Krishna Narasimhan **Agaram**

Incoming Computer Science grad student at the
University of Illinois, Urbana-Champaign

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Education

Indian Institute of Technology Bombay (Nov. 2021 - May. 2025)
B.Tech. with Honors in Computer Science and Engineering (GPA: 9.88/10.0, ranked 2/194)
Minor in Mathematics

Research Interests

Machine Learning Theory, Quantum Information, Complexity Theory,
Reinforcement Learning and Underactuated Robotics

Research Experience

Quantum Positional Proof Systems
Guide: Prof. **Nick Spooner**, Dept. of Computer Science, Cornell University

Summer@EPFL, EPFL, Switzerland
(Jun. 2024 - Present)

- Formalized the notion of multi-prover positional **interactive proof** systems in the classical and quantum regimes
- Proved a **phase-transition** phenomenon in the expressivity of classical systems as a function of party locations; currently using tools from **quantum cryptography** to force larger expressivity in the quantum setting

Efficient Stabilizer State Preparation
Guide: Prof. **Vikas Garg**, Dept. of Computer Science, Aalto University

AScI research program, Aalto, Finland
(May 2023 - Nov. 2024)

- Designed a problem-inspired and theoretically sound novel **reward function** to train sample-efficient agents, needing under **5 hours** of training before being able to prepare arbitrary stabilizer states of up to 9 qubits **on the fly**
- Proved via **concentration** that each agent generalizes to at least 4×10^{16} unseen states after being trained on only 2.3×10^7 states, corresponding to preparing at least 95% of all states after seeing only 10^{-8}% during training
- Paper presented orally at the APS Global Physics Summit 2025 and under review at NeurIPS 2025

Lower bounds on testing 3-colorability
Guide: Prof. **Akash Kumar**, Dept. of Computer Science, IIT Bombay

CS Honors Project, IIT Bombay
(Jan. 2024 - Apr. 2024)

- Established a **linear** lower-bound for 1-sided testing of 3-colorability on $(1/3 - \alpha)$-far vs 3-colorable **expander** graphs
- Studied various **lower-bound techniques** to prove a 2-sided lower bound for 3-colorable vs $(1/3 - \varepsilon)$-far graphs

Key Projects

Optimizing compiler for subset of Java
Guide: Prof. **Manas Thakur**

Course Project: Advanced Compilers
(Jan. 2025 - Apr. 2025)

- Wrote a `javacc`-based compiler for a Java-like language with **liveness analysis**, class-hierarchy analysis, variable renaming and **alias analysis** supported over an **control-flow graph** over a TAC intermediate representation
- Implemented optimizations such as **constant folding**, Chaitin-Briggs and linear-scan register allocation (LSRA) and compile-time **de-virtualization** of polymorphic calls using the above analyses and iterative data flow algorithms

Compiler for C-like language
Guide: Prof. **Uday Khedker**

Course Project: Compilers Lab
(Jan. 2024 - Apr. 2024)

- Built a **compiler** for a subset of C with parsing, syntactic-semantic analysis and code generation phases; handles expressions, control structures, loops, **nested scoping** and shadowing, **functions** and **arrays** of any dimension
- Wrote a **random program generator** for the code grammar to serve as **testbed** for compiler correctness and speed; beat the course baseline in speed by over **4x** on a large testbed, compiling **80,000**+ lines in under **10** seconds
- Proposed extensions to the code to support type inference, pre-processing, **pointers** and classes & **methods** ↗

Image and Video Style Transfer ↗
Guide: Prof. **Preethi Jyothi**

Course Project: Machine Learning
(Aug. 2023 - Nov. 2023)

- Reproduced convolution-based **style transfer** for images and **videos**, following Gatys et al and Ruder et al
- Enforced temporal coherence of output videos using **optical flow**, preserving style of moving objects across frames

FastChat: mini WhatsApp ↗
Guide: Prof. **Kavi Arya**

Course Project: Software Systems Lab
(Oct. 2022 - Dec. 2022)

- Built **chat service** with a distributed server architecture, **end-to-end** encryption and a dedicated **load-balancer**; users can choose to chat privately or in an admin-moderated **group** and can also send **arbitrarily large** files reliably
- Used a standard **message protocol** packet around messages; a message buffer ensures messages are **not lost**

