Curriculum Vitae

1 Personal Details

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2 Education and Further Employment

2.1 Education

01/2006-02/2010	**Dr.-Ing., Technische Universität München** (awarded 07/2010) Dept. of Electrical and Computer Engineering, Munich, Germany Thesis: Reachability Analysis and its Application to the Safety Assessment of Autonomous Cars Supervisor: Prof. Martin Buss
10/2001-12/2005	**Diploma, Technische Universität München** (awarded 12/2005) Course of studies: Mechatronics and Information Technology Dept. of Mechanical Engineering, Garching, Germany

2.2 Further Employment

06/2012 - 09/2013	**Assistant Professor, Technische Universität Ilmenau** Dept. of Computer Science, Ilmenau, Germany Professorship for *Automation Engineering* (pay grade W1) Dean: Kai-Uwe Sattler Area of work: Automation systems
04/2012 - 06/2012	**Lecturer, Technische Universität Ilmenau** Dept. of Computer Science, Ilmenau, Germany Dean: Kai-Uwe Sattler Area of work: Automation systems
03/2010 - 03/2012	**Postdoctoral Researcher, Carnegie Mellon University** Dept. of Electrical Engineering & Robotics Institute, Pittsburgh, USA Advisor in Electrical Engineering: Bruce Krogh Advisor in Robotics Institute: John Dolan Area of work: Cyber-physical systems, formal verification

3 Grants, Prizes, Awards, Honors

- *Best Tool Paper Award at the 24th ACM International Conference on Hybrid Systems: Computation and Control* **(12/2020)**
- *Teaching award for the best mandatory lecture in the computer science bachelor program* (lecture *Grundlagen der künstlichen Intelligenz*) **(12/2019)**
- *2nd place TUM IdeAward* **(11/2019)**
- *ERC Consolidator Grant* **(11/2018)**
- *2nd place CeDoSIA Supervisory Award* **(07/2018)**
- *Best Repeatability Evaluation Award* **(04/2017)**
  Cyber-Physical Systems Week
- *Nominee of the Technische Universität München for the Alfried Krupp Prize* **(02/2015)**
  (€1M for 5 years; 1 winner across all disciplines in Germany)
- *IEEE/ACM William J. McCalla ICCAD Best Paper Award* **(11/2011)**
  International Conference on Computer-Aided Design
- *PhD graduation with distinction* (summa cum laude) **(07/2010)**
- *Best Poster Award* **(06/2009)**
  IEEE Intelligent Vehicles Symposium

4 Publications

The latest list of publications can be found on my personal Google scholar page:
https://scholar.google.com/citations?user=E3zazJAAAAAJ&hl=de&oi=ao

4.1 Publications

4.1.1 Peer-Reviewed Journals

[1] F. Gruber and M. Althoff. Computing safe sets of linear sampled-data systems. *IEEE Control Systems Letters*, 5(2):385–390.

[2] M. Althoff. Reachability analysis of large linear systems with uncertain inputs in the Krylov subspace. *IEEE Transactions on Automatic Control*, 65(2):477–492, 2020.

[3] M. Althoff, G. Frehse, and A. Girard. Set propagation techniques for reachability analysis. *Annual Review of Control, Robotics, and Autonomous Systems*, 4(1):null, 2020. early access.

[4] M. Althoff, S. Maierhofer, and C. Pek. Provably-correct and comfortable adaptive cruise control. *IEEE Transactions on Intelligent Vehicles*, 2020. early access.

[5] F. Camara, N. Bellotto, S. Cosar, D. Nathanael, M. Althoff, J. Wu, J. Ruenz, A. Dietrich, and C. Fox. Pedestrian models for autonomous driving part i: Low-level models, from sensing to tracking. *IEEE Intelligent Transportation Systems Transactions*, 2020. early access.

[6] F. Camara, N. Bellotto, S. Cosar, F. Weber, D. Nathanael, M. Althoff, J. Wu, J. Ruenz, A. Dietrich, G. Markkula, A. Schieben, F. Tango, N. Merat, and C. Fox. Pedestrian models for autonomous driving part ii: High-level models of human behavior. *IEEE Transactions on Intelligent Transportation Systems*, 2020. early access.

[7] N. Kochdumper and M. Althoff. Sparse polynomial zonotopes: A novel set representation for reachability analysis. *Sparse Polynomial Zonotopes: A Novel Set Representation for Reachability Analysis*, 2020. early access.

[8] M. Koschi and M. Althoff. Set-based prediction of traffic participants considering occlusions and traffic rules. *IEEE Transactions on Intelligent Vehicles*, 2020. early access.

[9] S. Manzinger, C. Pek, and M. Althoff. Using reachable sets for trajectory planning of automated vehicles. *IEEE Transactions on Intelligent Vehicles*, 2020. early access.

[10] C. Pek and M. Althoff. Fail-safe motion planning for online verification of autonomous vehicles using convex optimization. *IEEE Transactions on Robotics*, 2020. early access.

[11] C. Pek, S. Manzinger, M. Koschi, and M. Althoff. Using online verification to prevent autonomous vehicles from causing accidents. *Nature Machine Intelligence*, 2:518–528, 2020.

[12] B. Schürmann and M. Althoff. Optimizing sets of solutions for controlling constrained nonlinear systems. *IEEE Transactions on Automatic Control*, 2020. early access.

[13] B. Schürmann, R. Vignali, M. Prandini, and M. Althoff. Set-based control for disturbed piecewise affine systems with state and actuation constraints. *Nonlinear Analysis: Hybrid Systems*, 36, 2020. Article 100826.

[14] P. Vogel and M. Althoff. Rekonstruktion von durch vollautomatisierte Fahrzeuge verursachten Verkehrsunfällen. *InTeR - Zeitschrift zum Innovations- und Technikrecht*, 8(2):89–94, 2020.

[15] M. Althoff, A. Giusti, S. B. Liu, and A. Pereira. Effortless creation of safe robots from modules through self-programming and self-verification. *Science Robotics*, 4(31):1–14, 2019.

[16] D. Nikol and M. Althoff. Die Formalisierung von Rechtsnormen am Beispiel des Überholvorgangs. *InTeR - Zeitschrift zum Innovations- und Technikrecht*, 7(1):12–16, 2019.

[17] H. Roehm, J. Oehlerking, M. Woehrle, and M. Althoff. Model conformance for cyber-physical systems: A survey. *ACM Transactions on Cyber-Physical Systems*, 3(3):Article 30, 2019.

[18] A. Giusti and M. Althoff. On-the-fly control design of modular robot manipulators. *IEEE Transactions on Control Systems Technology*, 26(4):1484–1491, 2018.

[19] A. Giusti, J. Malzahn, N. Tsagarakis, and M. Althoff. On the combined inverse-dynamics/passivity-based control of elastic-joint robots. *IEEE Transactions on Robotics*, 34(6):1461–1471, 2018.

[20] A. Giusti, M. J. A. Zeestraten, E. Icer, A. Pereira, D. G. Caldwell, S. Calinon, and M. Althoff. Flexible automation driven by demonstration: Leveraging strategies that simplify robotics. *IEEE Robotics and Automation Magazine*, 25(2):18–27, 2018.

[21] Y. Li, P. Zhang, and M. Althoff. Distributed formal analysis for power networks with deep integration of distributed energy resources. *IEEE Transactions on Power Systems*, 34(6):5147 – 5156, 2018.

[22] A. Pereira and M. Althoff. Overapproximative human arm occupancy prediction for collision avoidance. *IEEE Transactions on Automation Science and Engineering*, 15(2):818–831, 2018.

[23] S. Söntges and M. Althoff. Computing the drivable area of autonomous road vehicles in dynamic road scenes. *IEEE Transactions on Intelligent Transportation Systems*, 19(6):1855–1866, 2018.

[24] M. Althoff and S. Magdici. Set-based prediction of traffic participants on arbitrary road networks. *IEEE Transactions on Intelligent Vehicles*, 1(2):187–202, 2016.

[25] A. El-Guindy, D. Han, and M. Althoff. Formal analysis of drum-boiler units to maximize the load-following capabilities of power plants. *IEEE Transactions on Power Systems*, 31(6):4691–4702, 2016.

[26] M. Althoff. Formal and compositional analysis of power systems using reachable sets. *IEEE Transactions on Power Systems*, 29(5):2270–2280, 2014.

[27] M. Althoff and J. M. Dolan. Online verification of automated road vehicles using reachability analysis. *IEEE Transactions on Robotics*, 30(4):903–918, 2014.

[28] M. Althoff and B. H. Krogh. Reachability analysis of nonlinear differential-algebraic systems. *IEEE Transactions on Automatic Control*, 59(2):371–383, 2014.

[29] M. Althoff, A. Rajhans, B. H. Krogh, S. Yaldiz, X. Li, and L. Pileggi. Formal verification of phase-locked loops using reachability analysis and continuization. *Communications of the ACM*, 56(10):97–104, 2013.

[30] M. Althoff, M. J. Patil, and J. P. Traugott. Nonlinear modeling and control design of active helicopter blades. *Journal of the American Helicopter Society*, 57(1):1–11, 2012.

[31] M. Althoff and A. Mergel. Comparison of Markov chain abstraction and Monte Carlo simulation for the safety assessment of autonomous cars. *IEEE Transactions on Intelligent Transportation Systems*, 12(4):1237–1247, 2011.

