

Jonathan A. DeCastro

CONTACT INFORMATION	Toyota Research Institute One Kendall Square Cambridge, MA 02139 <i>public github</i> : jadecastro	<i>t</i> : +1-585-425-7184 <i>e</i> : jad455@cornell.edu <i>w</i> : jadecastro.github.io
RESEARCH INTERESTS	Learning for Human-Robot Collaboration • Formal Methods • Generative Modeling • Control and Dynamical Systems • Robotics	
EDUCATION	Ph.D., Mechanical and Aerospace Engineering Cornell University, Ithaca, NY Advisor: Prof. Hadas Kress-Gazit Graduate Minors: Computer Science, Computational Science and Engineering	2015–2017
	M.S., Mechanical and Aerospace Engineering Cornell University, Ithaca, NY	2011–2014
	B.S. / M.S., Mechanical Engineering (Magna Cum Laude) Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA	1997–2003
SOFTWARE SKILLS	Platforms: Linux, Mac OS X, Robot Operating System (ROS) Languages and software: Bazel, bash, C/C++, Docker, emacs, GCC, git, html, jupyter, LaTeX, Python, MATLAB/Simulink	
INDUSTRY AND RESEARCH EXPERIENCE	Senior Research Scientist, Toyota Research Institute, Cambridge, MA <i>Human-Aware Learning Group</i> <ul style="list-style-type: none">• Co-launched a multi-disciplinary initiative across disciplines in ML, HCI, and Behavioral Science on learning personalized human driver interaction modes based on past driving behavior. Collected training data from a set of 50 human drivers in a motion simulator, trained a latent variable model contained in an inverse reinforcement learning loop for constructing personalized interaction policies. Deployed a working prototype in real-time in the motion simulator, presented key findings to departments across Toyota, and wrote papers.• Led the development and deployment of data-driven, generative agent behavior models for simulation-based testing, with focus on agent interpretability and test coverage. Implemented the learning-based approach with an in-house simulator for use with regression tests.• Served as technical Co-PI for five TRI-sponsored multi-year research projects at MIT, Berkeley, Stanford and U. Michigan spanning topics from temporal logic-based planning, to behavior modeling and adversarial testing of an autonomous driving stack. Responsible for idea generation, mentoring of students and interns, paper writing and presentations, and tech transfer to TRI and Toyota Motor Corporation.• Contributed models and motion planning and control algorithms as a developer to the open-source <i>Drake toolkit</i>.	July 2016–Present
	Graduate Research Assistant, Cornell University, Ithaca, NY <i>Verifiable Robotics Research Group</i> <ul style="list-style-type: none">• Developed algorithms in C++, Python and MATLAB for automated, correct-by-construction synthesis of controllers for robots with nonlinear dynamics through application of formal methods and optimization.• Authored 7 publications featured in international conference proceedings, workshops and robotics journals.	August 2011–February 2017
	Lead Systems Engineer, Impact Technologies, Rochester, NY <i>Control and Prediction Group</i> <ul style="list-style-type: none">• Contributed to the body of research on algorithms for flight control, in-flight fault diagnosis and submarine navigation.• Awarded four Phase 1 and two Phase 2 Small Business Innovation Research (SBIR) grants as Principal Investigator totaling \$1.8M for DoD- and NASA-sponsored research.	July 2008–August 2011

Intelligent Control and Autonomy Branch

- Serves as a technical lead on **Commercial Modular Aero-Propulsion System Simulation (C-MAPSS)**, a MATLAB-based “virtual” aircraft engine serving and currently in wide use by researchers and practitioners in academia, industry and government.
- Investigated control algorithms for in-flight aircraft control reconfiguration during emergencies.

JOURNAL
PUBLICATIONS

C. Mavrogiannis, **J. DeCastro**, and S. S. Srinivasa. Multiagent Behavior Modeling and Reasoning for Traffic Scenes via Topological Braids. (in review) 2023.

