Vindula Jayawardana

Personal Information

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Research Interests

I am broadly interested in *learning-enabled autonomy*. In light of this, I am interested in making multi-agent reinforcement learning seamlessly generalize across problem variations (solving Contextual MDPs). Real-world application-wise, I am interested in learning-enabled planning for autonomous vehicles under problem variations. In the past, I have also worked on mathematical programming for on-demand high-capacity ride-sharing systems and natural language processing for information extraction.

Education

Massachusetts Institute of Technology, Cambridge, USA *Sep 2019-May 2025*
Ph.D. Electrical Engineering and Computer Science (GPA: 4.9/5.0)

Massachusetts Institute of Technology, Cambridge, USA *Sep 2019-Sep 2022*
M.S. Electrical Engineering and Computer Science (GPA: 4.9/5.0)
Thesis: *An Invisible Issue of Task Underspecification in Deep Reinforcement Learning Evaluations*

University of Moratuwa, Colombo, Sri Lanka *Mar 2014 -Dec 2017*
B.S. Computer Science and Engineering (GPA: 4.08/4.2)
Thesis: *Ontology-based Legal Information Extraction*

Relevant Experience

Massachusetts Institute of Technology, Cambridge, USA *Sep 2019-May 2025*
Ph.D. Candidate

- Working with Prof. Cathy Wu at Laboratory for Information and Decision Systems.
- Research on improving robustness and generalization in reinforcement learning, specifically when solving Contextual MDPs [1, 3, R1, F1, W1].
- Model and build large-scale traffic simulations that span over ten major US cities and nearly three million traffic scenarios for impact assessment of cooperative eco-driving [R1, 7, W1].
- Conduct studies validating the efficacy of reinforcement learning for real-world problems, including large-scale eco-driving [4, R1], socially compatible driving [5], traffic smoothing [2, 6], and combinatorial optimizations [F2].

Toyota Motor North America, Mountain View, USA *June 2023-Aug 2023*
Research Intern

- Worked with Dr. Yashar Farid and Mr. Kentaro Oguchi in the Advance Development and Planning group at Toyota InfoTech Labs.
- Improved generalization in multi-agent reinforcement learning across problem variations by combining model-based policies with learning-based policies. Paper published at ICRA 2024 [1].
- Conducted experiments to validate the effectiveness of the proposed method on eco-driving across 600 signalized intersections and 1200 traffic scenarios [1, W1].
- Proposed a hierarchical policy architecture aiming for continual learning for eco-driving across signalized intersections. The patent is in submission [R2].

University of Moratuwa, Colombo, Sri Lanka *Jan 2018-July 2019*
Research Assistant

- Worked with Dr. Shehan Perera and Dr. Uthayasankar Thayasivam.
- Conducted ride-sharing simulations with integer programming for request-driver matching.
- Conducted ride-pooling with meeting points simulations based on integer programming formulations for request-driver-meeting point matching.
- Analyzed the optimality gaps between heuristic methods and optimal methods for ride-pooling with meeting points problem [9].

Digital Mobility Solutions Lanka, Colombo, Sri Lanka *Jan 2018-July 2019*
Consultant Researcher

- Built numerical simulations of ride-sharing in major Sri Lankan cities based on real-world data.
- Evaluated the effectiveness of ride-sharing in select cities with large-scale numerical simulations.

Cornell University, Ithaca, USA *June 2018-Aug 2018*
Research Intern
- Worked with Prof. Samitha Samaranayake.
- Built an open source ride pooling simulator in C++ for large-scale ride pooling with integer programming based driver-passenger matching.
- Formulated Integer programming models for ride pooling with meeting points problem [9].

WSO2, Colombo, Sri Lanka *July 2016-Dec 2016*
Software Engineering Intern
- Developed an open-source library Charon for SCIM 2.0 support following IETF specifications.
- Integrated SCIM 2.0 support for the WSO2 Identity server.

Work in Review

[R1] V. Jayawardana, B. Freydt, A. Qu, C. Hickert, E. Sanchez, C. Tang, S.Chandrasiri, M. Taylor, B.Leonard, C. Wu, *Mitigating metropolitan vehicular carbon emissions with semi-autonomous vehicles using deep reinforcement learning*, In peer-review stage (Nature).
[R2] V. Jayawardana, Y. Farid, K. Oguchi. *Systems and methods for vehicles navigating roads using a control model trained with residual policies*, In review (U.S patent).
[R3] E. Sanchez, C. Tang, V. Jayawardana, and C. Wu, "Learning surrogates for diverse emission models," In review (Journal of Machine Learning Research)
[R4] Y. Kim, V. Jayawardana, S. Samaranayake, *Learning augmented vehicle dispatching with slack times for high-capacity ride-pooling*, In review (TR-C).