[32] M. J. Patil and M. Althoff. Energy-consistent, Galerkin approach for the nonlinear dynamics of beams using intrinsic equations. *Journal of Vibration and Control*, 17(11):1748–1758, 2011.

[33] M. Althoff, O. Stursberg, and M. Buss. Computing reachable sets of hybrid systems using a combination of zonotopes and polytopes. *Nonlinear Analysis: Hybrid Systems*, 4(2):233–249, 2010.

[34] M. Althoff, O. Stursberg, and M. Buss. Model-based probabilistic collision detection in autonomous driving. *IEEE Transactions on Intelligent Transportation Systems*, 10(2):299 – 310, 2009.

[35] M. Althoff, O. Stursberg, and M. Buss. Sicherheitsbewertung von Fahrstrategien kognitiver Automobile. *at - Automatisierungstechnik*, 56:653–661, 2008.

4.1.2 Book Chapter

[36] M. Althoff, B. H. Krogh, and O. Stursberg. *Modeling, Design, and Simulation of Systems with Uncertainties*, chapter Analyzing Reachability of Linear Dynamic Systems with Parametric Uncertainties, pages 69–94. Springer, 2011.

4.1.3 Peer-Reviewed Conference Articles

[37] A. Alanwar, H. Said, A. Mehta, and M. Althoff. Event-triggered diffusion kalman filters. In *Proc. of the 11th ACM/IEEE International Conference on Cyber-Physical Systems*, pages 206–215, 2020.

[38] M. Althoff, S. Bak, Z. Bao, M. Forets, G. Frehse, D. Freire, N. Kochdumper, Y. Li, S. Mitra, R. Ray, C. Schilling, S. Schupp, and M. Wetzlinger. ARCH-COMP20 category report: Continuous and hybrid systems with linear continuous dynamics. In Goran Frehse and Matthias Althoff, editors, *Proc. of the 7th International Workshop on Applied Verification of Continuous and Hybrid Systems*, volume 74 of *EPiC Series in Computing*, pages 16–48, 2020.

[39] M. Althoff, M. Mayer, and R. Müller. Automatic synthesis of human motion from temporal logic specifications. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 4040–4046, 2020.

[40] V. Gaßmann and M. Althoff. Scalable zonotope-ellipsoid conversions using the euclidean zonotope norm. In *Proc. of the American Control Conference*, pages 4715–4721, 2020.

[41] L. Geretti, J. A. dit Sandretto, M. Althoff, L. Benet, A. Chapoutot, X. Chen, P. Collins, M. Forets, D. Freire, F. Immler, N. Kochdumper, D. P. Sanders, and C. Schilling. ARCH-COMP20 category report: Continuous and hybrid systems with nonlinear dynamics. In Goran Frehse and Matthias Althoff, editors, *Proc. of the 7th International Workshop on Applied Verification of Continuous and Hybrid Systems*, volume 74 of *EPiC Series in Computing*, pages 49–75, 2020.

[42] M. Klischat and M. Althoff. A multi-step approach to accelerate the computation of the drivable area of mobile robots. In *Proc. of the 23rd IEEE International Conference on Intelligent Transportation Systems*, 2020.

[43] M. Klischat and M. Althoff. Synthesizing traffic scenarios from formal specifications for testing automated vehicles. In *Proc. of the IEEE Intelligent Vehicles Symposium*, 2020.

[44] M. Klischat, E. I. Liu, F. Hoeltke, and M. Althoff. Scenario factory: Creating safety-critical traffic scenarios for automated vehicles. In *Proc. of the 23rd IEEE International Conference on Intelligent Transportation Systems*, 2020.

[45] N. Kochdumper and M. Althoff. Computing non-convex inner-approximations of reachable sets for nonlinear continuous systems. In *Proc. of the 59th IEEE Conference on Decision and Control*, 2020.

[46] N. Kochdumper and M. Althoff. Reachability analysis for hybrid systems with nonlinear guard sets. In *Proc. of the 23rd ACM International Conference on Hybrid Systems: Computation and Control*, page Article No. 2, 2020. Article 2.

[47] N. Kochdumper, B. Schürmann, and M. Althoff. Utilizing dependencies to obtain subsets of reachable sets. In *Proc. of the 23rd ACM International Conference on Hybrid Systems: Computation and Control*, page Article No. 1, 2020.

[48] N. Kochdumper, A. Tarraf, M. Rechmal, M. Olbrich, L. Hedrich, and M. Althoff. Establishing reachset conformance for the formal analysis of analog circuits. In *Proc. of the 25th Asia and South Pacific Design Automation Conference (ASP-DAC 2020)*, pages 199–204, 2020.

[49] H. Krasowski, X. Wang, and M. Althoff. Safe reinforcement learning for autonomous lane changing using set-based prediction. In *Proc. of the 23rd IEEE International Conference on Intelligent Transportation Systems*, 2020.

[50] E. I. Liu, C. Pek, and M. Althoff. Provably safe cooperative driving via invariably safe sets. In *Proc. of the IEEE Intelligent Vehicles Symposium*, 2020.

[51] S. B. Liu and M. Althoff. Optimizing performance in automation through modular robots. In *Proc. of the International Conference on Robotics and Automation*, pages 4044–4050, 2020.

[52] S. Maierhofer, A.-K. Rettinger, E. C. Mayer, and M. Althoff. Formalization of interstate traffic rules in temporal logic. In *Proc. of the IEEE Intelligent Vehicles Symposium*, 2020.

[53] C. Pek, V. Rusinov, S. Manzinger, and M. Althoff. CommonRoad drivability checker: Simplifying the development and validation of motion planning algorithms. In *Proc. of the IEEE Intelligent Vehicles Symposium*, 2020.

[54] A. Schieben, M. Wilbrink, A. Dietrich, J. Ruenz, E. Portouli, A. Amditis, M. Althoff, M. Kaup, F. Tango, Y.-M. Lee, G. Markkula, N. Merat, and F. Weber. Designing cooperative interaction of automated vehicles in mixed traffic environments: Insights from the interact project. In *Proc. of 8th Transport Research Arena*, 2020.

[55] X. Wang, S. Nair, and M. Althoff. Falsification-based robust adversarial reinforcement learning. In *Proc. of the 19th International Conference on Machine Learning and Applications*, 2020.

[56] M. Wetzlinger, N. Kochdumper, and M. Althoff. Adaptive parameter tuning for reachability analysis of linear systems. In *Proc. of the 59th IEEE Conference on Decision and Control*, 2020.

[57] E. Ye and M. Althoff. Cooperative raw sensor data fusion for ground truth generation in autonomous driving. In *Proc. of the 23rd IEEE International Conference on Intelligent Transportation Systems*, 2020.

[58] E. Ye and M. Althoff. Mutual absolute calibration of lidar sensor mounting position on vehicle platforms with corresponding 3d models. In *Proc. of the 23rd IEEE International Conference on Intelligent Transportation Systems*, 2020.

[59] A. Alanwar, H. Said, and M-. Althoff. Distributed secure state estimation using diffusion kalman filters and reachability analysis. In *Proc. of the 58th IEEE Conference on Decsion and Control*, pages 4133–4139, 2019.

[60] M. Althoff, S. Bak, M. Forets, G. Frehse, N. Kochdumper, R. Ray, C. Schilling, and S. Schupp. ARCH-COMP19 category report: Continuous and hybrid systems with linear continuous dynamics. In Goran Frehse and Matthias Althoff, editors, *Proc. of the 6th International Workshop on Applied Verification of Continuous and Hybrid Systems*, volume 61 of *EPiC Series in Computing*, pages 14–40, 2019.

[61] J. I. Ge, B. Schürmann, R. M. Murray, and M. Althoff. Risk-aware motion planning for automated vehicle among human-driven cars. In *Proc. of the American Control Conference*, pages 3987–3993, 2019.

[62] F. Gruber and M. Althoff. Scalable robust model predictive control for linear sampled-data systems. In *Proc. of the 58th IEEE Conference on Decision and Control*, pages 438–444, 2019.

[63] F. Immler, M. Althoff, L. Benet, A. Chapoutot, X. Chen, M. Forets, L. Geretti, N. Kochdumper, D. P. Sanders, and C. Schilling. ARCH-COMP19 category report: Continuous and hybrid systems with nonlinear dynamics. In Goran Frehse and Matthias Althoff, editors, *Proc. of the 6th International Workshop on Applied Verification of Continuous and Hybrid Systems*, volume 61 of *EPiC Series in Computing*, pages 41–61, 2019.

[64] M. Klischat and M. Althoff. Generating critical test scenarios for automated vehicles with evolutionary algorithms. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 2352–2358, 2019.

[65] M. Klischat, O. Dragoi, M. Eissaand, and M. Althoff. Coupling sumo with a motion planning framework for automated vehicles. In *Proc. of the SUMO User Conference*, volume 62 of *EPiC Series in Computing*, pages 1–9, 2019.

[66] M. Koschi, C. Pek, S. Maierhofer, and M. Althoff. Computationally efficient safety falsification of adaptive cruise control systems. In *Proc. of the 22nd IEEE Intelligent Transportation Systems Conference*, pages 2879–2886, 2019.

[67] C. Pek, M. Koschi, and M. Althoff. An online verification framework for motion planning of self-driving vehicles with safety guarantees. In *Automatisiertes und Vernetztes Fahren (AAET)*, pages 260–274, 2019.

