

Rahul Bhadani

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Publications: <https://tinyurl.com/rbazpubs>

EDUCATION

The University of Arizona, Tucson, AZ, USA

GPA: 3.78/4.00

Doctor of Philosophy, Electrical & Computer Engineering, March 2022 (Expected)

Dissertation: Design and Synthesis of Controllers for Societal-Scale Cyber-Physical Systems
with an application to repeatable & scalable simulation of autonomous vehicles

Advisor: Dr. Jonathan Sprinkle

Master of Science, Statistics, April 2022

Thesis: Graph-Learning on Single-Cell Multi-Omics

Advisor: Dr. Lingling An

Master of Science, Electrical and Computer Engineering, May 2017

Institute for Pure & Applied Mathematics, UCLA

Visiting Researcher, Mathematical Challenges and Opportunities for Autonomous Vehicles, September 2020 – December 2020

PROJECTS

The Congestion Impacts Reduction via CAV-in-the-loop Lagrangian Energy Smoothing (CIRCLES) (2020 – Ongoing): The CIRCLES project aims to reduce instabilities in traffic flow, called "phantom jams," that cause congestion and wasted energy. As a part of this project, we are developing custom hardware and software to enable a stock vehicle to act as an autonomous vehicle, create machine-learning based vehicle control with a combined objective of mitigating phantom jams and reduce energy consumption. The deployment of machine-learning based controller on stock vehicle employs steps such as model-based design, software-in-the-loop and hardware-in-the-loop.

Principal Investigators: Alexandre Bayen, Benedetto Piccoli, Benjamin Seibold, Jonathan Sprinkle, Daniel B. Work.

Sponsor: Department of Energy

Award Number: CID DE-EE0008872

Attention-based Graph Neural Network for Label Transfer in in Single Cell Multiomics Data We see new opportunities arising due to breakthroughs in single-cell to gain novel biological insights. They can provide comprehensive cell profiling and genetic screening at the single-cell level. The study of cellular heterogeneity using novel multi-omics studies can leverage existing labeled single-cell datasets. Such

studies can be done through semi-supervised or supervised learning that relies on a notion of similarity metrics. We propose a machine learning method that uses an attention-based graph neural network for label transfer. The performance of our method scAGN is to be evaluated on publicly available single-cell multi-omics datasets using label transfer accuracy.

Advisor: Lingling An

EXPERIENCE

Graduate Research Assistant ECE/SIE, The University of Arizona
08/2015 – Present Tucson, Arizona

Research Assistant for Leidos/Federal Highway Administration funded project on cooperative driving automation and TSMO (Transportation Systems Management and Operations) use cases (*PI: Professor Larry Head*)

Research Assistant on CIRCLES Project: Lagrangian Energy Smoothing via Vehicle Automation (*PI: Professor Alexandre Bayen*) funded by National Science Foundation and Department of Energy, US

Research Assistant for Arizona Ring-road Experiment: Control of Vehicular Traffic Flow via Low Density Autonomous Vehicles (*PI: Professor Jonathan Sprinkle*) funded by National Science Foundation, US

Research Assistant for Cyber-physical Systems Virtual Organization (CPS-VO) project (*PI: Professor Jonathan Sprinkle*) funded by National Science Foundation, US

Instructor for Graduate-level ECE, The University of Arizona
Software Engineering ECE 473/573

01/2021 – 06/2021 Tucson, Arizona
Taught Software Engineering to a class size of 20 consisting of seniors and graduate students.

Graduate Teaching Assistant for ECE, The University of Arizona
Programming for Engineering

Applications (C++)
08/2019 – 12/2019 Tucson, Arizona
Co-taught sophomore/junior level class on application of C++ to solve engineering problems with Professor Jonathan Sprinkle

Graduate Mentor and Project NSF CAT Vehicle Research Experience
Coordinator for Undergraduates

05/2016 – 08/2020, Every Summer Tucson, Arizona
Mentoring and supervising undergraduate students on projects related to intelligent transportation, and autonomous driving; Crash course development to train undergraduate students on Robot Operating System (ROS), Linux, Control Theory and DevOps Tools.