X. Huang, S. McGill, **J. DeCastro**, L. Fletcher, J. Leonard, B. Williams, G. Rosman. CARPAL: Confidence-aware intent recognition for parallel autonomy. *Robotics and Automation Letters*. 6(3):4433–4440, 2021.

X. Li, G. Rosman, I. Gilitschenski, C. I. Vasile, **J. DeCastro**, S. Karaman, D. Rus. Vehicle Trajectory Prediction Using Generative Adversarial Network With Temporal Logic Syntax Tree Features. *Robotics and Automation Letters*. 6(2):3459–3466, 2021.

X. Huang, S. McGill, **J. DeCastro**, L. Fletcher, J. Leonard, B. Williams, G. Rosman. DiversityGAN: Diversity-Aware Vehicle Motion Prediction via Latent Semantic Sampling. *Robotics and Automation Letters*. 5(4):5089–5096, 2020.

J. Alonso-Mora, **J. DeCastro**, V. Raman, D. Rus and H. Kress-Gazit. Reactive Mission and Motion Planning while Avoiding Dynamic Obstacles. *Autonomous Robots*, 42(4):801–824, 2018.

J. DeCastro, R. Ehlers, M. Rungger, A. Balkan, and H. Kress-Gazit. Automated Generation of Dynamics-Based Runtime Certificates for High-Level Control. *Discrete Event Dynamic Systems Special Issue on Formal Methods in Control*, 27(2):371–405, 2017.

J. DeCastro and H. Kress-Gazit. Synthesis of Nonlinear Continuous Controllers for Verifiably-Correct High-Level, Reactive Behaviors. *International Journal of Robotics Research*, 34(3):378–394, 2015.
doi:10.1177/0278364914557736

X. Zhang, L. Tang and **J. DeCastro**. Robust Fault Diagnosis of Aircraft Engines: A Nonlinear Adaptive Estimation-Based Approach. *IEEE Trans. on Control Systems Technology*, 21(3):861–868, 2013.
doi:10.1109/TCST.2012.2187057.

J. DeCastro. Rate-Based Model Predictive Control of Turbofan Engine Clearance. *AIAA Journal of Propulsion and Power*. 23(4):804–813, 2007. doi:10.2514/1.25846

AIAA NOS Best Young Professional Paper

REFEREED
CONFERENCE
PUBLICATIONS

A. Shah, **J. DeCastro**, J. Gideon, G. Rosman, S. Seshia, Specification-Guided Data Aggregation for Semantically Aware Imitation Learning. (in review) 2023.

J. Lidard, et. al., GAME-UP: Game-Aware Mode Enumeration and Understanding for Trajectory Prediction. (in review) 2023.

R. Karagulle, N. Aréchiga, **J. DeCastro**, and N. Ozay. Classification of Driving Behaviors using STL Formulas: A Comparative Study. *Formal Modeling and Analysis of Timed Systems: 20th International Conference, FORMATS 2022*, Warsaw, Poland, September 13–15, 2022.

D. Li, M.L. Shehab, Z. Liu, N. Aréchiga, **J. DeCastro**, and N. Ozay. Outlier-robust Inverse Reinforcement Learning and Reward-based Detection of Anomalous Driving Behaviors. *25th International Conference on Intelligent Transportation Systems (ITSC)*, Macau, China, October 08–12 2022.

C. Mavrogiannis, **J. DeCastro**, and S. S. Srinivasa. Implicit Multiagent Coordination at Uncontrolled Intersections via Topological Braids. *Algorithmic Foundations of Robotics XV: Proceedings*, 2022.

Invited to IJRR Special Issue: The Best of WAFR 2022

C. Mavrogiannis, **J. DeCastro**, and S. S. Srinivasa. Analyzing Multiagent Interactions in Traffic Scenes via Topological Braids. *International Conference on Robotics and Automation (ICRA)*, May 23–27, 2022.

X. Li, **J. DeCastro**, C. I. Vasile, S. Karaman, D. Rus. Learning A Risk-Aware Trajectory Planner From Demonstrations Using Logic Monitor. *5th Annual Conference on Robot Learning (CoRL)*, November 8–11, 2021.