[68] T. Phan-Minh, S. Guo, B. Schürmann, M. Althoff, and R. M. Murray. A modal interface contract theory for guarded input/output automata with an application in traffic system design. In *Proc. of the American Control Conference*, pages 1704–1711, 2019.

[69] J. Wu, J. Ruenz, and M. Althoff. Calibration of controlled markov chains for predicting pedestrian crossing behavior using multi-objective genetic algorithms. In *Proc. of the 22nd Intelligent Transportation Systems Conference*, pages 1032–1038, 2019.

[70] E. Ye and M. Althoff. Model-based offline vehicle tracking in automotive applications using a precise 3D model. In *Proc. of the 22nd Intelligent Transportation Systems Conference*, pages 1128–1135, 2019.

[71] M. Althoff, S. Bak, X. Chen, C. Fan, M. Forets, G. Frehse, N. Kochdumper, Y. Li, S. Mitra, R. Ray, C. Schilling, and S. Schupp. ARCH-COMP18 category report: Continuous and hybrid systems with linear continuous dynamics. In *Proc. of the 5th International Workshop on Applied Verification for Continuous and Hybrid Systems*, pages 23–52, 2018.

[72] M. Althoff, D. Grebenyuk, and N. Kochdumper. Implementation of Taylor models in CORA 2018. In *Proc. of the 5th International Workshop on Applied Verification for Continuous and Hybrid Systems*, pages 145–173, 2018.

[73] M. Althoff and S. Lutz. Automatic generation of safety-critical test scenarios for collision avoidance of road vehicles. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1326–1333, 2018.

[74] F. Gruber and M. Althoff. Anytime safety verification of autonomous vehicles. In *Proc. of the 21st IEEE International Conference on Intelligent Transportation Systems*, pages 1708–1714, 2018.

[75] F. Immler, M. Althoff, X. Chen, C. Fan, G. Frehse, N. Kochdumper, Y. Li, S. Mitra, M. S. Tomar, and M. Zamani. ARCH-COMP18 category report: Continuous and hybrid systems with nonlinear dynamics. In *Proc. of the 5th International Workshop on Applied Verification for Continuous and Hybrid Systems*, pages 53–70, 2018.

[76] M. Koschi, C. Pek, and M. Althoff. Set-based prediction of pedestrians in urban environments considering formalized traffic rules. In *Proc. of the 21st IEEE International Conference on Intelligent Transportation Systems*, pages 2704–2711, 2018.

[77] M. Koschi, S. Söntges, and M. Althoff. Worst-case analysis of the time-to-react using reachable sets. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1891–1897, 2018.

[78] S. B. Liu and M. Althoff. Reachset conformance of forward dynamic models for the formal analysis of robots. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 370–376, 2018.

[79] S. Manzinger and M. Althoff. Tactical decision making for cooperative vehicles using reachable sets. In *Proc. of the 21st IEEE International Conference on Intelligent Transportation Systems*, pages 444–451, 2018.

[80] G. Mesesan, M. A. Roa, E. Icer, and M. Althoff. Hierarchical path planner using workspace decomposition and parallel task-space RRTs. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 6524–6531, 2018.

[81] C. Miller, C. Pek, and M. Althoff. Efficient mixed-integer planning for longitudinal and lateral control of autonomous vehicles. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1954–1961, 2018.

[82] B. Mirchevska, C. Pek, M. Werling, M. Althoff, and J. Boedecker. High-level decision making for safe and reasonable autonomous lane-changing with reinforcement learning. In *Proc. of the 21st IEEE International Conference on Intelligent Transportation Systems*, pages 2156–2162, 2018.

[83] C. Pek and M. Althoff. Computationally efficient fail-safe trajectory planning for self-driving vehicles using convex optimization. In *Proc. of the 21st IEEE International Conference on Intelligent Transportation Systems*, pages 1447–1454, 2018.

[84] C. Pek and M. Althoff. Efficient computation of invariably safe states for motion planning of self-driving vehicles. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 3523–3530, 2018.

[85] A. Rizaldi, F. Immler, B. Schürmann, and M. Althoff. A formally verified motion planner for autonomous vehicles. In *Proc. of the International Symposium on Automated Technology for Verification and Analysis*, pages 75–90, 2018.

[86] B. Schürmann, N. Kochdumper, and M. Althoff. Reachset model predictive control for disturbed nonlinear systems. In *Proc. of the 57th IEEE Conference on Decision and Control*, pages 3463–3470, 2018.

[87] C. Stark, A. Pereira, and M. Althoff. Reachset conformance testing of human arms with a biomechanical model. In *Proc. of the IEEE International Conference on Robotic Computing*, pages 209–216, 2018.

[88] M. Wagner, S. Liu, A. Giusti, and M. Althoff. Interval-arithmetic-based trajectory scaling and collision detection for robots with uncertain dynamics. In *Proc. of IEEE International Conference on Robotic Computing*, pages 41–48, 2018.

[89] J. Wu, J. Ruenz, and M. Althoff. Probabilistic map-based pedestrian motion prediction taking traffic participants into consideration. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1285–1292, 2018.

[90] A. Zhu, S. Manzinger, and M. Althoff. Evaluating location compliance approaches for automated road vehicles. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 642–649, 2018.

[91] M. Althoff, S. Bak, D. Cattaruzza, X. Chen, G. Frehse, R. Ray, and S. Schupp. ARCH-COMP17 category report: Continuous and hybrid systems with linear continuous dynamics. In *Proc. of the 4th International Workshop on Applied Verification for Continuous and Hybrid Systems*, pages 143–159, 2017.

[92] M. Althoff, M. Koschi, and S. Manzinger. CommonRoad: Composable benchmarks for motion planning on roads. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 719–726, 2017.

[93] S. Bak, S. Bogomolov, and M. Althoff. Time-triggered conversion of guards for reachability analysis of hybrid automata. In *Proc. of the 15th International Conference on Formal Modelling and Analysis of Timed Systems*, pages 133–150, 2017.

[94] D. Beckert, A. Pereira, and M. Althoff. Online verification of multiple safety criteria for a robot trajectory. In *Proc. of the 56th IEEE Conference on Decision and Control*, pages 6454–6461, 2017.

[95] D. Calzolari, B. Schürmann, and M. Althoff. Comparison of trajectory tracking controllers for autonomous vehicles. In *Proc. of the 20th IEEE International Conference on Intelligent Transportation Systems*, 2017.

[96] X. Chen, M. Althoff, and F. Immler. ARCH-COMP17 category report: Continuous systems with nonlinear dynamics. In *Proc. of the 4th International Workshop on Applied Verification for Continuous and Hybrid Systems*, pages 160–169, 2017.

[97] A. El-Guindy, Y. C. Chen, and M. Althoff. Compositional transient stability analysis of power systems via the computation of reachable sets. In *Proc. of the American Control Conference*, pages 2536–2543, 2017.

[98] A. El-Guindy, D. Han, and M. Althoff. Estimating the region of attraction via forward reachable sets. In *Proc. of the American Control Conference*, pages 1263–1270, 2017.

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[100] A. Giusti and M. Althoff. Efficient computation of interval-arithmetic-based robust controllers for rigid robots. In *Proc. of the First IEEE International Conference on Robotic Computing*, pages 129–135, 2017.

[101] A. Giusti, J. Malzahn, N. G. Tsagarakis, and M. Althoff. Combined inverse-dynamics/passivity-based control for robots with elastic joints. In *Proc. of the IEEE International Conference on Robotics and Automation*, pages 5281–5288, 2017.

[102] F. Hisch, A. Giusti, and M. Althoff. Robust control of continuum robots using interval arithmetic. In *Proc. of the 20th World Congress of the International Federation of Automatic Control*, pages 5660–5665, 2017.

[103] E. Icer, H. A. Hassan, K. El-Ayat, and M. Althoff. Evolutionary cost-optimal composition synthesis of modular robots considering a given task. In *Proc. of the IEEE International Conference on Robotics and Automation*, pages 3562–3568, 2017.

[104] A.-K. Kopetzki, B. Schürmann, and M. Althoff. Methods for order reduction of zonotopes. In *Proc. of the 56th IEEE Conference on Decision and Control*, pages 5626–5633, 2017.

[105] M. Koschi and M. Althoff. Interaction-aware occupancy prediction of road vehicles. In *Proc. of the 20th IEEE International Conference on Intelligent Transportation Systems*, 2017.

[106] M. Koschi and M. Althoff. SPOT: A tool for set-based prediction of traffic participants. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 1686–1693, 2017.

[107] S. B. Liu, H. Roehm, C. Heinzemann, I. Lütkebohle, J. Oehlerking, and M. Althoff. Provably safe motion of mobile robots in human environments. In *Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems*, pages 1351–1357, 2017.

[108] S. Magdici and M. Althoff. Adaptive cruise control with safety guarantees for autonomous vehicles. In *Proc. of the 20th World Congress of the International Federation of Automatic Control*, pages 5774–5781, 2017.

[109] S. Magdici, Z. Ye, and M. Althoff. Determining the maximum time horizon for vehicles to safely follow a trajectory. In *Proc. of the 20th IEEE International Conference on Intelligent Transportation Systems*, 2017.

