

# Krishna Narasimhan Agaram

Third year undergraduate, Computer Science, IIT Bombay

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## Education

### Indian Institute of Technology Bombay

B.TECH. WITH HONORS IN COMPUTER SCIENCE AND ENGINEERING

2021 - 2025 (expected)  
(GPA: 9.80/10)

## Research Interests

- **Experienced.** Algorithms and Combinatorics, Reinforcement Learning, Cryptography, Theory of Computation
- **Interested.** Theoretical Machine Learning, Networked and Operating Systems, Algorithmic Game Theory

## Research Experience

### On Quantum State Preparation using Deep RL

*Summer Internship, Aalto University, Finland*

GUIDE: PROF. VIKAS GARG, DEPT. OF COMPUTER SCIENCE, AALTO UNIVERSITY

(May 2023 - Present)

- Set up a RL framework for high-fidelity quantum **state preparation** for use in various NISQ-era applications such as in **classical-to-quantum** data encoders for Quantum Machine Learning algorithms, to speed up factoring, etc
- Tested **home-made** implementations of deep RL algorithms from **DQN** to **PPO** and **TD3** to solve the environment
- Implemented a novel **single-shot** training regimen after which the agent can efficiently prepare any target state

## Scholastic Achievements

- Department rank **7** in a class of 194 students in the Computer Science department (2023)
- Placed **1st** (India) and **8th** (East Division) in the pairs category, **Simon Marais Mathematics Competition** (2022)
- Conferred with the **AP** (Advanced Performer) grade for exceptional performance in
  - CS228 (Logic in Computer Science), awarded to 2 out of 196 students (Spring 2023)
  - CS207 (Discrete Structures), awarded to 3 out of 195 students (Fall 2022)
  - CS215 (Data Analysis and Interpretation), awarded to 3 out of 197 students (Fall 2022)
  - MA108 (Differential Equations), awarded to 7 out of 1372 students (Spring 2022)
  - PH107 (Quantum Physics & Application), awarded to 12 out of 1364 students (Fall 2021)
  - CH107 (Physical Chemistry), awarded to 21 out of 1387 students (Fall 2021)
- Secured **All India Rank 40** in JEE Advanced among 140,000 aspirants (2021)
- Secured **All India Rank 122** in JEE Main among more than 1,000,000 aspirants (2021)
- Among the **top 35** selected for the Indian **International Mathematics Olympiad** training camp (2020, 2021)
- Secured **Global Rank 1** in the **Southeast Asian Mathematical Olympiad 2020** (2020)
- Among the **top 47** eligible for the **International Olympiad on Astronomy and Astrophysics** OCSC (2020)
- Stood **1st** in India at the **Technothon 2019 Mains** conducted by IIT Guwahati (2019)

## Scholarships and Recognition

- Received **Institute Academic Prize** given to the top 20 out of 1300+ students for stellar academic record (2022)
- Awarded the *Kishore Vaigyanik Protsahan Yojana* **KVPY** scholarship for **All India Rank 23** (2020)
- Awarded the *National Talent Search Examination* **NTSE** scholarship, ranked **2nd** in Stage 1 (2019)

## Key Projects

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### Railway Management System

GUIDE: PROF. SUPRATIK CHAKRABORTY

Course Project: Data Structures Lab

(Aug 2022 - Nov. 2022)

- Implemented a railway journey planning system in C++ allowing clients to find all journeys between stations and curated (by keywords or rating) journey reviews, all with the ease of **autocomplete** of station names
- Data structures implemented for use include lists, hash tables, **self-balancing** trees, heaps, **tries** and graphs
- Modified the breadth-first search algorithm to find **all** routes between two stations and return a **timetable of journeys** while also allowing for **filtering** based on waiting time between trains and layovers in between

### FastChat [↗](#)

GUIDE: PROF. KAVI ARYA

Course Project: Software Systems Lab

(Oct. 2022 - Dec. 2022)

- Built chat service with a **distributed** server-client architecture, **end-to-end** encryption and dedicated **load-balancer**
- Users can choose to chat **privately** or in a **group**, and apart from text, one can also send arbitrarily large **files**
- Encoded messages using standard **message protocol** and a message buffer ensures messages are not lost

### An Introduction to Quantum Computation and QML [↗](#)

SEASONS OF CODE, 2022

Web and Coding Club, IIT Bombay

(Apr. 2022 - Jul. 2022)

- Analysed **quantum algorithms** such as Quantum Teleportation, Phase Estimation, **Shor's Algorithm** and Search with home-made implementations in IBM Qiskit following a study of Linear Algebra and Quantum Circuits
- Built a SAT solver with time complexity  $\mathcal{O}(2^{n/2})$  using **Grover's Algorithm** for unstructured search
- Examined and implemented a paper on finding the ground-state **molecular geometry** of simple molecules using the **Jordan-Wigner** transform for encodings and a **variational quantum circuit** for the optimization, in **PennyLane**

## Reading Projects

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### Probabilistic Method

(Sep. 2023 - Present)

- Studying the fundamentals of the **probabilistic method** in combinatorics with emphasis on extremal graph theory from *The Probabilistic Method* by Alon & Spencer

