

# Mohammad Afzal

Curriculum Vitæ

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## INTERESTS

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- **Intersection of Formal Methods and AI:** Research interests lie at the intersection of formal methods and AI, focusing on robustness verification, runtime monitoring, and explainable AI for neural networks.
- **Explaining Reactive Traces:** Providing explanations in LTL form for desired and undesired traces in reactive systems and RL agents.
- **Formal Verification of Programs:** Scalable and sound verification of programs, particularly array programs, with implemented techniques in the VERIABS framework.

## EDUCATION

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**PhD (Trustworthy AI)** Jan 2021 – Feb 2026

*Indian Institute of Technology Bombay, Mumbai, India*

Thesis: *From Counterexamples to Confidence: Advancing Neural Network Verification.*

**Master of Science (Computer Science)** Jul 2015 – May 2017

*Chennai Mathematical Institute, Chennai, India*

Master's Thesis: *Property Checking of Array Programs involving Quantification over Array Elements*  
(Supervisor: Shrawan Kumar, TCS Research Pune, India).

**Bachelor of Technology (Information Technology)** Jul 2011 – May 2015

*Rajkiya Engineering College, Bijnor (studied at HBTI Kanpur, India)*

Percentage: 68.04%

## PHD THESIS SUMMARY

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*Title: From Counterexamples to Confidence: Advancing Neural Network Verification. Advisors: Prof. Ashutosh Gupta and Prof. S. Akshay.* My PhD research focused on formal robustness verification of neural networks, an NP-complete problem. I developed scalable counterexample-guided abstraction refinement techniques, analyzed robustness in terms of false and true positives, and incorporated

classification confidence to obtain more practical robustness guarantees. I also worked on learning and explaining reward functions in inverse reinforcement learning.

## EXPERIENCE

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*Note: The duration of Ph.D. and full-time research roles overlapped during Jan 2021 – Feb 2026, as the doctoral program was sponsored by TCS Research.*

- **Scientist** **TCS Research, Pune, India**  
*Aug 2023 – Present*
  - Conducting research on the formal verification and robustness analysis of neural networks, aligned with Ph.D. objectives and internal R&D initiatives.
  - Developed a grammar to capture diverse robustness notions in neural networks and enable their automatic verification, applicable to large-scale models, including those trained on the ImageNet-1K dataset.
- **Researcher** **TCS Research, Pune, India**  
*Jul 2017 – Jul 2023*
  - Designed and implemented verification techniques for array programs, integrated into the portfolio verifier VERIABS, contributing to multiple gold medals at SV-COMP (2019 - 2021).
  - Performed path-sensitive static code analysis on large industrial C codebases, reducing approximately 80% of false-positive warnings.

## INTERNSHIP

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- **Oct 2023, Three-Week Research Visit, CNRS@NUS Lab, Singapore**  
I worked on the robustness verification of neural networks under the supervision of [Prof. Blaise Genest](#). In particular, I developed techniques to efficiently identify branching heuristics for neural network verification problems, improving the scalability of robustness analysis.
- **Jan 2017 – Jun 2017, TCS Research, Pune**  
I worked on *property checking of array programs involving quantification over array elements* as part of my thesis work under the supervision of [Shrawan Kumar](#). Existing tools such as CBMC fail to verify properties for certain classes of array programs. We proposed a technique that enables CBMC to handle such properties. I also gained hands-on experience with TCS's in-house program analysis framework and implemented the proposed technique within it.
- **May 2016 – July 2016, Chennai Mathematical Institute (CMI), Chennai**  
I worked on the *Prototype Verification System (PVS)* under the guidance of [Prof. M. Praveen](#), [Prof. Madhavan Mukund](#), and [Prof. Mandayam Srivas](#). PVS is a specification language integrated with support tools and an automated theorem prover, developed at the Computer Science Laboratory of SRI International, Menlo Park, California.

## SKILLS

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- **Tools Developed:** [DREFINE](#), [QUANTLEARN](#), [VERIABS](#).
- **Tools Used:**  $\alpha$ - $\beta$ -CROWN, MARABOU, NEURALSAT, Z3, GUROBI.
- **Selected Courses:**
  - **Core Foundations:** Logic, Automata Theory, Algorithms.
  - **Formal Methods:** Model Checking, Analysis of Concurrent Programs, Automated Reasoning.
  - **Emerging Topics:** [CS725](#)–Foundations of Machine Learning, Artificial Intelligence, Introduction to Blockchains, Cryptocurrencies and Smart Contracts.
  - **Online Courses:** Machine Learning Specialization ([link](#)), TensorFlow Developer Professional Certificate ([link](#)), Deep Learning Specialization ([link](#)), Generative Adversarial Networks ([GANs](#)) Specialization, Introduction to Large Language Models ([LLMs](#)).

## SELECTED PUBLICATIONS : Details at [Google Scholar](#)

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- **Formal Reasoning About Confidence and Automated Verification of Neural Networks**, Mohammad Afzal, S. Akshay, Blaise Genest, Ashutosh Gupta, *FM*, 2026.
- **False Positives in Robustness Checking of Neural Networks**, Mohammad Afzal, Ashutosh Gupta, R. Venkatesh, S. Akshay, *OVERLAY@ECAI*, 2025.
- **Unifying Syntactic and Semantic Abstractions for Deep Neural Networks**, Sanaa Siddiqui, Diganta Mukhopadhyay, Mohammad Afzal, Hrishikesh Karmakar, Kumar Madhukar, *FMICS*, 2024.
- **Using Counterexamples to Improve Robustness Verification in Neural Networks**, Mohammad Afzal, Ashutosh Gupta, S. Akshay, *ATVA*, 2023.
- **LTL-Based Non-Markovian Inverse Reinforcement Learning**, Mohammad Afzal, Sankalp Gambhir, Ashutosh Gupta, Ashutosh Trivedi, Alvaro Velasquez, *AAMAS*, 2023.
- **System and Method for Software Verification**, Priyanka Darke, Bharti Chimdyalwar, Avriti Chauhan, Punit Shah, Shrawan Kumar, Mohammad Afzal, Venkatesh Ramanathan, Advaita Datar, Asia Akhtar, Tanha Shah, *US Patent*, 2022.
- **VeriAbs: Verification by Abstraction and Test Generation (Competition Contribution)**, Mohammad Afzal, Supratik Chakraborty, Avriti Chauhan, Bharti Chimdyalwar, Priyanka Darke, Ashutosh Gupta, Shrawan Kumar, Charles Babu M., Divyesh Unadkat, R. Venkatesh, *TACAS*, 2020.
- **VeriAbs: Verification by Abstraction and Test Generation**, Mohammad Afzal, A. Asia, Avriti Chauhan, Bharti Chimdyalwar, Priyanka Darke, Advaita Datar, Shrawan Kumar, R. Venkatesh, *IEEE/ACM ASE*, 2019.

## OTHERS

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Talks and Professional Service: Details at [link](#)

## REFERENCES

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[Prof. Ashutosh Gupta](#)

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Indian Institute of Technology Bombay, India  
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