[110] S. Manzinger and M. Althoff. Kooperative Bewegungsplanung autonomer Fahrzeuge unter Verwendung von Manöver-Templates. In *Proc. of Automatisierungssysteme, Assistenzsysteme und eingebettete Systeme für Transportmittel (AAET)*, pages 348–367, 2017.

[111] S. Manzinger and M. Althoff. Negotiation of drivable areas of cooperative vehicles for conflict resolution. In *Proc. of the 20th IEEE International Conference on Intelligent Transportation Systems*, 2017.

[112] S. Manzinger, M. Leibold, and M. Althoff. Driving strategy selection for cooperative vehicles using maneuver templates. In *Proc. of the IEEE Intelligent Vehicles Symposium*, pages 647–654, 2017.

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5 Research Funding

More than 90% of my research group is funded by third parties. Over the last five years, I have acquired more than €9 million of research funding from diverse resources.

5.1 Projects

05/2014 - 04/2017 **DFG project *Formal Verification of Collision Avoidance Systems for Road Vehicles***
Funds: 235 kEUR
Role: PI

12/2014 - 11/2017 **DFG project *Analysis and Synthesis of Robustly Controlled Smart-Grid-Systems (ROCS-Grid)***
Funds: 207 kEUR
Role: PI

01/2015 - 02/2019 **EU project *Unifying Control and Verification of Cyber-Physical Systems (UnCoVerCPS)***
Funds: 573 kEUR (total: 4.9 mEUR)
Role: Coordinator

02/2016 - 01/2019 **DFG SPP project *Cooperative and Intrinsically-Correct Control of Vehicles in Diverse Environments (CoInCiDE)***
Funds: 264 kEUR
Role: PI

09/2016 - 08/2019 **Industry project with BMW *Trajectory Planning with Safety Guarantees***
Funds: 352 kEUR
Role: PI

05/2017 - 04/2020 **DFG project *Formal Abstraction and Verification of Analog Circuits (faveAC)***
Funds: 267 kEUR
Role: PI

05/2017 - 04/2020 **EU project *Designing Cooperative Interaction of Automated Vehicles with other Road Users in Mixed Traffic Environments (interACT)***
Funds: 285 kEUR
Role: PI

8/2017 - 05/2020 **ZIM project *Development of a Modular Robotic System* (ModRob)**
Funds: 190 kEUR
Role: PI

02/2018 - 01/2020 **Industry project with Ford *Formal Methods for Active Trajectory Verification* (FORMAT)**
Funds: 430 kUSD
Role: PI

03/2018 - 02/2021 **DFG project *Co-design of Reachability Analysis and Trajectory Planning for Collision Avoidance Systems* (CoPlan)**
Funds: 278 kEUR
Role: PI

04/2018 - 03/2019 **EXIST Business Start-up Grant *Gastrobotics***
Funds: 105 kEUR
Role: Advisor

05/2018 - 12/2020 **ZIM project *Automatic Generation of Critical Situations for Autonomous Vehicles* (critGen)**
Funds: 190 kEUR
Role: PI

10/2018 - 09/2021 **DFG project *Formalization and Analysis of Traffic Rules* (FormalRules)**
Funds: 283 kEUR
Role: PI

03/2019 - 05/2021 **ZIM project *Energy-optimal motion planning of industrial robots* (ecoRobots)**
Funds: 190 kEUR
Role: PI

04/2019 - 03/2022 **EU project *Integrated, Fail-Operational, Cognitive Perception, Planning and Control Systems for Highly Automated Vehicles* (NewControl)**
Funds: 184 kEUR
Role: PI

05/2019 - 04/2022 **Industry project with BMW *Trajectory Planning in Compliance with Traffic Regulations* (BMWtrafficRules)**
Funds: 360 kEUR
Role: PI

05/2019 - 04/2022 **DFG SPP project *Cooperative and Intrinsically-Correct Control of Vehicles in Diverse Environments – Phase 2* (CoInCiDE)**
Funds: 283 kEUR
Role: PI

07/2019 - 06/2024 **DFG Research Training Group *Continuous Verification of Cyber-Physical Systems* (CONVEY)**
Funds: 404 kEUR (2 PhD positions)
Role: PI

07/2019 - 06/2024 **ERC Consolidator Grant *Just-in-time Self-Verification of Autonomous Systems* (justITSELF)**
Funds: 1,999 kEUR
Role: PI

03/2019 - 05/2021 **ZIM project *Development of a Construction Robot for Renovating Concrete Walls* (wallBot)**
Funds: 190 kEUR
Role: PI

04/2018 - 03/2019 **EXIST Transfer of Research Grant *proModular***
Funds: 949 kEUR
Role: Advisor

03/2019 - 05/2021 **ZIM project *Synthesizing Traffic Situations with Temporal Logics* (virtualDriver)**
Funds: 190 kEUR

05/2019 - 04/2022 **Industry project with Huawei *Key Technologies of Safety Assurance for Autonomous Driving* (safeDriving)**
Funds: 193 kEUR
Role: PI

01/2021 - 12/2023 **EU project *Configurable Collaborative Robot Technologies (CONCERT)***
Funds: 578 kEUR
Role: PI

03/2021 - 02/2024 **Bayfor project *Sector coupling and Microgrids, Electrification and Digitization***
Funds: 217 kEUR
Role: PI

03/2021 - 02/2024 **BMVI project *Cooperative Autonomous Driving with Safety Guarantees (KoSi)***
Funds: 446 kEUR
Role: PI

5.2 Industry Cooperations

5.2.1 National

- Dr. Jens Oehlerking, Dept. CR/AEA4, Bosch GmbH, Germany; topic: formal verification (data exchange; 4 joint papers; joint project: UnCoVerCPS; co-advising of a PhD student at Bosch)
- Dr. Matthias Woehrle, Dept. CR/AEA4, Bosch GmbH, Germany; topic: formal verification
  (data exchange; 2 joint papers; joint project: UnCoVerCPS, co-advising of a PhD student at Bosch)
- Dr. Moritz Werling, BMW Group, Germany; topic: motion planning

(data exchange of automated vehicles test drives; 2 joint papers; joint project: CAR@TUM)

- Dr. Florian Obermeier, Saneon GmbH, Germany; topic: automatic generation of critical situations for vehicles
  (data exchange of automated vehicles test drives; joint project: critGen)
- Dr. Pei Ke, Euro RAMS lab of Huawei, Germany; topic: safety assurance for autonomous driving
  (joint software development, joint project: safeDriving)
- Dr. Patrick Krümpelmann, BMW Group, Germany; topic: formal traffic rules
  (joint software development; joint project: BMWtrafficRules)

5.2.2 International

- Kyle Post, Ford Motor Company, USA; topic: autonomous driving
  (joint project: Ford)
- Dr. Md Tawhid Bin Waez, Ford Motor Company, USA; topic: autonomous driving
  (joint project: Ford)
- Xavier Fornari, Esterel Technologies, France; topic: formal verification
  (joint project: UnCoVerCPS)
- Geoff Pegman, CEO of RURobots, UK; topic: human-robot co-working
  (joint development of the software for the GRAIL robot; joint project: UnCoVerCPS; joint effort in robot certification)

6 Supervision of PhD Students

02/2014 - 12/2017	**Sebastian Söntges** Advisor: Matthias Althoff PhD project: DFG vCar Current activity: Works in research department at MAN
07/2014 - 10/2017	**Andrea Giusti** Advisor: Matthias Althoff Graduation: 04.07.2018 Title: Automatic Design of Controllers for Modular Reconfigurable Robot Manipulators PhD project: EU SMART-E Current activity: Works at Fraunhofer Italia Research in Bolzano
07/2014 - 10/2017	**Esra Icer** Advisor: Matthias Althoff PhD project: EU SMART-E Current activity: Works at TUM in science management
07/2014 - 10/2017	**Aaron Pereira** Advisor: Matthias Althoff Graduation: 08.02.2019 Title: Guaranteeing Safe Robot Motion PhD project: EU SMART-E

Current activity: Works at DLR Oberpfaffenhofen

07/2014 - 06/2018 **Albert Rizaldi**
Advisor: Matthias Althoff
Graduation: 18.12.2019
Title: Formal Specification, Monitoring, and Verification of Autonomous Vehicles with Isabelle/HOL
PhD project: DFG PUMA & EU UnCoVerCPS
Current activity: Postdoc at Nanyang Technological University, Singapore

11/2014 - 10/2017 **Hendrik Röhm**
Advisors: Jens Oehlerking, Matthias Woehrle, Matthias Althoff
PhD project: EU UnCoVerCPS (external PhD student at Bosch)
Current activity: Works in several start-ups

01/2015 - 07/2017 **Ahmed El-Guindy**
Advisor: Matthias Althoff
Graduation: 05.12.2017
Title: Control and Stability of Power Systems using Reachability Analysis
PhD project: DFG ROCS-Grid
Current activity: Works at German Development Cooperation for renewable energy projects in Egypt

04/2015 - 06/2019 **Bastian Schürmann**
Advisor: Matthias Althoff
PhD project: EU UnCoVerCPS
Current activity: Works at Siemens Corporate Research

06/2015 - 07/2018 **Silvia Magdici**
Advisor: Matthias Althoff
PhD project: DFG PUMA & EU interACT
Current activity: Works in research department of Audi