### Group Theory [↗](#)

(Jun. 2023-Jul. 2023)

- Learned group theory with emphasis on combinatorial application, covering topics from the isomorphism & **Sylow theorems** to Burnside's lemma and the **Pólya enumeration theorem**, from *Abstract Algebra* by Dummit & Foote

### Linear Cryptanalysis

(Mar. 2023-Apr. 2023)

- Explored introductory Linear Cryptanalysis of the DES cipher following the paper by Matsui (1994), running tests to verify and exploit the **S-box weakness**; also gave a presentation on the same that can be found here

### Analytic Combinatorics

(Nov. 2022 - Dec. 2022)

- Examined **symbolic specifications** for various combinatorial structures & applied them to **enumeration** problems and finding **asymptotic** properties of random structures, from *Analytic Combinatorics* by Flajolet & Sedgewick

### Complex Analysis

(Oct. 2021 - Nov. 2021)

- Studied the Cauchy-Riemann equations, **Cauchy Integral theorem** and formula, Fundamental Theorem of Algebra, Laurent Series and **Residues** from *A first course in Undergraduate Complex Analysis* by Richard Spindler

## Other Projects

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### Replacement Policies for Graph Algorithms [↗](#)

GUIDE: PROF. BISWABANDAN PANDA

Course Project: Computer Architecture

(Mar. 2023 - Apr. 2023)

- Tinkered with various LLC **replacement policies** for graph algorithm workloads and compared the numbers to those of the theoretically optimal **Belady** policy, using the ChampSim microarchitecture simulator

## Linear Algebra Library

INSPIRED BY MA106, LINEAR ALGEBRA

Self Project

(Apr. 2022 - Jul. 2022)

- C++ library for linear algebra supporting row operations, reduction to reduced row **echelon** form, **Gram Schmidt** & QR decompositions, a **system-of-equations** solver (and for square matrices, **determinant** and **inverse** as well)

## Service

### Department Academic Mentor

(Jun. 2023 - Present)

- Guiding six sophomores of the department in navigating **coursework**, research and other opportunities as well as personal development during their second academic year

### Teaching Assistantships

- **MA106 (Linear Algebra)**: Conducted **weekly** live tutorials and a help-session for **40+** freshmen (Spring 2023)
- **CS213 (Data Structures)**: Holding bi-weekly problem-solving sessions for 25+ sophomores and helping with creating autograded programming labs and exam grading (Fall 2023)

### Combinatorics-in-a-nutshell

GUIDE: PROF. REKHA SANTHANAM, IIT BOMBAY

(Jul. 2023 - Present)

- Writing a **book** in the spirit of an adventure novel meant to serve as a primer for **enumerative combinatorics** for students in early high school; covers permutations, inclusion-exclusion, the twelve-fold way, generating functions

### Technical Mentorships

- **Summer of Science**: Guided **four** students in a self-study of modern cryptography (May. 2023 - Jul. 2023)
- **Season of Code**: Co-mentored **eight** students studying the basics of Quantum Computing culminating in a review of a Quantum Cryptography or Quantum Machine Learning algorithm (May. 2023 - Jul. 2023)

## Relevant Coursework

Computer Science	Theory	Discrete Structures, Data Structures & Algorithms, Analysis of Algorithms, Logic for Computer Science, Automata Theory*, Spectral Graph Theory*
	Systems	Software Systems Lab, Computer Architecture, Computer Networks, Operating Systems*, Programming Languages and Compilers**, Databases**
	Other	Computer Programming and Utilization, Paradigms in Programming, Data Analysis and Interpretation, Artificial Intelligence and Machine Learning*
Mathematics	Calculus, Linear Algebra, Differential Equations, Mathematical Structures for control, Modern Cryptography, Quantum Information, Extremal Graph Theory*, Numerical Analysis**	
Others	Engineering Drawing, Quantum Physics, Basics of Electricity and Magnetism, Introduction to Electronics, Physical Chemistry, Organic and Inorganic Chemistry, Biology	

\*To be completed by November 2023 \*\*To be completed by April 2024

## Technical Skills

Languages	C/C++, Python, Bash, $\LaTeX$ , x86 Assembly, Haskell, MATLAB, Java
Development	HTML5, CSS, Git, JavaScript, SQLite3, PostgreSQL, Sphinx, Wireshark
Libraries	IBM Qiskit, PennyLane, Manim, NumPy, Pandas, PyTorch, TensorFlow, Matplotlib

## Extracurriculars

- Completed the Trinity College London **Piano** Grade 6 examination (2018)
- Delivered four **lectures** on **Projective Geometry**, Barycentric Coordinates, Generating Functions & **Symbolic Combinatorics** to high-school students as part of the staff at the **Online Math Club** (Nov. 2021 - Dec. 2022)
- Worked with **Vizura** in developing short animated videos to **motivate concepts** in school-level Mathematics for use in **schools**, using the Python library **Manim** (Oct. 2022 - Dec. 2022)
- Actively participated in the **Monsoon Math Camp** taught by students from top colleges like **MIT**, **Berkeley** and **IISc**; studied topics such as Knot theory, Analytical Number Theory & Automated theorem proving (Jul. 2020, 2021)