B. Araki, X. Li, K. Vodrahalli, **J. DeCastro**, M. Fry, D. Rus. The Logical Options Framework. *Proceedings of the 38th International Conference on Machine Learning (ICML)*, July 18–24, 2021.

- X. Li, G. Rosman, I. Gilitschenski, **J. DeCastro**, C. I. Vasile, S. Karaman, and D. Rus. Differentiable Logic Layer for Rule Guided Trajectory Prediction. *5th Annual Conference on Robot Learning (CoRL)*, November 16–18, 2020.
- S. Shiroshita, S. Maruyama, D. Nishiyama, M. Ynocente Castro, K. Hamzaoui, G. Rosman, **J. DeCastro**, K. -H. Lee, and A. Gaidon. Behaviorally Diverse Traffic Simulation via Reinforcement Learning. *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Virtual Conference, October 25–29, 2020.
- J. DeCastro**, K. Leung, N. Aréchiga, and M. Pavone. Interpretable Policies from Formally-Specified Temporal Properties. *Proceedings of the 23rd IEEE International Conference on Intelligent Transportation Systems (ITSC)*, Virtual Conference, September 20–23, 2020.
- D. Nishiyama, M. Ynocente Castro, S. Maruyama, S. Shiroshita, K. Hamzaoui, Y. Ouyang, G. Rosman, **J. DeCastro**, K. -H. Lee, and A. Gaidon. Discovering Avoidable Planner Failures of Autonomous Vehicles using Counterfactual Analysis in Behaviorally Diverse Simulation. *Proceedings of the 23rd IEEE International Conference on Intelligent Transportation Systems (ITSC)*, Virtual Conference, September 20–23, 2020.
- J. DeCastro**, L. Liebenwein, C. I. Vasile, R. Tedrake, S. Karaman and D. Rus. Counterexample-Guided Safety Contracts for Autonomous Driving. *Proceedings of the 13th International Workshop on the Algorithmic Foundations of Robotics (WAFR)*, Mérida, Mexico, December 9–11, 2018.
- L. Liebenwein, W. Schwarting, C. I. Vasile, **J. DeCastro**, J. Alonso-Mora, S. Karaman and D. Rus. Compositional and Contract-based Verification for Autonomous Driving on Road Networks. *International Symposium on Robotics Research (ISRR)*, Puerto Varas, Chile, December 11–14, 2017.
- J. DeCastro** and H. Kress-Gazit. Nonlinear Controller Synthesis and Automatic Workspace Partitioning for Reactive High-Level Behaviors. *Proceedings of the 19th ACM International Conference on Hybrid Systems: Computation and Control (HSCC)*, Vienna, Austria, April 12–14, 2016.
- J. DeCastro**, J. Alonso-Mora, V. Raman, D. Rus and H. Kress-Gazit. Collision-Free Reactive Mission and Motion Planning for Multi-Robot Systems. In: *Proceedings of the 17th International Symposium on Robotics Research (ISRR)*, Sestri Levante, Italy, September 12–15, 2015.
- J. DeCastro**, V. Raman and H. Kress-Gazit. Dynamics-Driven Adaptive Abstraction for Reactive High-Level Mission and Motion Planning. In: *Proceedings of the IEEE/RSJ International Conference on Robotics and Automation (ICRA 2015)*, Seattle, WA, USA, May 26–30, 2015.
- J. DeCastro** and H. Kress-Gazit. Guaranteeing Reactive High-Level Behaviors for Robots with Complex Dynamics. In: *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2013)*, Tokyo, Japan, November 3–8, 2013.
- J. DeCastro**, L. Tang, B. Zhang and G. Vachtsevanos. A Safety Verification Approach to Fault-Tolerant Aircraft Supervisory Control. In: *Proceedings of the AIAA Guidance, Navigation, and Control Conference*, Portland, OR, USA, August 8–11, 2011.
- J. DeCastro**, J. S. Litt, and D. K. Frederick. A Modular Aero-Propulsion System Simulation of a Large Commercial Aircraft Engine. In: *Proceedings of the 44th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit*, Hartford, CT USA, July 21–23, 2008.
- J. DeCastro**, D. Gopinath, G. Rosman, E. Sumner, S. Hakimi, and S. Stent. Learning Latent Traits for Simulated Cooperative Driving Tasks. *CoRR*, abs/2207.09619, 2022. arXiv:<https://arxiv.org/abs/2207.09619>.
- D. Gopinath, **J. DeCastro**, G. Rosman, E. Sumner, A. Morgan, S. Hakimi, and S. Stent. HMIway-env: A Framework for Simulating Behaviors and Preferences to Support Human-AI Teaming in Driving. *HCIS Workshop at Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition*, pp. 4342–4350, 2022.
- C. Mavrogiannis, **J. DeCastro**, and S. S. Srinivasa. Implicit Multi-Agent Coordination at Unsignalized Intersections via Topological Inference. *CoRR*, abs/2109.07060, 2021. arXiv:<https://arxiv.org/abs/2109.07060>.
- D. Jackson, **J. DeCastro**, S. Kong, D. Koutentakis, A. Leong Feng Ping, A. Solar-Lezama, M. Wang and X. Zhang. Certified Control for Self-Driving Cars. *4th Workshop on the Design and Analysis of Robust Systems (DARS)*, New York, NY, USA, 2019.