06/2016 - 04/2020 **Christian Pek**
Advisors: Moritz Werling, Peter Zahn, Matthias Althoff
Graduation: 23.07.2020
Title: Provably Safe Motion Planning for Autonomous Vehicles Through Online Verification
PhD project: car@TUM (external PhD student at BMW, later group member)
Current activity: Postdoc at KTH Royal Institute of Technology

09/2016 - 03/2020 **Markus Koschi**
Advisor: Matthias Althoff
PhD project: car@TUM
Current activity: Works at Zenuity

11/2016 - 12/2020 **Stefanie Manzinger**
Advisor: Matthias Althoff
PhD project: DFG SPP CoInCar

05/2017 - present **Jingyuan Wu**
Advisors: Johannes Ruenz, Matthias Althoff
PhD project: EU interACT (external PhD student at Bosch)

09/2017 - present **Stefan Boson Liu**
Advisor: Matthias Althoff
PhD project: ZIM modular robots

01/2018 - present **Felix Gruber**
Advisor: Matthias Althoff
PhD project: EU UnCoVerCPS

01/2018 - present **Niklas Kochdumper**
Advisor: Matthias Althoff
PhD project: faveAC

08/2018 - present **Egon Ye**
Advisor: Matthias Althoff
PhD project: BMWperception

01/2019 - present **Xiao Wang**
Advisor: Matthias Althoff
PhD project: CoPlan/FORMAT

02/2019 - 04/2020 **Anna-Katharina Rettinger**
Advisor: Matthias Althoff
PhD project: CoPlan/FORMAT

05/2019 - 05/2020 **Amr Alanwar**
Advisor: Matthias Althoff
PhD project: EU interACT
Current activity: Postdoc at KTH Royal Institute of Technology

05/2019 - present **Victor Gaßmann**
Advisor: Matthias Althoff
PhD project: justITSELF

05/2019 - present **Sebastian Maierhofer**
Advisor: Matthias Althoff
PhD project: BMWtrafficRules

12/2019 - present **Mark Wetzlinger**
Advisor: Matthias Althoff
PhD project: Convey

02/2020 - present **Matthias Mayer**
Advisor: Matthias Althoff
PhD project: ecoRobots

04/2020 - present **Hanna Krasowski**
Advisor: Matthias Althoff
PhD project: Convey

07/2020 - present **Adrian Kulmburg**
Advisor: Matthias Althoff
PhD project: justITSELF

09/2020 - present **Gerald Würsching**
Advisor: Matthias Althoff
PhD project: CoPlan

10/2020 - present **Luis Gressenbuch**
Advisor: Matthias Althoff

PhD project: FormalRules

6.1 Supervision of Postdoctoral Researcher

11/2014 - 10/2016	**Dongkun Han** project: DFG ROCS-Grid Current activity: Lecturer at Chinese University of Hong Kong
02/2019 - 02/2020	**Jagat J. Rath** project: FORMAT Current activity: Assistant Professor, IITRAM, Ahmedabad, India
08/2020 - present	**Ashish Kothyari** project: CosesForschungsverbund

7 Academic Cooperation

7.1 National

- Prof. Olaf Stursberg, Dept. of Electrical Engineering, University of Kassel, Germany; topic: control of hybrid systems
  (16 joint papers; joint projects: ROCS-Grid, CoInCiDE, UnCoVerCPS)
- Prof. Lars Hedrich, Dept. of Electrical Engineering, Goethe University Frankfurt, Germany; topic: AMS circuits
  (joint paper, joint project: faveAC)
- Prof. Erich Barke, University of Hanover, Germany; topic: AMS circuits
  (joint paper)
- Dr. Markus Olbrich, University of Hanover, Germany; topic: AMS circuits
  (2 joint papers, joint project: faveAC)
- Prof. Thomas Sattel, Dept. of Mechanical Engineering, Ilmenau University of Technology, Germany; topic: motion planning
  (3 joint papers)
- Prof. Eric Hilgendorf, University of Würzburg, Germany; topic: formalization of traffic rules
  (2 joint papers with his group, joint project: FormalRules)
- Prof. Tobias Nipkow, Technical University of Munich, Germany; topic: formalization of traffic rules
  (joint paper, joint project: FormalRules)

7.2 International

- Prof. Goran Frehse, ENSTA Paris, France; topic: formal verification
  (mutual support in tool development between SpaceEx and CORA (my tool); joint workshop organization; 8 joint papers; joint project: UnCoVerCPS)
- Dr. Colas Le Guernic, DGA-MI, France; topic: formal verification
  (joint paper, joint project: CMACS)

- Prof. Bruce H. Krogh, Carnegie Mellon University, USA; topic: formal verification
  (7 joint papers; joint projects: CMACS, AMSver,CPSarchitecture)
- Prof. John Dolan, Robotics Institute, Carnegie Mellon University, USA; topic: automated driving
  (data exchange of automated vehicles; 3 joint papers; exchange of Master students)
- Prof. Marija Ilić, Carnegie Mellon University, USA; topic: power systems
  (joint paper)
- Prof. Xin Li, Carnegie Mellon University, USA; topic: analog/mixed-signal circuits
  (2 joint papers, joint project: AMSver)
- Prof. Larry Pileggi, Carnegie Mellon University, USA; topic: AMS circuits
  (2 joint papers, joint project: AMSver)
- Prof. Mayuresh Patil, Virginia Tech, USA; topic: control of structures
  (4 joint papers)
- Prof. Peng Zhang, Stony Brook University, USA; topic: power systems
  (1 joint paper)
- Prof. Darwin Caldwell, Italian Institute of Technology, Italy; topic: modular robotics
  (1 joint paper, joint project: SMART-E)
- Prof. Richard Murray, California Institute of Technology, USA; topic: formal controller synthesis
  (2 joint papers)
- Prof. Nikolaos G. Tsagarakis, Italian Institute of Technology, Italy; topic: modular robotics
  (2 joint papers, joint project: CONCERT)
- Prof. Antoine Girard, Centrale Supelec, France; topic: reachability analysis
  (joint paper)

8 Technology Transfer and Entrepreneurship

8.1 Patents

[176] M. Althoff, S. Maierhofer, and C. Pek. Provably-correct and comfortable adaptive cruise control.

[177] S. B. Liu and M. Althoff. Measures for a reconfigurable moduar robot.

[178] C. Pek and M. Althoff. Determining the safety of lane change maneuvers based on formailized traffic rules.

[179] C. Pek and M. Althoff. Verifying the safety of lane change maneuvers of self-driving vehicles based on formalized traffic rules.

[180] C. Pek, M. Koschi, and M. Althoff. Enhancing motion safety by identifying passageways unsing safe invariant sets.

8.2 Technology Transfer Projects and Support of Startups

- *EXIST Transfer of Research for proModular*
  Modular robots for flexible production solutions. Developed the idea for the startup and recruited the startup team. The originating company from the technology transfer is Kea Robotics GmbH (https://kea-robotics.de).
- *EXIST Business Start-up Grant for Gastrobotics*
  Robotic solutions for food production in restaurants.
- *Technology transfer within EU projects*
  - Companies participating in UnCoVerCPS: Bosch (Germany), Esterel Technologies (France), and RURobots (UK).
  - Companies participating in interACT: BMW (Germany), Fiat (Italy), Hella (Germany), and Bosch (Germany).
  - Companies participating in CONCERT: Profactor GmbH (Austria) and Budimex SA (Poland).
- *Technology transfer within ZIM projects*
  - Company participating in ModRob: BAM Maschinenbau GmbH (Germany).
  - Company participating in critGen: Saneon GmbH (Germany).
  - Company participating in ecoRobots: Jabertools & Robotics (Germany).
  - Companies participating in wallBot: Xaver Lutzenberger GmbH & Co. KG (Germany), Telerob Gesellschaft für Fernhantierungstechnik mbH (Germany), and AutomationsRobotic GmbH (Germany).
  - Company participating in virtualDriver: Saneon GmbH (Germany).
- *Technology transfer within Bayfor/BMVI projects*
  - Companies participating in Bayfor project (selection): Adaptricity AG (Switzerland), Sonnen GmbH (Germany), and National Instruments (USA).
  - Companies participating in KoSi: Infineon Technologies AG (Germany), Saneon GmbH (Germany), and TWT GmbH Science & Innovation (Germany).

9 Talks

9.1 Invited Talks

In total 70 invited talks: 19 talks at companies, 25 conference/workshop presentations, 24 presentations at universities, and 2 podium discussions.

04.12.2020	*Seminar at the Northwestern Polytechnical University, Xi'an, China (held online)* Title: Guaranteeing Safety of Autonomous Systems via Online Verification
30.10.2020	*Highlightvorlesung der Semestereinführungstage an der TUM, Garching, Germany (held online)* Title: Wie behalte ich die Kontrolle über künstliche Intelligenz?

20.09.2020 *IEEE ITSC Workshop on Automated Vehicle Safety, Rhodes, Greece (held online)*
Title: Just-in-Time Verification of Autonomous Vehicles

08.07.2020 *Seminar of Virtual vehicle, Graz, Austria (held online)*
Title: Ensuring Legal Safety of Autonomous Vehicles with Unverifiable Software

08.05.2020 *Online Retreat of the DFG Research Training Group on Continuous Verification of Cyber-Physical Systems, Herrenchiemsee, Germany (held online)*
Title: Reachability Analysis (and More) Based on Polynomial Zonotopes

13.02.2020 *Colloquium des Unternehmerkreises (MUK) zum Thema "Autonome Elektromobilität – von KI und Intuition"*
Title: Can We Prove Safety of Autonomous Systems?