Quantum Computing and Quantum for ML ⧉
SEASONS OF CODE, 2022

- Analysed **quantum algorithms** such as Quantum Teleportation, Phase Estimation, **Shor's Algorithm** and Search with **scratch** implementations in IBM Qiskit following a study of Linear Algebra, Quantum Mechanics and Circuits
- Built a SAT solver with optimal gate complexity $\mathcal{O}(2^{n/2})$ using **Grover**'s Algorithm for unstructured search
- 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, with **PennyLane**

Other Course Projects

Mobile Robot Localization & Navigation
GUIDE: PROF. LEENA VACHHANI

Course Project: Embedded Control & Robotics
(Oct. 2024 - Nov. 2024)

- Implemented a **ROS** package to move a mobile robot along a desired trajectory, using **Vicon** motion capture data
- Estimated robot's live location by **trilateration**, correcting sensor noise via a **Kalman filter** for accurate positioning

Verification of Neural Network Robustness ⧉
GUIDE: PROF. SUPRATIK CHAKRABORTY

Course Project: Formal methods in ML
(Oct. 2024 - Nov. 2024)

- Built a Linear Relaxation-based Perturbation Analysis verifier with the AutoLiRPA framework to **verify robustness** of an image recognition model to **spatially local** ℓ_p perturbations applied to an arbitrary region of the image

Replacement Policies for Graph Algorithms ⧉
GUIDE: PROF. BISWABANDAN PANDA

Course Project: Computer Architecture
(Mar. 2023 - Apr. 2023)

- Analysed various LLC **replacement policies** for graph algorithm workloads and compared the LLC miss rate with that of the optimal Belady policy, using the ChampSim simulator and a scratch cache and Belady implementation

Linear Cryptanalysis of the DES Cipher ⧉
GUIDE: PROF. MANOJ PRABHAKARAN

Course Project: Cryptography and Network Security
(Mar. 2023 - Apr. 2023)

- Explored linear cryptanalysis of DES, following Matsui 1994; wrote tests to verify the **S-box weakness** in DES and presented a **key recovery** attack for reduced-round DES using graph shortest paths & single-round weaknesses

Railway Management System
GUIDE: PROF. SUPRATIK CHAKRABORTY

Course Project: Data Structures Lab
(Aug. 2022 - Nov. 2022)

- Architected a tiny "Google Maps" for a railway network in C++, allowing clients to find **all journeys** between two stops (filtered by layovers/wait time) with dropdown **suggestions** & reviews; all data structures written from scratch

Reading Projects

- ▷ **Probabilistic Proof Systems**: Examined the complexity-theoretic foundations of probabilistic proof systems, covering interactive proofs, Succinct ARGuments, PCPs and IOPs, from Proofs, Arguments, and Zero-Knowledge
- ▷ **Fast single-node PageRank**: Explored fast algorithms for single-node PageRank; wrote a unifying survey bringing out similarities between different existing algorithms; also implemented this very fast, essentially optimal algorithm
- ▷ **Analytic Combinatorics**: Studied the symbolic method arising from Pólya's enumeration theorem for combinatorial structures; applied it extensively to enumeration problems, exact and asymptotic, from Analytic Combinatorics

Misc Dev Projects

- ▷ **Scene2Screen** ⧉: Implemented a **multi-threaded ray-tracer** in C++ supporting reflection, refraction & absorption through Lambertian surfaces, **metals** and dielectrics like **glass**, scene lighting, camera positioning & **depth-of-field**
- ▷ **LinAlg** ⧉: Built a C++ linear algebra library supporting vector operations, matrix manipulation, reduction to **echelon** form, Gram Schmidt & **QR** decompositions, determinant and **inverse** methods, and a **system-of-equations** solver
- ▷ **Minute-learn** ⧉: Authored a python toolkit **implementing** portions of the **scikit-learn** & **PyTorch API**s; includes API support for regression, clustering, decision trees, PCA, computational graph backprop and neural networks
- ▷ **AutoLib** ⧉: Wrote a toolkit to work with finite **automata**, supporting unions, joins, transformations from ε-NFAs to DFAs, DFA **minimization**; also supports context-free grammars (CFG) and the **CYK** algorithm for CFG membership

