

Atanu Kundu

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Research Area

I am a researcher in formal verification and falsification of cyber-physical systems, with expertise in developing algorithms for bounded model checking (BMC) and machine learning-based falsification. My doctoral research focused on advancing BMC and falsification frameworks for industrial CPS. Key contributions include:

- Developed a novel BMC algorithm for affine hybrid systems, enabling efficient verification of safety properties.
- Designed a bounded reachability algorithm for compositional affine hybrid systems, specifically tailored for compositional systems, thereby improving scalability in the analysis of large-scale CPS.
- Designed machine learning-based falsification frameworks for industrial CPS, bridging data-driven techniques with robustness monitoring to address the limitations of traditional optimization-based falsification methods.

Education

2020 – continue

■ **Ph.D. in Computer Science from IACS Kolkata, India.**

Thesis title: *Algorithms for detecting unsafe behavior in CPS design.*

2016 – 2018

■ **M.Sc. in Computer Science from Visva-Bharati, India.**

2013 – 2016

■ **B.Sc. in Computer Science from The University of Burdwan.**

Research Publications

- 1 A. Kundu, S. Gon, and R. Ray, “Data-driven falsification of cyber-physical systems,” *IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems*, 2025. DOI: 10.1109/TCAD.2025.3608632.
- 2 L. Bu, A. Kundu, R. Ray, and Y. Shi, “Arch-comp24 category report: Hybrid systems with piecewise constant dynamics and bounded model checking,” in *Proceedings of the 11th Int. Workshop on Applied Verification for Continuous and Hybrid Systems*, G. Frehse and M. Althoff, Eds., ser. EPiC Series in Computing, vol. 103, EasyChair, 2024, pp. 1–14. DOI: 10.29007/nv67.
- 3 T. Khandait, F. Formica, A. Kundu, et al., “Arch-comp 2024 category report: Falsification,” in *Proceedings of the 11th Int. Workshop on Applied Verification for Continuous and Hybrid Systems*, G. Frehse and M. Althoff, Eds., ser. EPiC Series in Computing, vol. 103, EasyChair, 2024, pp. 122–144. DOI: 10.29007/hgfv.
- 4 A. Kundu, S. Gon, and R. Ray, “Data-driven falsification of cyber-physical systems,” in *Proceedings of the 17th Innovations in Software Engineering Conference*, ser. ISEC ’24, Bangalore, India, Association for Computing Machinery, 2024, ISBN: 9798400717673. DOI: 10.1145/3641399.3641401.
- 5 A. Kundu, S. Das, and R. Ray, “Sat-reach: A bounded model checker for affine hybrid systems,” *ACM Trans. Embed. Comput. Syst.*, vol. 22, no. 2, Jan. 2023, ISSN: 1539-9087. DOI: 10.1145/3567425.

- 6 C. Menghi, P. Arcaini, A. Kundu, *et al.*, “Arch-comp23 category report: Falsification,” in *Proceedings of 10th International Workshop on Applied Verification of Continuous and Hybrid Systems (ARCH23)*, G. Frehse and M. Althoff, Eds., ser. EPiC Series in Computing, vol. 96, EasyChair, 2023, pp. 151–169.
DOI: 10.29007/6nqs.
- 7 L. Bu, G. Frehse, A. Kundu, R. Ray, Y. Shi, and E. Zaffanella, “Arch-comp22 category report: Hybrid systems with piecewise constant dynamics and bounded model checking,” in *Proceedings of 9th International Workshop on Applied Verification of Continuous and Hybrid Systems (ARCH22)*, vol. 90, 2022, pp. 44–57. DOI: 10.29007/lnzf.

Projects and Work Experiences

- 2017 - May 2018 ■ Ralay TCP over wireless network with free-space optical and worldwide interoperability for microwave access.
under the supervision of Mr. Subhasis Banerjee, Visva-Bharati, India.
- May - Dec 2022 ■ Building neural network models of the standard Cyber-Physical Systems (CPS) benchmarks.
Under the supervision of Dr. Rajarshi Ray, IACS Kolkata, India.
Building Feed-forward Neural Networks (FNNs) for CPS benchmarks such as hybrid automata and Simulink models. We built FNN models for systems with non-deterministic behavior and time-varying input signals. These models are an approximation of the original models and can be useful in developing the application of such systems.

Skills

- Languages ■ Native language Bengali. Fluent in English, Hindi.
- Coding ■ Proficient in C, C++, Python, SMT-LIB2. Familiar with MATLAB and LaTeX.
- DevOps ■ Experience in git and Docker.
- Tools ■ FlexiFal, NNFal, XSpeed, SAT-Reach, SpaceEx, Flow*, dReach, and breach.
- Misc. ■ Academic research, teaching, training, consultation, LaTeX typesetting, and publishing.

Teaching Experiences

- Spring 2022 ■ Teaching assistant on Artificial Intelligence (COM 4211)
Responsibilities included setting and evaluating lab assignments. Supervising students throughout the course to succeed in the lab assignments.
- Autumn 2023 ■ Teaching assistance on Object-Oriented Programming with C++ Lab (COM 4111)
My duties involved creating and assessing assignments and surprise tests. Additionally, I was responsible for overseeing students' progress during the course, ensuring their success in laboratory assignments.

Miscellaneous Experience

Invited Talks

- 2024 ■ Research paper **Data-driven Falsification of Cyber-physical Systems** accepted at ISEC 2024 and presented the paper at IIIT Bangalore.

Miscellaneous Experience (continued)

2023 ■ A short presentation titled **A Framework for Detecting Unsafe Behavior in Cyber-Physical Systems** presented in Tech Symposium on Computing Trends 2023, organized by THALES associated with UNIVERSITY OF CALCUTTA.

2022 ■ **SAT-Reach: A Bounded Model Checker for Affine Hybrid Systems** presented in the formal methods update meeting 2022 at IIT Delhi.

Certification

2023 ■ **Special recognition for completing a short thesis presentation in exactly 5 minutes.**
Awarded by THALES associated with UNIVERSITY OF CALCUTTA.