04.02.2020 *Industry talk, Siemens, Colloquium of the Campus Automation Digitization, Munich, Germany*
Title: Can We Ensure Safety of Autonomous Systems with Unverified Software?

20.02.2020 *Distinguished Lecture Series in Robotics, Systems and Control, ETH Zürich, Zurich, Switzerland*
Title: Let's Make Autonomous Systems Formally Correct

31.01.2020 *Seminar series of the DFG Research Training Group on Continuous Verification of Cyber-Physical Systems, TUM, Garching, Germany*
Title: Verifying Autonomous Vehicles with Unverifiable Software

31.07.2019 - 03.08.2019 *Summer School Marktoberdorf – Safety and Security of Software Systems: Logics, Proofs, Applications*
Title: Taming the Beast: Online Verification for Autonomous Systems

11.07.2019 *Industry talk, BMW, Dingolfing, Germany*
Title: Sichere modulare Roboter

09.06.2019 *Workshop Formal Methods vs. Machine Learning Approaches for Reliable Navigation, IEEE Intelligent Vehicles Symposium, Paris, France*
Title: Verifying Autonomous Vehicles with Unverifiable Software

09.06.2019 *Workshop Cooperative Interactive Vehicles, IEEE Intelligent Vehicles Symposium, Paris, France*
Title: Driving in the Bubble: Cooperation through Separation

06.06.2019 *Second Summer School on Formal Methods for Cyber-Physical Systems, Verona, Italy*
Title: Online Verification of Cyber-Physical Systems

06.12.2018 *Industry talk, Airbus, Ottobrunn, Germany*
Title: Formal Methods for Online Verification of Motion Planning

22.11.2018 *2nd Winter School Human Factors Aspects of Cooperative Systems Design, Garching, Germany*
Title: Keeping Humans Safe Using Formal Methods

10.09.2018 *Podium Discussion on Specification & Design Languages, Munich, Germany*
Title: Safe Human-Robot Co-Existence through Online Verification

17.06.2018 *Robocluster @ Automatica, Munich, Germany*
Title: Guaranteeing Safety of Robotic Systems using Formal Methods

06.06.2018	*UnCoVerCPS workshop, Milano, Italy* Title: Human-Robot Interaction and Online Verification
11.05.2018	*Celebrating the Career of Bruce Krogh, Carnegie Mellon University, USA* Title: Let's Get the Robots out of the Cage – But Safely!
11.05.2018	*Seminar series of the Field Robotics Center, Carnegie Mellon University, USA* Title: Composable Benchmarks for Safe Motion Planning on Roads
10.05.2018	*Industry talk, Argo, Pittsburgh, USA* Title: Formal Methods for Online Verification of Motion Planning
18.01.2018	*Industry talk, Ford, Dearborn, USA* Title: Formal Methods for Online Verification of Motion Planning
11.10.2017	*Industry talk, BMW, Garching, Germany* Title: Online Verification of Autonomous Vehicles
09.08.2017	*International Summer School on Cooperative Interacting Automobiles, Schwäbisch Gmünd, Germany* Title: Ensuring Safety of Autonomous Vehicles by Set-Based Techniques
14.04.2017	*Seminar series of the Field Robotics Center, Carnegie Mellon University, USA* Title: Ensuring Safe Human-Robot Co-Existence by Reachability Analysis
06.02.2017	*TUM Winter School, Garching, Germany* Title: How to Guarantee Safety of Cyber-Physical Systems?
31.01.2017	*Smart Cyber-Physical Systems Concertation Event, Brussels, Belgium* Title: The UnCoVerCPS Approach Towards Certifiable Human-Robot Co-Existence
11.12.2016	*Workshop Verification and Control of Cyber-physical Systems: Theory and Applications, Las Vegas, USA* Title: Self-Verification of Automated Vehicles
12.10.2016	*Workshop PUMA graduate school, St.Martin, Austria* Title: Safe Human-Robot Co-Existence through Online Verification
19.09.2016	*International Symposium on Networked Cyber-Physical Systems, Garching, Germany* Title: Online Verification of Cyber-Physical Systems
22.05.2016	*GlobalTech Alliance Robotic Workshop, Munich, Germany* Title: Safe Human-Robot Co-Existence through Online Verification
14.04.2016	*ARTEMIS Spring Event, Vienna, Austria* Title: Unifying Control and Verification of Cyber-Physical Systems
31.03.2016	*Industry talk, TÜV Süd GmbH, Garching, Germany* Title: Self-Certification of Cyber-Physical Systems
14.03.2016	*Industry talk, Robert Bosch GmbH, Renningen, Germany* Title: Safe Human-Robot Co-Existence through Online Verification
07.10.2015	*ARTEMIS Technology Conference, Turin, Italy* Title: Provably Safe Maneuvers of Automated Vehicles
28.09.2015	*Workshop Robotic co-workers: Methods, Challenges and Industrial Test Cases at IROS'15, Hamburg, Germany* Title: Certifiable Control of Robots using Reachable Sets

28.09.2015	*Keynote of the 7th Workshop on Planning Perception and Navigation for Intelligent Vehicles, Hamburg, Germany* Title: Determining the Nonexistence of Evasive Trajectories for Collision Avoidance Systems
14.07.2015	*BMW We live Innovations Dialogue, Munich, Germany* Title: Formalization of Traffic Rules for Defending against Liability Claims in Automated Driving
14.07.2015	*BMW We live Innovations Dialogue, Munich, Germany* Title: Provably Correct Collision Avoidance Systems
01.07.2015	*Podium Discussion of the International Scientific Conference on Mobility and Transport, Munich, Germany* Title: Cyber Physical Transport Systems — ITS on the Move Towards the Internet of Things
16.06.2015	*Research Day of the Bavarian Graduate School of Computational Engineering, Munich, Germany* Title: How to Prove Safe Maneuvers of Autonomous Vehicles?
29.05.2015	*Lecture series of the PUMA graduate school, Munich, Germany* Titles: Modeling and Simulation of Continuous Systems (29.05.2015); Timed Automata and Modeling and Simulation of Hybrid Systems (05.06.2015); Analysis of Hybrid Systems (12.06.2015)
09.04.2015	*Seminar series of the Logical Systems Lab, Carnegie Mellon University, USA* Title: Online Verification for Automated Vehicles
02.12.2014	*Industry talk, Siemens AG, München, Germany* Title: Automatic Analysis and Verification of Cyber-Physical Systems
12.12.2014	*MSE Workshop Electrical Engineering and Computer Science, Garching, Germany* Title: Transient Stability Analysis by Reachable Set Computation
19.09.2014	*Seminar series of the Field Robotics Center, Carnegie Mellon University, USA* Title: Guaranteeing Safety of Autonomous Vehicles with On-the-Fly Verification
24.07.2014	*Industry talk, Robert Bosch GmbH, Schwieberdingen, Germany* Title: Ensuring Safety of Automated Vehicles with On-The-Fly Verification
15.07.2014	*Seminar at DLR, Oberpfaffenhofen, Germany* Title: Formal Verification of Cyber-Physical Systems
12.05.2014	*Talk during the visit of the vice president of the South China Univeristy of Technology (SCUT), München, Germany* Title: Safety Verification of Autonomous Vehicles
14.02.2014	*Industry talk, Siemens AG, München, Germany* Title: Formal Verification of Cyber-Physical Systems
16.12.2013	*Seminar series World of Engineering, Garching, Germany* Title: Formal Verification of Cyber-Physical Systems
11.12.2013	*Seminar on Control Theory at Prof. Lohmann's chair, Garching, Germany* Title: Formal Verification of Cyber-Physical Systems
15.11.2013	*Seminar of the PUMA graduate school, Garching, Germany*

	Title: Formal Verification of Cyber-Physical Systems
10.07.2013	*Siegmundsburg Workshop, Siegmundsburg, Germany* Title: Erreichbarkeitsanalyse linearer Systeme
08.07.2013	*Industry talk, Robert Bosch GmbH, Schwieberdingen, Germany* Title: Formale Verifikation automatisierter Systeme
30.11.2012	*Siegmundsburg Workshop, Siegmundsburg, Germany* Title: Formally Verifying Transient Stability of Power Systems
26.06.2012	*Workshop Analysis and Design of Cyber-Physical Transportation Systems: Challenges, Progress, and Future Directions, Montreal, Canada* Title: Guaranteeing Crash Avoidance of Autonomous Cars
19.12.2011	*Seminar Autonomous Driving, Gothenburg, Sweden* Title: Guaranteeing Crash Avoidance of Autonomous Cars
03.11.2011	*Seminar series Center for Silicon System Implementation, Pittsburgh, USA* Title: Using Reachability Analysis for the Formal Verification of a Phase-Locked Loop
29.06.2011	*Industry talk, Toyota USA, Los Angeles, USA* Title: Reachability Analysis: State of the Art for Various System Classes
28.06.2011	*Seminar at Caltech, Pasadena, USA* Title: Reachability Analysis of Linear, Nonlinear, and Hybrid Systems
27.06.2011	*Workshop Guaranteeing Motion Safety for Robots, Los Angeles, USA* Title: Worst-Case Deviations of Planned Trajectories for High-Speed Mobile Robots
07.05.2010	*Seminar series Computational Modeling and Analysis of Complex Systems, Pittsburgh, USA* Title: Reachability Analysis of Nonlinear and Hybrid Systems using Zonotopes
19.11.2009	*Seminar at Verimag, Grenoble, France* Title: Reachability Analysis of Nonlinear and Hybrid Systems with Zonotopes
22.02.2008	*Workshop Regelungstechnisches Kolloquium, Boppard, Germany* Title: Online-Analyse von Fahrstrategien kognitiver Automobile
17.07.2008	*Industry talk, Daimler AG, Boeblingen, Germany* Title: Online-Analyse von Fahrstrategien kognitiver autonomer Fahrzeuge

