Aayush Rajesh

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Research Interests

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

Education

Indian Institute of Technology Bombay   Mumbai, India
Bachelor of Technology in Electrical Engineering   *2020 - present*
CPI: 9.81/10 (4th out of 101 students)
Minor in Computer Science and Engineering

Scholastic Achievements

- Recipient of **Institute Academic Prize** (top **20** out of **1356** students) for academic excellence (*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*)
- Awarded **Certificate of Merit** by Central Board of Secondary Education, Government of India for being among top 0.1 percent of candidates in **Computer Science** and **Chemistry** (*2020*)
- Among the top **331** students selected for **Indian National Astronomy Olympiad** (*2019*)

Research Experience ⧉

Information-Theoretic Cryptography   *May 2022 - Present*
Guide: Prof. Vinod Prabhakaran   *Tata Institute of Fundamental Research, Mumbai*

- Working on information-theoretic cryptography, specifically the analysis of 3-party **multi-secret sharing** schemes over binary functions
- Computed the optimal lower bound on **randomness complexity** of secret sharing for candidate functions
- Searched for secret sharing schemes, under the constraints of **privacy** and **correctness**, with upper bounds on randomness complexity matching the calculated lower bounds
- Analysing the relation between **combinatorial lower bounds** and information-theoretic bounds on complexities, as well as applications of these to modified settings of the original problem

Technical Projects ⧉

Reinforcement Learning   *August 2022 - November 2022*
Guide: Prof. Shivaram Kalyanakrishnan   *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 a **Markov Decision Process**, complete with states, transition probabilities and associated rewards
- Used various methods like **policy iteration** and **evaluation** to solve for an optimal policy given an MDP
- Developed an algorithm based on action-value **function approximation** methods to operate an autonomous vehicle out of a given region with obstacles

Introduction to Polar Codes *August 2022 - November 2022*
Guide: Prof. Nikhil Karamchandani *EE605: Error Correcting Codes*

○ Conducted an extensive **literature review** on the construction and use of polar codes, building on the knowledge of classical error control coding

○ Presented a concise talk covering major aspects of **channel polarization**, **encoding** and **decoding** of polar codes as a modern coding technique

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**

Microprocessor Implementations *January 2022 - May 2022*
Guide: Prof. Saravanan Vijayakumaran *EE337: Microprocessors Lab*

○ Implemented a **reaction timer** capable of displaying the time it takes for the user to respond to a stimulus

○ Interfaced LM35 sensor with the microcontroller using an ADC, through **serial peripheral interfacing** to monitor and display real-time ambient temperature

○ Developed a subroutine capable of generating voltage waveforms corresponding to **music note frequencies**, which can play music when connected to an **audio driver circuit**

○ Simulated a **two-party ATM** capable of taking action inputs from a keyboard using **UART**

Digital Circuit Design *July 2021 - November 2021*
Guide: Prof. Maryam Shojaei Baghini *EE214: Digital Circuits Lab*

○ Simulated basic combinational circuits using both structural and behavioral descriptions, such as **Multiplier**, **Adder-Subtractor**, and an **Arithmetic Logic Unit** on Quartus software using VHDL

○ Created a logical representation of an **ATM Machine**, capable of specifying number of smaller denomination currencies in order to comprise an amount given as input through a CPLD Board

○ Built upon the concept of **finite state machines** to design a sequential **String Detector** capable of recognizing and displaying a specific string on an LCD

Other Projects ↗

Lasso Game *January 2021 - March 2021*
Guide: Prof. Bhaskaran Raman *CS101: Computer Programming and Utilization*

○ Used **C++** to program a Lasso game, involving catching projected objects using a lasso controlled by the computer keys, complete with a scoring system, life count, and three different **levels**, last level being **timed**

○ Implemented randomly projected objects using **classes**, each with different game properties and effects, such as affecting the total score, life count, or altering the speed of the thrown lasso

T.O.H.F.A. *May 2019 - September 2019*
Self Project

○ Developed an easy-to-use Python-based assistant, capable of **speech recognition**, with the purpose of helping teachers in attendance and grading duties

○ Allowed for multiple users to securely access and store data, making use of **Python-SQL interfacing**

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, and academically mentoring students over the duration of the following courses:

- ○ MA109: Calculus-I *Autumn 2021*
- ○ MA106: Linear Algebra *Spring 2022*

Department Academic Mentor *June 2022 - Present*
Department of Electrical Engineering, IIT Bombay

- ○ Selected from among **100+ applicants** on the basis of interviews and extensive peer reviews
- ○ Mentoring **8** sophomores in the department in managing their academics and extracurriculars

Technical Skills

Languages	C++, Python, VHDL, Assembly, MySQL
Software	GNU Radio, Quartus, Keil μVision, MATLAB, Ngspice, LaTeX

Courses Undertaken

Electrical Engineering	Error Correcting Codes, Communication Systems, EM Waves, Markov Chains and Queuing Systems, Electronic Devices and Circuits, Control Systems, Power Engineering, Microprocessors, Probability and Random Processes, Digital Systems, Signal Processing, Analog Circuits
Computer Science	Foundations of Intelligent and Learning Agents, 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	Quantum Physics and Application, Basics of Electricity and Magnetism, Biology

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 Krittika - The Astronomy Club, IIT Bombay *(2021)*