

Seminar

Wednesday, 11 November 2025

14:45, D011

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Title: Reachability Analysis in the Continuous and Discrete Spaces and Its Applications to LLMs

Abstract: Reachability analysis determines the set of all states a system can reach under uncertainties in initial conditions, inputs, and parameters. It plays a central role in the formal verification of Cyber-Physical Systems (CPS), ensuring that unsafe states can be systematically avoided. This talk highlights recent advances in reachability analysis across continuous and discrete domains, with an emphasis on applications to Large Language Models (LLMs). In the continuous domain, the challenge of constructing accurate models for CPS is addressed through data-driven reachability analysis algorithms that rely solely on input/output data while providing formal guarantees. The effectiveness of these methods is demonstrated through applications such as ensuring safety for an LLM-controlled robot. In the discrete domain, the focus shifts to logical zonotopes and polynomial logical zonotopes, novel binary set representations capable of compactly capturing exponentially large Boolean state spaces. These tools enable efficient verification and model checking of discrete systems and open new directions for applications such as cryptographic key search.



Short bio: [Amr Alanwar](#) has been an Assistant Professor at the Technical University of Munich (TUM) since September 2023. Prior to this, he was an Assistant Professor at Constructor University in Bremen and a Postdoctoral Researcher at the KTH Royal Institute of Technology in Sweden. He received his Ph.D. in 2020 from the Cyber-Physical Systems Group at TUM. Before that, he was a research assistant at the University of California, Los Angeles (UCLA).

He has been selected by the German Research Foundation (DFG) for the Emmy Noether Program, which is a prestigious funding program for early-career researchers. He won the Best Demonstration Paper Award at the 16th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN/CPS Week) and was a two-time finalist in the Qualcomm Innovation Fellowship. He earned his B.Sc. and M.Sc. degrees in Electrical Engineering from Ain Shams University, Egypt. His current research interests include safety, privacy, and security in cyber-physical systems, with a particular focus on reachability analysis, formal verification, and data-driven methods.