9.2 Talks Presented at Conferences and Workshops

25.10.2020	*International Conference on Intelligent Robots and Systems, Las Vegas, USA (held online)* Title: Automatic Synthesis of Human Motion from Temporal Logic Speci cations
12.07.2020	*7th Workshop on Applied Verification for Continuous and Hybrid Systems, Berlin, Germany* Title: ARCH-COMP Category Report: Continuous and Hybrid Systems with Linear Continuous Dynamics

11.04.2019	*6th Workshop on Applied Verification for Continuous and Hybrid Systems, Montreal, Canada* Title: ARCH-COMP Category Report: Continuous and Hybrid Systems with Nonlinear Dynamics
13.07.2018	*5th Workshop on Applied Verification for Continuous and Hybrid Systems, Oxford, UK* Title: Implementation of Taylor Models in CORA 2018
13.07.2018	*5th Workshop on Applied Verification for Continuous and Hybrid Systems, Oxford, UK* Title: ARCH-COMP Category Report: Continuous and Hybrid Systems with Linear Continuous Dynamics
13.07.2018	*5th Workshop on Applied Verification for Continuous and Hybrid Systems, Oxford, UK* Title: ARCH-COMP Category Report: Continuous and Hybrid Systems with Nonlinear Dynamics
05.09.2017	*15th International Conference on Formal Modelling and Analysis of Timed Systems, Berlin, Germany* Title: Time-Triggered Conversion of Guards for Reachability Analysis of Hybrid Automata
13.06.2017	*IEEE Intelligent Vehicles Symposium, Los Angeles, USA* Title: CommonRoad: Composable Benchmarks for Motion Planning on Roads
17.04.2017	*4th Workshop on Applied Verification for Continuous and Hybrid Systems, Pittsburgh, USA* Title: ARCH-COMP Category Report: Continuous and Hybrid Systems with Linear Continuous Dynamics
17.04.2017	*4th Workshop on Applied Verification for Continuous and Hybrid Systems, Pittsburgh, USA* Title: A Smart Grid Energy Management Problem for Data-driven Design with Probabilistic Reachability Guarantees
14.12.2016	*55th IEEE Conference on Decision and Control, Las Vegas, USA* Title: Combining Zonotopes and Support Functions for Efficient Reachability Analysis of Linear Systems
02.11.2016	*19th IEEE International Conference on Intelligent Transportation Systems, Rio de Janeiro, Brazil* Title: Can Automated Road Vehicles Harmonize with Traffic Flow While Guaranteeing A Safe Distance?
20.06.2016	*Summer Workshop on Interval Methods, Lyon, France* Title: Bounding Nonlinear Functions by Combining Interval Arithmetic, Taylor Models, and Global Optimization
11.04.2016	*3rd Workshop on Applied Verification for Continuous and Hybrid Systems, Vienna, Austria* Title: Implementation of Interval Arithmetic in CORA 2016
13.04.2015	*2nd Workshop on Applied Verification for Continuous and Hybrid Systems, Seattle, USA* Title: An Introduction to CORA 2015
15.09.2014	*IEEE/RSJ International Conference on Intelligent Robots and Systems, Chicago, USA* Title: Formal Verification of Maneuver Automata for Parameterized Motion Primitives

09.10.2013	*16th IEEE Conference on Intelligent Transportation Systems, The Hague, Netherlands* Title: Should Collision Avoidance Systems use Yaw Stabilization?
07.10.2013	*16th IEEE Conference on Intelligent Transportation Systems, The Hague, Netherlands* Title: Road Occupancy Prediction of Traffic Participants
10.04.2013	*Hybrid Systems: Computation and Control, Philadelphia, USA* Title: Reachability Analysis of Nonlinear Systems using Conservative Polynomialization and Non-Convex Sets
16.10.2012	*IEEE PES Conference on Innovative Smart Grid Technologies Europe, Berlin, Germany* Title: Transient Stability Analysis by Reachable Set Computation
28.06.2012	*American Control Conference, Montreal, Canada* Title: Reachability Computation of Low-Order Models for the Safety Verification of High-Order Road Vehicle Models
17.04.2012	*Hybrid Systems: Computation and Control, Beijing, China* Title: Avoiding Geometric Intersection Operations in Reachability Analysis of Hybrid Systems
15.12.2011	*50th IEEE Conference on Decision and Control, Orlando, USA* Title: Zonotope Bundles for the Efficient Computation of Reachable Sets
09.11.2011	*Int. Conference on Computer Aided Design, San Jose, USA* Title: Formal Verification of Phase-Locked Loops Using Reachability Analysis and Continuization
03.10.2011	*14th IEEE Conference on Intelligent Transportation Systems, Washington D.C., USA* Title: Set-Based Computation of Vehicle Behaviors for the Online Verification of Autonomous Vehicles
15.07.2011	*Frontiers in Analog Circuit (FAC) Synthesis and Verification, Salt Lake City, USA* Title: Using Continuization in Reachability Analysis for the Verification of a Phase-Locked Loop
13.04.2011	*Hybrid Systems: Computation and Control, Chicago, USA* Title: Reachable Set Computation for Uncertain Time-Varying Linear Systems
24.08.2009	*European Control Conference, Budapest, Hungary* Title: Safety Assessment for Stochastic Linear Systems using Enclosing Hulls of Probability Density Functions
04.06.2009	*IEEE Intelligent Vehicles Symposium, Beijing, China* Title: Safety Assessment of Driving Behavior in Multi-Lane Traffic for Autonomous Vehicles
11.12.2008	*47th IEEE Conference on Decision and Control, Cancun, Mexico* Title: Reachability Analysis of Nonlinear Systems with Uncertain Parameters using Conservative Linearization
06.06.2008	*IEEE Intelligent Vehicles Symposium, Eindhoven, Netherlands* Title: Stochastic Reachable Sets of Interacting Traffic Participants
08.04.2008	*3. Tagung Aktive Sicherheit durch Fahrerassistenz, Garching, Germany* Title: Erreichbarkeitsanalyse von Verkehrsteilnehmern zur Verbesserung von Fahrerassistenzsystemen

14.02.2008	*Automatisierungssysteme, Assistenzsysteme und eingebettete Systeme für Transportmittel, Braunschweig, Germany* Title: Online-Analyse von Fahrstrategien kognitiver autonomer Fahrzeuge
12.12.2007	*46th IEEE Conference on Decision and Control, New Orleans, USA* Title: Reachability Analysis of Linear Systems with uncertain Parameters and Inputs
12.07.2007	*American Control Conference, New York, USA* Title: Safety Assessment of Autonomous Cars using Verification Techniques
14.06.2007	*IEEE Intelligent Vehicles Symposium, Istanbul, Turkey* Title: Online Verification of Cognitive Car Decisions

9.3 Posters at Conferences

28.06.2018	*IEEE Intelligent Vehicles Symposium, Changshu, China* Title: Automatic Generation of Safety-Critical Test Scenarios for Collision Avoidance of Road Vehicles
13.06.2017	*IEEE Intelligent Vehicles Symposium, Los Angeles, USA* Title: CommonRoad: Composable Benchmarks for Motion Planning on Roads
24.06.2010	*IEEE Intelligent Vehicles Symposium, San Diego, USA* Title: Safety Verification of Autonomous Vehicles for Coordinated Evasive Maneuvers
04.06.2009	*IEEE Intelligent Vehicles Symposium, Beijing, China* Title: Cognition and Emotion in Autonomous Cars
06.06.2008	*IEEE Intelligent Vehicles Symposium, Eindhoven, Netherlands* Title: Design and Capabilities of the Munich Cognitive Automobile

10 Academic Engagement

10.1 Honorary Positions and Memberships of Committees

- Associate editor *IEEE Transactions on Intelligent Vehicles*, since 2018.
- Associate editor *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2015.
- Associate editor *IEEE Intelligent Vehicles Symposium*, 2016, 2017.
- Award committee of best paper award for the conference Hybrid Systems: Computation and Control, 2015.

