

# Aayush Rajesh

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## Research Interests

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

## Education

### Stanford University

*PhD in Electrical Engineering*

Stanford, CA  
2024 - Present

### Indian Institute of Technology Bombay

*Bachelor of Technology (with Honours) in Electrical Engineering*  
*Minor in Computer Science and Engineering*  
*CPI: 9.90/10*

Mumbai, India  
2020 - 2024

## Scholastic Achievements

- Recipient of 3-year **Stanford Graduate Fellowship** (SGF) (2024)
- Conferred **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)

## Publications

- M. Gastpar and **A. Rajesh**, "The Persuasion Bottleneck," *2024 IEEE International Symposium on Information Theory (ISIT)*, Athens, Greece, 2024, pp. 2472-2477, doi: 10.1109/ISIT57864.2024.10619395
- 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 - August 2024

*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

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

### Information-Theoretic Persuasion

May 2023 - February 2024

*Guide: Prof. Michael Gastpar*

*École Polytechnique Fédérale de Lausanne*

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

- Studied 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

- Worked 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

## 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

### 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

### 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

### CISC and RISC Processor Design

January 2022 - May 2022

Guide: Prof. Virendra Singh

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

June 2022 - May 2023

Department of Electrical Engineering, IIT Bombay

- 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

<b>Languages</b>	C++, Python, VHDL, Assembly, SQL
<b>Software</b>	Eagle, GNU Radio, Quartus, Keil $\mu$ Vision, MATLAB, Ngspice, $\LaTeX$

## Relevant Coursework

<b>Communication Theory and Systems</b>	Information and Coding Theory, Error Correcting Codes, Communication Networks, An Introduction to Number Theory and Cryptography, Cryptocurrency and Blockchain Technologies, Digital Image Processing, Signal Processing
<b>Probability and Statistics</b>	Advanced Probability and Random Processes, Estimation and Identification, Advanced Concentration Inequalities, Introduction to Stochastic Optimization, Foundations of Intelligent and Learning Agents, Markov Chains and Queueing Systems
<b>Computer Science</b>	Discrete Structures, Design and Analysis of Algorithms, Data Structures and Algorithms, Logic for Computer Science, Computer Programming and Utilization
<b>Mathematics</b>	Calculus, Linear Algebra, Differential Equations, Complex Analysis
<b>Miscellaneous</b>	Optimization, 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)