Muhammad Bilal Sarwar

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Personal Webpage

Research Interests

Formal Verification Methods, Theorem Proving, Higher Order Logic, Model Checking, Probabilistic Analysis

Education

MS in Computational Science & Engineering | ***Advisor: Dr. Osman Hasan*** Sep. 2022 – Feb. 2025
National University of Sciences & Technology (NUST), Pakistan CGPA: 3.75/4.0 | Ranked 2nd
Thesis: Formal Analysis of Lane-Changing Algorithms for Autonomous Vehicles Using Probabilistic Model Checking

Bachelor of Science in Electrical Engineering Oct. 2017 – Oct 2021
University of Engineering & Technology (UET), Taxila, Pakistan

Publications

Submitted:

Formal Analysis of Lane-Changing Algorithms using Probabilistic Model Checking 2025
M.B. Sarwar *and O. Hasan* | ***Revisions Submitted*** J. Signal Process. Syst.

Unified Framework for YouTube Traffic Classification and Out-of-Distribution Detection in Encrypted Networks 2025
M.B. Sarwar*, S.M. Ahmad, M. Amjad, M.U.S. Khan, A.W. Malik, S.U. Khan* | ***Revisions Submitted*** IEEE Access

Published:

Revolutionizing ICT with AI and ML: A Comprehensive Study of Current Applications and Future Potential 2024
M.B. Sarwar*, G.M. Raza, M.A. Sarwar, & B.-S. Kim* IEIE SPC

Work Experience

Research Assistant | ***System Analysis & Verification (SAVe) Lab*** Jun. 2025 – Present
SEECS, NUST Islamabad, Pakistan

- Developing neuro-symbolic optimization frameworks that combine LLMs with SAT-solver heuristics, enabling constraint satisfaction without model fine-tuning.
- Designing and evaluating LLM-guided heuristics for algorithm synthesis, contributing to novel methodologies in automated reasoning and AI-assisted solver design.
- Formalizing quantum algorithms using HOL Light, focusing on proof of correctness toward verified quantum computing.
- Aiming to contribute to a paper for a top-tier journal submission.

Research Assistant | ***Data Science & Machine Learning Lab*** Feb. 2025 – May 2025
SINES, NUST Islamabad, Pakistan

- Conducted research on out-of-distribution (OOD) detection in YouTube videos using deep learning and anomaly detection techniques.
- Developed models to identify and classify anomalous videos via content dynamics and metadata distributions.
- First author of an OOD detection paper currently under review at **IEEE Access**.

Graduate Research Student | ***System Analysis & Verification (SAVe) Lab*** Jan. 2024 – Jan. 2025
SINES, NUST Islamabad, Pakistan

- Researched formal verification of autonomous vehicle lane-changing algorithms using probabilistic model checking.
- Modeled behavior with Markov Decision Processes and verified properties using the **PRISM** model checker.
- Applied PCTL to formally specify robustness under dynamic traffic conditions.
- Verified safety and performance of the MOBIL model, addressing limitations of simulation-only analyses.

Research Associate | ***Geo Visual Analytics Lab*** Jan. 2023 – Dec. 2023
IGIS, NUST Islamabad, Pakistan

- Designed real-time image analysis pipelines for mosquito detection on embedded IoT platforms.
- Integrated computer-vision algorithms with Raspberry Pi systems.
- Led a 4-week workshop on Python for computer-vision applications.

Skills

Programming: C/C++, Python, MATLAB, OCaml, Shell Scripting
Formal Methods Tools: HOL4, HOL Light, PRISM
Platforms & Tools: GNU/Linux, Windows/WSL2, Docker, Git, Vim
Cloud & Cluster Management: Slurm, OpenStack, OpenHPC, Kubernetes
ML & DL Frameworks: PyTorch, TensorFlow, Keras, Scikit-learn
Documentation: LaTeX, Markdown, Microsoft Office Suite

Selected Projects

Formal Verification of Lane-Changing Behavior 2024 – 2025
Modeled AV lane-changing with Markov Decision Processes (MDPs); specified safety properties in PCTL; verified robustness using the PRISM model checker

Multiclass Image Classification using Transfer Learning 2023
Built an image classifier using InceptionResNetV2 with transfer learning; applied augmentation and normalization to improve generalization

Sentiment Analysis Using BERT 2023
Implemented sentiment classification with BERT; fine-tuned pre-trained models via HuggingFace Transformers; employed advanced NLP preprocessing

Adaptive Irrigated Agriculture Monitoring (Embedded + Cloud) 2022
Developed IoT + embedded sensor system for agriculture; enabled real-time monitoring of soil/air conditions and optimized irrigation scheduling

Selected Honors and Awards

The Punjab Educational Endowment Fund (PEEF), Pakistan 2017–2024
Awarded by the Government of Punjab to exceptional students pursuing higher education. Awarded during my studies at:

- National University of Sciences & Technology (NUST), Pakistan
- University of Engineering & Technology (UET), Taxila, Pakistan

References

Dr. Osman Hasan
Professor, Pro-Rector (Academics), NUST, Islamabad
Reference: Master's Thesis Supervisor
Email: osman.hasan@seecs.nust.edu.pk

Dr. Ammar Mushtaq
Associate Professor, SINES, NUST, Islamabad
Reference: Master's Thesis Co-Supervisor
Email: ammar.mushtaq@sines.nust.edu.pk