10.2 Service to TUM

10/2020	Head of course of studies *Robotics, Cognition, Intelligence.*
10/2019	Head of selection committee *Tenure Track Assistant Professor in Healthcare and Rehabilitation Robotics.*

10/2019	Head of selection committee *Tenure Track Assistant Professor in Machine Learning for Robotics*.
08/2019	Host of Prof. Bai Xue, State Key Laboratory of Computer Science, Institute of Software Chinese Academy of Sciences, Beijing, China.
10/2018	ISMAR'18 TUM Open House Reception: Formally Safe Human-Robot Co-existence Demonstration.
10/2018	Open house day: Who let the robots out of the cage (demonstration of our modular robot).
08/2018	Host of the August-Wilhelm Scheer Visiting Professor Peng Zhang, University of Connecticut, Electrical and Computer Engineering, USA.
05/2018	Panel discussion of equal opportunity event from IFF (Informatik Forum Frauen)
12/2017	Talk at information event *Let's talk about Courses & Exams @ in.tum.*
10/2017	Host of the August-Wilhelm Scheer Visiting Professor Maria Prandini, Politecnico di Milano, Dipartimento di Elettronica, Italy.
10/2017	Open house day: Who let the robots out of the cage (demonstration of our modular robot).
06/2017	Talk at information event *Let's talk about Courses & Exams @ in.tum.*
12/2016	Talk at information event *Let's talk about Courses & Exams @ in.tum.*
10/2016	Open house day: Who let the robots out of the cage (demonstration of our modular robot).
01/2016	Member of the selection committee for the professorship *Cyber-Physical Production Systems*.
06/2015	Development of document *Getting Started at TUM* for incoming PhD students (contact: Zizheng Zhang, M.A., Project Manager, International Cooperations & Diversity)
01/2015	Member of the TUM focus group to initiate a robotics center.
10/2015	Focus group member of the TUM-IAS Hans Fischer Senior Fellow Anca Muscholl, University of Bordeaux, Computer Science, France.
09/2015	Co-host of the TÜV SÜD Foundation Visiting Professor Marco Caccamo, University of Illinois at Urbana-Champaign, Computer Science, USA.
04/2015	Co-author of proposal for the integrative research center *TUM Robotics*.
03/2015	Examinations board of course of studies *Robotics, Cognition, Intelligence*
11/2013	Hosting of a 7th grade class from the Günter-Stöhr-Gymnasiums in Icking including a research presentation on automated vehicles

10.3 Service to Academic Community

To showcase the usefulness of our research and tools, I have established with Goran Frehse the workshop series *Applied Verification for Continuous and Hybrid Systems (ARCH)*. The goal of ARCH is to bring people from industry together with researchers and tool developers interested in applying verification to continuous and hybrid systems.

10.3.1 Organization of Scientific Meetings

07/2020	Organizer (with Goran Frehse, Sergiy Bogomolov, and Taylor T. Johnson) of the *7th Workshop on Applied Verification for Continuous and Hybrid Systems* (`http://cps-vo.org/group/ARCH`), Berlin, Germany (held virtually as part of the IFAC World Congress). The workshop also hosted a competition.
04/2019	Organizer (with Goran Frehse, Sergiy Bogomolov, and Taylor T. Johnson) of the *6th Workshop on Applied Verification for Continuous and Hybrid Systems* (`http://cps-vo.org/group/ARCH`), Montreal, Canada (held as part of the Cyber-Physical Systems Week). The workshop also hosted a competition.
07/2018	Organizer (with Goran Frehse, Sergiy Bogomolov, and Taylor T. Johnson) of the *5th Workshop on Applied Verification for Continuous and Hybrid Systems* (`http://cps-vo.org/group/ARCH`), Oxford, UK (held as part of the IFAC Conference on Analysis and Design of Hybrid Systems). The workshop also hosted a competition.
04/2017	Organizer (with Goran Frehse, Sergiy Bogomolov, and Taylor T. Johnson) of the *4th Workshop on Applied Verification for Continuous and Hybrid Systems* (`http://cps-vo.org/group/ARCH`), Pittsburgh, USA (Within top 3 most visited workshop out of 21 at CPS Week). The workshop also hosted a competition.
04/2016	Organizer (with Goran Frehse, Sergiy Bogomolov, and Taylor T. Johnson) of the *3rd Workshop on Applied Verification for Continuous and Hybrid Systems* (`http://cps-vo.org/group/ARCH`), Vienna, Austria (Within top 3 most visited workshop out of 21 at CPS Week).
10/2015	Organizer of the midterm conference of the EU project *SMART-E* (5 days).
04/2015	Organizer (with Goran Frehse, Sergiy Bogomolov, and Taylor T. Johnson) of the *2nd Workshop on Applied Verification for Continuous and Hybrid Systems* (`http://cps-vo.org/group/ARCH`), Seattle, USA (Top 3 most visited workshop out of 12 at CPS Week).
10/2014	Organizer of the technical skills workshop on human-robot interaction and cooperation in the EU project *SMART-E* (5 days including company visits to BMW, DLR, Festo.).
04/2014	Organizer (with Goran Frehse) of the *1st Workshop on Applied Verification for Continuous and Hybrid Systems* (`http://cps-vo.org/group/ARCH`), Berlin, Germany (Most visited workshop out of 10 at CPS Week).

10.3.2 Organizing committees

- *IFAC World Congress*, 2020.
- *14th IEEE International Conference on Automation Science and Engineering*, 2018.

10.3.3 Program committees

- *Hybrid Systems: Computation and Control*, 2014, 2015, 2017-2020.
- *11 the ACM/IEEE International Conference on Cyber-Physical Systems*, 2020.
- *IEEE Workshop on Modeling and Simulation of Cyber-Physical Energy Systems*, 2015 - 2016.

- *Future Active Safety Technology towards Zero traffic accidents (FastZero15)*, 2015.
- *International Workshop on Symbolic and Numerical Methods for Reachability Analysis*, 2015-2019.
- *Workshop on Applied Verification for Continuous and Hybrid Systems*, 2015-2019.
- *1st International Workshop on Cyber-Physical Systems in the Context of Smart Cities*, 2016.
- *1st Int. Workshop on Assurance of Safety-Critical Systems with Higher - Order Dynamics*, 2016.
- *Workshop on Formal Verification of Autonomous Vehicles*, 2017.
- *1st International Workshop on Safe Control of Connected and Autonomous Vehicles*, 2017.
- *Winter Simulation Conference (WSC)*, 2017.
- *IFAC Conference on Analysis and Design of Hybrid Systems (ADHS)*, 2018.
- *Ninth Workshop on Model-Based Design of Cyber Physical Systems (CyPhy)*, 2019.
- *ACM/IEEE International Conference on Cyber-Physical Systems (ICCPS2020)*, 2020.

10.3.4 Review Activities

Journals

- IEEE Transactions on Intelligent Transportation Systems
- IEEE Transactions on Automatic Control
- Automatica
- Asian Journal of Control
- Nonlinear Analysis: Hybrid Systems
- Autonomous Robots
- The International Journal of Robotics Research
- IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems
- Engineering Applications of Artificial Intelligence
- Advances in Operations Research
- IEEE Transactions on Vehicular Technology
- Mathematics in Computer Science
- Microelectronics Journal
- Formal Methods in System Design
- IEEE Design & Test of Computers

- IEEE Transactions on Energy Conversion
- IEEE Robotics and Automation Letters
- ACM Transactions on Design Automation of Electronic Systems
- Reliable Computing
- ACM Transactions on Cyber-Physical Systems
- IEEE Intelligent Transportation Systems Magazine
- Robotics and Autonomous Systems
- IEEE Transactions on Industrial Electronics
- Control Engineering Practice
- IEEE Control Systems Letters
- IEEE Transactions on Intelligent Vehicles
- IET Cyber-Physical Systems: Theory & Applications
- IEEE Transactions on Network Science and Engineering
- International Journal of Control
- IEEE Transactions on Aerospace and Electronic Systems
- Advances in Space Research
- IEEE Access
- Mechanical Systems and Signal Processing
- Transportation Research Part C

Conferences

- Hybrid Systems: Computation and Control
- IEEE Conference on Decision and Control
- IEEE Intelligent Vehicles Symposium
- American Control Conference
- European Control Conference
- IEEE Conference on Intelligent Transportation Systems
- IEEE International Conference on Robotics and Automation
- IEEE/RSJ International Conference on Intelligent Robots and Systems
- Mediterranean Conference on Control and Automation
- IEEE International Conference on Automation Science and Engineering

- Computer Aided Verification
- IEEE Multi-Conference on Systems and Control
- International Symposium on Resilient Control Systems
- IFAC Conference on Analysis and Design of Hybrid Systems
- International Symposium on Real-Time and Embedded Systems and Technologies

Workshops

- Workshop on Advanced Control and Navigation for Autonomous Aerospace Vehicles
- International Workshop on Reachability Problems
- IEEE Workshop on Modeling and Simulation of Cyber-Physical Energy Systems
- Future Active Safety Technology towards Zero traffic accidents (FastZero15)
- International Workshop on Symbolic and Numerical Methods for Reachability Analysis
- Workshop on Applied Verification for Continuous and Hybrid Systems
- International Workshop on Safe Control of Connected and Autonomous Vehicles
- International Workshop on Symbolic and Numerical Methods for Reachability Analysis
- International Workshop on Cyber-Physical Systems in the Context of Smart Cities
- Workshop on Formal Verification of Autonomous Vehicles
- mobil.TUM

Grants

- Carl-Zeiss Foundation
- German Research Foundation (DFG)
- Alexander von Humboldt Foundation

10.3.5 Tool Development (selection)

- **CORA**: Tool for reachability analysis of continuous and hybrid systems (cora.in.tum.de).
- **AROC**: Tool for automated reachset optimal control (aroc.cps.in.tum.de).
- **SPOT**: Tool for set-based prediction of traffic participants (spot.in.tum.de).
- **CommonRoad**: Benchmark suite for autonomous driving (commonroad.in.tum.de).