

Omar Muhammad

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EDUCATION

B-Tech in Mathematics and Computing | 2023 – 2027 | Indian Institute of Science, Bengaluru | CGPA: 9.5/10.0

Grade 12 (CBSE) | 2022 – 2023 | Saraswathi Vidyanikethan, Ernakulam | 98.4% (School Top)

Grade 10 (CBSE) | 2020 – 2021 | Rajagiri Public School, Ernakulam | 98%

PUBLICATIONS

Verification Modulo Tested Library Contracts

Abhishek Uppar, Omar Muhammad, Sumanth Prabhu S, Deepak D'Souza, P.Madhusudan, Adithya Murali.

Accepted to ACM SIGPLAN Conference on Programming Language Design and Implementation (PLDI 2026) and appeared in PACMPL. [\[Paper\]](#) [\[Code\]](#)

Have a thing? Reasoning around recursion with dynamic typing in grounded arithmetic

Bryan Ford, Elliot Bobrow, Stefan Milenković, Omar Muhammad, Dimitrios Alexopoulos, Yusuf Demir, Ananthajit Srikant

Under review at the ACM SIGPLAN Conference on Principles of Programming Languages. [\[Paper\]](#)

Mask2Cause: Causal Discovery via Adjacency Constrained Causal Attention

Omar Muhammad, Pasupuleti Dhruv Shivkant, Deepak N. Subramani

Under review at the conference on Neural Information Processing Systems (NeurIPS 2026). [\[Paper\]](#) [\[Code\]](#)

RESEARCH EXPERIENCE

Summer Research Fellow, Grounded Deduction | EPFL, Switzerland (Onsite for May – July 2026; Remote after) | May 2026 – Present

Adviser: Prof. Bryan Ford, DEDIS Lab

- Developing Grounded Arithmetic, a non-classical logic that admits arbitrary recursive definitions without prior termination proofs, and mechanising its metatheory in Isabelle.
- Proved truth preservation and primitive recursiveness for the inference rules of Basic Grounded Arithmetic (BGA). Contributed to the design of Propositional Grounded Arithmetic (PGA).
- Built a quantified extension of Grounded Arithmetic as a usable object logic in Isabelle/Pure, and established the consistency of BGA within it.
- Designing automated proof-search tactics for the Isabelle/Pure development, which inherits none of the automation built for classical and intuitionistic logics.

Student Researcher, Verification Modulo Tested Library Contracts | IISc | May 2025 – Apr 2026

Advisers: Prof. D. D'Souza (IISc), Prof. P.Madhusudan (UIUC), Prof. A. Murali (UW-Madison)

- Co-developed VMTLC, a hybrid framework that verifies client programs by synthesizing library specifications that are formally proven against the client but validated via testing against the library.
- Designed the Learner component within a Teacher-Learner CEGIS loop, developing two distinct LLM-integrated architectures (a pure LLM learner and an LLM-seeded ICE learner) to leverage semantic intuition, synthesizing valid contracts where traditional enumerative baselines could not.
- Designed and built the core LLM pipeline responsible for generating contracts from logical rules and integrated it into a feedback loop with formal verifiers and testing engines to ensure correctness.

Research Intern, Enhancing Formal Verification with LLMs | University of Virginia, USA (Remote) | Aug 2025 – Oct 2025

Adviser: Prof. Wenxi Wang, The University of Virginia

- Developed ACPRO, a framework that uses a multi-agent LLM pipeline to transform low-level Z3 proofs into interpretable, high-level Verus verification steps.
- This work also produced the VSVerus dataset, a new resource for studying fine-grained LLM reasoning in formal verification.

Summer Research Fellow, Formalization of Group Theoretic Algorithms | Krea University, India (Onsite) | May 2025 – July 2025

Advisers: Prof. Rishi Vyas (KREA), Prof. T.V.H Prathamesh (KREA)

- Formalized proofs for decision problems in geometric group theory (including the word, conjugacy, and subgroup membership problems) using the Lean 4 proof assistant.
- Key contributions include formalizing two definitions of the Dehn function and proving their equivalence and verifying the algorithm for the conjugacy problem in free groups.
- Current work focuses on the computability of the Dehn function for hyperbolic groups.

Student Researcher, Game Theory and Automata | Jan 2026 – Present | IISc

- Investigating supergames played by finite automata under finite costs for complexity to analyze the sequential collapse of equilibrium states.
- Deriving critical phase change thresholds that characterize these equilibrium dynamics.

Student Researcher, Causal Discovery in Time Series | IISc | Aug 2025 – Present

Adviser: Prof. Deepak N. Subramani, Computational and Data Sciences, IISc

- Proposed and developed Mask2Cause, an end-to-end Transformer that recovers the causal graph during the forecasting forward pass via a learnable sparse adjacency injected as a log-barrier into masked attention over inverted variable embeddings.
- Formulated causal discovery under volatility spillover, where one variable governs the conditional variance rather than the mean of another. Motivated the heteroscedastic objective through the theory of directed information graphs and showed neural Granger causality to be its additive-noise special case.
- Built Mixed Physics, the first benchmark separating mean-parents from variance-parents, and the first model to recover variance-mediated edges explicitly. Attained state-of-the-art accuracy at reduced parameter count.