Software Engineer-II Oracle India

July 2014 – July 2015
Oracle HCM Products

Hyderabad, India

Software Engineer-I

June 2012 – July 2014

Software Suites for testing LTE equipment

Polaris Networks

Kolkata, India

PUBLICATIONS

1. **Bhadani, Rahul**, and Ivan B. Djordjevic. “Optimized Receiver Design for Entanglement Assisted Communication using BPSK” **submitted** to IEEE Transactions on Communications, July 2021.
2. Chou, Fang-Chieh, Alben Bagabaldo, and Alexandre M. Bayen, **Rahul Bhadani**, et al. “The Lord of the Ring Road: A review and evaluation of autonomous control policies for traffic in a ring road” **Accepted** in Transactions on Cyber-Physical Systems, October 2021.
3. **Bhadani, Rahul**, and Ivan B. Djordjevic. “Optimized Squeezing Operation for Phase-Shift Keying Quantum State Discrimination” **submitted** to IEEE Access, July 2021.
4. **Bhadani, Rahul**, and Ivan B. Djordjevic. “Optical Hybrid-based Optimal Receiver Design for Entanglement-Assisted Communication” **accepted** to Frontiers in Optics and Laser Science (FiO-LS), 31 October – 04 November 2021.
5. Chou, Fang-Chieh, Marsalis Gibson, **Rahul Bhadani**, Alexandre M. Bayen, and Jonathan Sprinkle. “Reachability Analysis for FollowerStopper: Safety Analysis and Experimental Results.” In 2021 IEEE International Conference on Robotics and Automation (ICRA), pp. 8607-8613. IEEE, 2021.
6. Nice, Matthew, Safwan Elmadani, **Rahul Bhadani**, Matt Bunting, Jonathan Sprinkle, and Dan Work. “CAN coach: vehicular control through human cyber-physical systems.” In Proceedings of the ACM/IEEE 12th International Conference on Cyber-Physical Systems, pp. 132-142. April 2021.
7. Elmadani, Safwan, Matthew Nice, Matthew Bunting, Jonathan Sprinkle, and **Rahul Bhadani**. “From CAN to ROS: A Monitoring and Data Recording Bridge.” In Proceedings of the Workshop on Data-Driven and Intelligent Cyber-Physical Systems, pp. 17-21. April 2021.
8. Bunting, Matthew, **Rahul Bhadani**, and Jonathan Sprinkle. “Libpanda: A High Performance Library for Vehicle Data Collection.” In Proceedings of the Workshop on Data-Driven and Intelligent Cyber-Physical Systems, pp. 32-40. April 2021.
9. Lee, Jonathan W., George Gunter, Rabie Ramadan, Sulaiman Almatrudi, Paige Arnold, John Aquino, William Barbour, **Rahul Bhadani** et al. “Integrated Framework of Vehicle Dynamics, Instabilities, Energy Models, and Sparse Flow Smoothing Controllers.” In Proceedings of the Workshop on Data-Driven and Intelligent Cyber-Physical Systems, pp. 41-47. April 2021.

10. **Bhadani, Rahul**, and Ivan B. Djordjevic. “Constellation Optimization for Phase-Shift Keying Coherent States With Displacement Receiver to Maximize Mutual Information.” *IEEE Access*, December 2020.
11. **Bhadani, Rahul**, Michael Grace, Ivan B. Djordjevic, Jonathan Sprinkle, and Saikat Guha. “Programming the Kennedy receiver for capacity maximization versus minimizing one-shot error probability.” In *Frontiers in Optics*, pp. JM6B-29. Optical Society of America, September 2020.
12. Gunter, George, Derek Gloudemans, Raphael E. Stern, Sean McQuade, **Rahul Bhadani**, Matt Bunting, Maria Laura Delle Monache et al. “Are commercially implemented adaptive cruise control systems string stable?.” *IEEE Transactions on Intelligent Transportation Systems*, June 2020.
13. **Bhadani, Rahul**, Matt Bunting, and Jonathan Sprinkle. “Model-Based Engineering with Application to Autonomy.” *Complexity Challenges in Cyber Physical Systems: Using Modeling and Simulation (M&S) to Support Intelligence, Adaptation and Autonomy*, December 2019.
14. Bentley, Landon, Joe MacInnes, Hannah Mason, **Rahul Bhadani**, and Tamal Bose. “A Sliding Window for Path Mapping Based on a Pseudo-Derivative Method in Autonomous Navigation.” In *2019 IEEE 90th Vehicular Technology Conference (VTC2019-Fall)*, pp. 1-4. IEEE, September 2019.
15. Delle Monache, Maria Laura, Thibault Liard, Anaïs Rat, Raphael Stern, **Rahul Bhadani**, Benjamin Seibold, Jonathan Sprinkle, Daniel B. Work, and Benedetto Piccoli. “Feedback control algorithms for the dissipation of traffic waves with autonomous vehicles.” In *Computational Intelligence and Optimization Methods for Control Engineering*, pp. 275-299. Springer, Cham, September 2019.
16. **Bhadani, Rahul**, Matthew Bunting, Benjamin Seibold, Raphael Stern, Shumo Cui, Jonathan Sprinkle, Benedetto Piccoli, and Daniel B. Work. “Real-time distance estimation and filtering of vehicle headways for smoothing of traffic waves.” In *Proceedings of the 10th ACM/IEEE International Conference on Cyber-Physical Systems*, pp. 280-290. April 2019.
17. Wu, Fangyu, Raphael E. Stern, Shumo Cui, Maria Laura Delle Monache, **Rahul Bhadani**, Matt Bunting, Miles Churchill et al. “Tracking vehicle trajectories and fuel rates in phantom traffic jams: Methodology and data.” *Transportation research part C: emerging technologies*, February 2019.
18. **Bhadani, Rahul**, Benedetto Piccoli, Benjamin Seibold, Jonathan Sprinkle, and Daniel Work. “Dissipation of emergent traffic waves in stop-and-go traffic using a supervisory controller.” In *2018 IEEE Conference on Decision and Control (CDC)*, pp. 3628-3633. IEEE, December 2018.
19. Segata, Michele, Renato Lo Cigno, **Rahul Bhadani**, Matthew Bunting, and Jonathan Sprinkle. “A lidar error model for cooperative driving simulations.” In *2018 IEEE Vehicular Networking Conference (VNC)*, pp. 1-8. IEEE, December 2018. **Best paper award.**

