



# Mohammad Afzal

Curriculum Vitæ

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*Address* TCS SP2, Phase 3, Hinjawadi, Pune, Maharashtra 411057  
*Phone* (+91) 9793 132 904  
*Mail* afzal7242mohd@gmail.com  
*Profiles* [Linkedin](#), [Google Scholar](#), [GitHub](#)

## EDUCATION

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**PhD (Safe AI)** Jan 2021 – Present

*Indian Institute of Technology Bombay, Mumbai, India*

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

Status: Thesis submitted.

**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.

## INTERESTS

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- **Safe AI:** Formal verification and certification of AI models for robustness and correctness before and during deployment, including runtime safety guards and explainability, by integrating formal methods with machine learning.

## **EXPERIENCE**

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*Note: The Ph.D. and full-time research roles overlapped during Jan 2021 – Present, 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 scalable and efficient verification methods 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 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](#)**

- **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**

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

## **REFERENCES**

### **Prof. Ashutosh Gupta**

*Professor*, Department of Computer Science  
Indian Institute of Technology Bombay, India  
✉[akg@cse.iitb.ac.in](mailto:akg@cse.iitb.ac.in)

### **Prof. S. Akshay**

*Professor*, Department of Computer Science  
Indian Institute of Technology Bombay, India  
✉[akshayss@cse.iitb.ac.in](mailto:akshayss@cse.iitb.ac.in)