N. Aréchiga, **J. DeCastro**, S. Kong and K. Leung. Better AI through Logical Scaffolding. *2nd Workshop on Formal Methods for ML-Enabled Autonomous Systems (FoMLAS)*, New York, NY, USA, 2019. arXiv:<https://arxiv.org/abs/1909.06965>.

J. DeCastro, R. Ehlers, M. Rungger, A. Balkan, P. Tabuada, and H. Kress-Gazit. Dynamics-Based Reactive Synthesis and Automated Revisions for High-Level Robot Control. *CoRR*, abs/1410.6375, 2014. arXiv:<http://arxiv.org/abs/1410.6375>.

J. DeCastro. Mission Possible: Guaranteeing Reactive Missions for Complex Robots. In: *ICRA 2015 Ph.D. Forum*, Seattle, WA, USA, May 26, 2015.

INVITED TALKS

Learning Descriptions of Risky Human Behavior using Temporal Logics, *Safe and Reliable Robot Autonomy under Uncertainty at ICRA 2022*, May 2022. **Host:** Glen Chou.

Formally-Specifiable Agent Behavior Models for Autonomous Vehicle Test Generation, *Automation and Test in Europe Conference (DATE 2020)*, March 2020. **Hosts:** Prof. Jyotirmoy Deshmukh and Nikos Aréchiga.

Simulation and Verification for Autonomous Vehicles in Traffic Scenarios, *NSF ExCAPE Annual Meeting*, U. Penn, June 2017. **Host:** Prof. Rajeev Alur.

Guaranteeing Reactive Missions for Complex Robots, *Invited Seminar Speaker*, NASA Jet Propulsion Laboratory, December 2015.

Guaranteeing Reactive Missions for Complex Robots, *Invited Seminar Speaker*, MIT Lincoln Laboratory, November 2015.

Generalized Collision-Free Reactive Mission and Motion Planning for Multi-Robot Systems, *NSF ExCAPE Annual Meeting*, MIT, June 2015. **Host:** Prof. Armando Solar-Lezama.

Abstractions and Revisions for Synthesis for Nonlinear Robots, *NSF ExCAPE Annual Meeting*, U. C. Berkeley, March 2014. **Host:** Prof. Sanjit Seshia.

Reactive High-Level Robot Controller Synthesis: Optimality, Environment, and Dynamics, *NSF ExCAPE Robotics Workshop*, Rice University, November 2013. **Host:** Prof. Lydia Kavraki.

GRANTED PATENTS

S.H. Kong, **J. DeCastro**, N. Aréchiga, F. Permenter. Personalized notification system for mobility as a service, US Patent 11,543,258.

