miscellaneous	Introduction to Machine Learning, Control Systems, Electromagnetic Waves

Extracurriculars

- Completed one year of **Chess** training under **National Sports Organisation, IIT Bombay** (2020-21)
- Stood **first** in **Bazinga Physics** organized by Math and Physics Club, IIT Bombay (2021)
- Achieved **second place** in **Astromania** organized by Kritika - The Astronomy Club, IIT Bombay (2021)