Scholastic Achievements

- Department **rank 2** in a class of 194 students in the Computer Science department at IIT Bombay (2023-2025)
- Invited to and participated in the Cornell-Maryland-Max Planck Pre-doctoral Research School (CMMRS) (2024)
- Placed in the **top 10** ($\times 3$) of the East Division at the **Simon Marais Mathematics Competition** (2022, 2023, 2024)
- Among the **top 35** students invited to the **International Mathematics Olympiad Training Camp** (2020, 2021)
- Placed **40th** across India in the **JEE Advanced** exam among 140K+ aspirants (2021)
- Secured **Global Rank 1** in the Southeast Asian Mathematical Olympiad (SEAMO) 2020 (2020)
- Conferred with the **AP** (Advanced Performer) grade for exceptional performance in **Compilers** Lab, **Logic** in CS, **Discrete** Structures, **Data** Analysis, **Quantum** Physics, **Physical** Chemistry and **Differential** Equations (2021-2024)

Scholarships and Recognition

- Received the **Institute Academic Prize** given to the **top 1%** of students for stellar academic record (2022, 2024)
- Conferred with the *Kishore Vaigyanik Protsahan Yojana* (**KVPY**) scholarship with All India Rank **23** (2020)
- Granted the *National Talent Search Examination* (**NTSE**) scholarship, ranking **2nd** in Stage 1 (2019)

Teaching and Mentorships

Teaching Assistantships

- **MA 106, Linear Algebra**: Conducted **weekly** tutorial sessions for **40+** freshmen (Spring 2023, Spring 2024)
- **CS 213, Data Structures**: Held bi-weekly problem-solving sessions for 25+ sophomores and helped with creating programming lab assignments, setting and grading term papers and an end-term project (Fall 2023)
- **CS 215, Data Analysis**: Responsible for setting and grading quizzes and exams for a class of **200** (Fall 2024)
- **CS 785, Theoretical CS Toolkit** (Graduate): Took bi-weekly problem solving sessions; set and graded problem sheets and exams. (Spring 2025)

Technical Mentorships

- **Season of Code**. Co-mentored **eight** students studying **Quantum Computing** principles (May. 2023 - Jul. 2023)
- **Summer of Science**. Guided **four** students in a self-study of modern **cryptography** (May. 2023 - Jul. 2023)
- **Summer of Science**. Mentored **six** students in a self-study of probability and **statistics** (May. 2024 - Jul. 2024)
- **Summer of Science**. Co-mentored **nine** students in a self-study of **compiler development** (May. 2025 - Jul. 2025)

High School Tutoring

- Taught Physics & Chemistry **one-on-one** as part of the **National Service Scheme** (NSS) (Jun. 2024 - Aug. 2024)
- Worked with the **Vizuara** team in developing short animated videos **motivating math concepts** in early high-school Mathematics for use in schools, using the Python animation library **Manim** (Oct. 2022 - Dec. 2022)
- Delivered **lectures** covering topics in Symbolic Combinatorics, Barycentric Coordinates, Generating Functions and Projective Geometry to interested high-school students as part of the **Online Math Club** (Nov. 2021 - Dec. 2022)

Selected Coursework

Computer Science	CS/ML Theory	Discrete Structures, Data Structures, Algorithm Analysis, Logic, Automata Theory, Statistical Learning, Math of Deep Learning, Theoretical ML, Formal Methods in ML, Randomized & Approximation Algorithms, Probabilistic Proofs, Cryptography
	Systems	Software Systems Lab, Computer Architecture, Computer Networks, Operating Systems, Compilers, Databases, Embedded Robotics, Advanced Compilers
Mathematics		Real, Complex, Fourier Analysis, Abstract Algebra, Extremal & Spectral Graph Theory

Technical Skills

Languages	C/C++, Python, LaTeX > Java, x86 Assembly, Bash, JavaScript > Haskell, Rust, Prolog, MATLAB
Frameworks	Git, PyTorch, TensorFlow, ROS, Gazebo, Postgres, Wireshark, Champsim, Doxygen, Sphinx
Libraries	NumPy, Matplotlib, Pandas, scikit-learn, SciPy, Sympy, OpenAI Gym, IBM Qiskit, Stim, Manim