N. Aréchiga, S.H. Kong, **J. DeCastro**, F. Permenter, D. Park. Predictive impairment monitor system and method, US Patent 11,518,408.

N. Aréchiga, S.H. Kong, **J. DeCastro**, F. Permenter, D. Park. Predictive parking due to weather, US Patent 11,479,239.

N. Aréchiga, K.Y. Leung, S.H. Kong, **J. DeCastro**, F. Permenter. Simulation-based technique to synthesize controllers that satisfy signal temporal logic specifications, US Patent 11,256,611.

N. Aréchiga, S.H. Kong, **J. DeCastro**, S. Behere, D. Park. System and method for detecting errors and improving reliability of perception systems using logical scaffolds, US Patent 11,157,756.

S.H. Kong, **J. DeCastro**, N. Aréchiga, F. Permenter. Actively adapting to driving environments based on human interactions, US Patent 11,072,342.

G. Rosman, **J. DeCastro**, N. Aréchiga, J. Leonard, L. Fletcher, D. Stonier. Systems and methods for agent tracking, US Patent 10,882,522.

J. DeCastro, F. Permenter, S. Kong, N. Aréchiga. Systems and methods for improving situational awareness of a user, US Patent 10,621,858.

TEACHING AND MENTORING EXPERIENCE

Ph.D. Thesis Committee Member, Abolfazl Karim, University of North Carolina at Chapel Hill.

Teaching Assistant, System Dynamics, Cornell University Spring 2016

Teaching Assistant, Autonomous Mobile Robots, Cornell University Spring 2015

Mentor, Undergraduate Research, Cornell University Spring 2015, Spring 2016

	Instructor , System Modeling, Rochester Institute of Technology	Winter 2010–2011
	<ul style="list-style-type: none"> Administered, lectured and graded an entire course for senior undergrad and graduate students 	
SERVICE AND OUTREACH	Panelist , “AI is All Around Us: A High School Symposium”, Museum of Science, Boston	2022
	Panelist , “Navigating a World with AI Science and Society: A High School Symposium”, Museum of Science, Boston, attended by 750 high school students from 24 states and 6 countries	2022
	Workshop Co-Organizer , “Transforming Specifications into Robot Programs: A Survey of Formal Methods Tools for Non-Experts”	2021
	Workshop Organizer , “Command Your Own Robot”	2014, 2015
	Voting Member , Cornell Graduate and Professional Student Assembly	2013–2014
	Program Committee	
	<ul style="list-style-type: none"> Robotics Science and Systems (RSS) 37th AAAI Conference on Artificial Intelligence (AAAI) Conference on Robot Learning (CoRL) Spring Simulation Conference (SpringSim) Hybrid Systems Computation and Control (HSCC) 	2023 2023 2022 2020 2018, 2019
	Reviewer	
	<ul style="list-style-type: none"> International Conference on Robotics and Automation (ICRA) International Conference on Intelligent Robots and Systems (IROS) American Control Conference (ACC) Journal of Artificial Intelligence Research (JAIR) Robotics and Automation Letters (RA-L) Intelligent Vehicles Symposium (IV) Hybrid Systems Computation and Control (HSCC): Program Committee Member IEEE Transactions on Robotics (T-RO) International Conference on Cyber-Physical Systems (ICCPs) IEEE Transactions on Industrial Electronics 	2023, 2022, 2020, 2018, 2017, 2015, 2014 2022, 2021, 2019, 2018, 2016 2022, 2014 2021 2020, 2018 2020 2019, 2018 2016, 2018 2015 2013, 2012, 2011
HONORS AND AWARDS	Travel Grant to ICRA in Seattle, WA; sponsored by IEEE RAS and NSF	2015
	Cornell MAE Fellowship , a merit-based award to incoming Ph.D. students	2011–2012
	ASME Propulsion Best Paper Award	2009
	NASA Group Achievement Award for outstanding group accomplishment (C-MAPSS Team)	2009
	NASA Space Act Award for an outstanding technical contribution	2007
	AIAA Best Young Professional Paper awarded by the Northern Ohio Section of AIAA	2007