TEACHING

Teaching Assistant, Program Analysis and Verification | IISc | Aug 2026 – Present

Instructors: Prof. Deepak D'Souza, Prof. K. V. Raghavan

- Designed the course project and mentored student teams through it. Graded assignments, conducted vivas, and held regular office hours for doubt clearing.

PROJECTS

Independent Study, Logic and Automated Theorem Proving | IISc | Aug 2026 – Present

Adviser: Prof. Deepak D'Souza

- Studying structural proof theory (sequent calculi, cut-elimination and the properties a calculus needs for proof search to be feasible), provability and self-reference (Gödel's incompleteness theorems, the derivability conditions, Löb's and Tarski's theorems), decidable fragments of logic, and automated reasoning (unification, resolution, superposition, tableaux and decision procedures for decidable theories).

Reading Project, Threshold for Random k-SAT | Jan 2026 – April 2026

- Explored the satisfiability threshold for random k-SAT as part of the "Techniques in Discrete Probability" course under the guidance of Prof. Riddhipratim Basu, IISc.
- Analyzed the foundational work by Dimitris Achlioptas and Yuval Peres, on the application of weighted moment methods to bound the threshold. [\[Report\]](#) [\[Presentation\]](#)

Reading Project, PCP Theorem | Aug 2025 – Nov 2025

- Conducted an in-depth study of the PCP theorem, analyzing its formulations in terms of both probabilistically checkable verifiers and the hardness of approximation under the guidance of Prof. Anand Louis, Department of Computer Science and Automation, IISc .
- Analyzed Irit Dinur's proof of the theorem using gap amplification. [\[Report\]](#)

Formalization Project, Rubik's Cube Solvability Conditions | Feb 2025 – May 2025

- Modeled the nxn Rubik's Cube as a group, formalized proof of validity of solvability conditions of the $4 \times 4 \times 4$ Rubik's Cube and formulated the solvability conditions for the nxn Rubik's cube in Lean 4. [\[Github Repo\]](#)

Reading Project, Undecidability of First-Order Logic | Feb 2025 – April 2025

- Studied the foundational proof by Alonzo Church, and its implications for computability and formal verification systems.

Research Project, Image Denoising Algorithms | March 2025 – April 2025

- Implemented and evaluated various frameworks for image restoration without clean data.
- Designed and conducted experiments to analyze the hyperparameter sensitivity of Zero-Shot Noise2Noise implementation. [\[Report\]](#) [\[Presentation\]](#)

Reading project, Differential Topology and Knot Theory | May 2024 – July 2024

- Explored topics in Differential Topology and Knot Theory under the guidance of Prof. Subhojoy Gupta, Department of Mathematics, Indian Institute of Science.

Developer DataBased (CS club at IISc) | Oct 2023 – Dec 2023

- Utilized Generative AI to develop components for an automated Refute Problem Generation system.

SOFTWARE

Intern | National Payments Corporation of India (NPCI) | Dec 2024 – June 2025

Adviser: Prof. Viraj Kumar, Divecha Centre for Climate Change, IISc

- Developed an internal tool to enable NPCI employees to query databases and generate data visualizations via natural language prompts.
- Implemented a pipeline that translates natural language queries to SQL queries, fetches data, determines correct visualization types, and renders visual output.

- Fine-tuned LLMs with Tool Integrated reasoning for solving math and physics problems.
- Used proof assistants and symbolic solvers to verify the chain of thought of the models.

ACHIEVEMENTS AND RECOGNITIONS

- Selected for MITACS Globalink Research Internship 2026 (Offers: Undergraduate Summer Research Program [UGSRP] at University of Toronto; Fields Undergraduate Summer Research Program [FUSRP] at University of Waterloo)
- JEE Advanced Examination: 646th rank
- JEE Mains Examination: 99.95 percentile, 654th rank
- KVPY (Kishore Vaigyanik Protsahan Yojana) Scholar
- NTSE (National Talent Search Examination) Scholar

TECHNICAL SKILLS

- **Verification & Logic:** Isabelle, Lean 4, Z3, SMT Solvers, Alloy, Spin, Rodin, VCC, JPF, Verus
- **Mathematics:** Statistics, Probability, Topology, Abstract Algebra, Real Analysis, Linear Algebra, Combinatorics, Graph Theory, Number Theory, Multivariable Calculus, Stochastic Processes
- **Theoretical Computer Science:** Automata Theory, Game Theory & Mechanism Design, Program Analysis & Verification, Numerical Methods, Probabilistic Methods, Information Theory, Discrete Fourier Analysis, Convex Optimization
- **Machine Learning:** PyTorch, Scikit-learn, Transformers, LLM Fine-Tuning, Causal Discovery
- **Languages & Tools:** Python, C, SML, SQL

EXTRACURRICULAR ACTIVITIES

- Mentored underprivileged students in STEM concepts through the Notebook Drive Mentorship Outreach Program, IISc.
- Active Member of DataBased (Computer Science Club at IISc).
- Designed competitive programming problems for the RevCoding Contest as a Volunteer for Pravega 2025 (IISc UG Fest).
- Presented on 'Online Decision-Making Algorithms' at Algorithm Festival 2024, IISc.
- Enthusiastic participant in MUN (Model United Nations) conferences and debate competitions.

LANGUAGES

- **Fluent:** English, Malayalam
- **Intermediate:** Hindi