20. **Bhadani, Rahul**, Jonathan Sprinkle, and Matthew Bunting. “The CAT vehicle testbed: A simulator with hardware in the loop for autonomous vehicle applications.” arXiv preprint arXiv:1804.04347, Proceedings 2nd International Workshop on Safe Control of Autonomous Vehicles (SCAV 2018), Porto, Portugal, Electronic Proceedings in Theoretical Computer Science, April 2018.
21. Stern, Raphael E., Shumo Cui, Maria Laura Delle Monache, **Rahul Bhadani**, Matt Bunting, Miles Churchill, Nathaniel Hamilton et al. “Dissipation of stop-and-go waves via control of autonomous vehicles: Field experiments.” Transportation Research Part C: Emerging Technologies, April 2018.

NOTABLE OPEN-SOURCE PROJECTS

- ★ **strym**: An open-source python package for decoding, quality-control and analysis of vehicle CAN data. URL: <https://github.com/jmcsclgroup/strym>
- ★ **bagpy**: An open-source python package for decoding Robot Operating Systems (ROS) bagfiles. URL: <https://github.com/jmcsclgroup/bagpy>. **Key Statistics:** Among top 10% packages on PyPI as per package.wiki.
- ★ **CAT Vehicle Tested**: An open-source ROS package for multi-vehicle simulation to develop and test autonomous driving applications. URL: <https://github.com/jmcsclgroup/catvehicle>
- ★ **CATGraph**: A ROS-based android application developed to read and visualize ROS data from the CAT Vehicle, the self-driving car at the University of Arizona’s Compositional Systems Lab. URL: <https://github.com/rahulbhadani/CATGraph>
- ★ **py3rosmgs**: A python 3.x port of ROS messages obtained from genpy-generated ros_msgs. URL: <https://github.com/rahulbhadani/CATGraph>. **Key Statistics:** Among top 10% packages on PyPI as per package.wiki.

SCHOLARSHIPS & AWARD

1. Michael Pate Memorial Scholarship, College of Optical Sciences, The University of Arizona, Fall 2020 – Spring 2021
2. International Switching Symposium Fellowship, every summer, 2016-2019
3. Best paper award, IEEE Vehicular Networking Conference, 2018, Taipei City

SERVICE

1. Reviewer for IEEE International Conference on Robotics and Automation
2. Reviewer for IEEE Transaction on Vehicular Technology
3. Reviewer for IEEE Transactions on Intelligent Vehicles
4. Reviewer for IEEE Transaction on Intelligent Transportation Systems
5. Reviewer for Transportation Research Board
6. Organizer for The Workshop on Data-Driven and Intelligent Cyber-Physical Systems (DI-CPS), In conjunction with the 2021 CPS-IoT Week