Selected Publications

[1] V. Jayawardana, S. Li, C. Wu, Y. Farid, K. Oguchi. *Generalizing cooperative eco-driving via multi-residual task learning*, IEEE International Conference on Robotics and Automation (ICRA) 2024.
[2] D. Suo*, V. Jayawardana*, C. Wu, *Model-free learning corridor clearance: A near term deployment perspective*, IEEE Transactions on Intelligent Transportation Systems (T-ITS) 2023. *** equal contribution**.
[3] V. Jayawardana, C. Tang, S. Li, D. Suo, C. Wu. *The impact of task underspecification in evaluating deep reinforcement learning*, Advances in Neural Information Processing Systems (NeurIPS) 2022.
[4] V. Jayawardana, C. Wu. *Learning eco-driving strategies at signalized intersections*, European control Conference (ECC) 2022. **MIT News Spotlight, NPR, and Tech Crunch featured**.
[5] S. Jayawardana, V. Jayawardana*, K.Vidanage, C. Wu*. *Multi-behavior learning for socially compatible autonomous driving*, IEEE International Conference on Intelligent Transportation Systems (ITSC) 2023. *** equal supervision**
[6] D. Zhuang, Y. Huang, V. Jayawardana, J. Zhao, D. Suo, and C. Wu, *The braess paradox in dynamic traffic*, IEEE International Conference on Intelligent Transportation Systems (ITSC) 2022.
[7] Qu, A. Valiveru, C. Tang, V. Jayawardana, B. Freydt, and C. Wu, *What is a typical signalized intersection in a city ?* Transportation Research Board (TRB) 2022.
[8] V. Jayawardana, A. Landler, C. Wu. *Mixed autonomous supervision in traffic signal control*, IEEE International Conference on Intelligent Transportation Systems (ITSC) 2021.
[9] M. Mounesan, V. Jayawardana, Y. Wu, S. Samaranayake, H. T. Vo, *Fleet management for ride-pooling with meeting points at scale: A case study in the five boroughs of New York City*, 2021.
* More on Google Scholar.

Work in preparations

[F1] V. Jayawardana, C. Wu. *Learning-guided calibrations of microscopic traffic simulators*, In preparation (NeurIPS 2024).
[F2] V. Jayawardana, Z. Yan, A. Qu, B. Freydt, C. Wu. *ScenarioGym : Three million traffic scenarios for benchmarking contextual and adaptive reinforcement learning*, In preparation (NeurIPS 2024).
[F3] J. Cho, V. Jayawardana, C. Wu. *Model-based transfer learning for contexual reinforcement learning*, In preparation (NeurIPS 2024).

Workshop papers

[W1] V. Jayawardana, S. Li, C. Wu, Y. Farid, K. Oguchi. *Robust Driving Across Scenarios via Multi-residual Task Learning*, In Generalization in Planning workshop at Advances in Neural Information Processing Systems (NeurIPS) 2023 and Machine Learning for Autonomous Driving Symposium 2023.
[W2] V. Jayawardana, C. Wu. *Reinforcement Learning for Eco-Lagrangian Control at Intersections*, In Robotics for Climate Change workshop at IEEE International Conference on Robotics and Automation (ICRA) 2022.

Skills and Projects

Technical Skills: Python (Numpy, PyTorch), C++, Java, C#, JavaScript/CSS/HTML, SQL, Bash, Linux, VSCode, Latex, Gurobi, Mosek, SUMO

Research Skills: Reinforcement learning, planning for autonomous vehicles, numerical simulations, intelligent transportation systems, machine learning, control theory, optimizations, traffic engineering, and data analytics.

Selected Research Projects: Greenwave (AI-driven eco-driving) - Project lead for 14-member team

Open Source Projects

Open Ridepool Simulator - Co-main contributor
SCIM 2.0 Compliance Test Suite - Main contributor (Google Summeer of Code 2017)
Charon 3.0: SCIM 2.0 Implementation - Main contributor

Awards and Achievements

IEEE ITSS WiE/YP Fellowship (IEEE Intelligent Transportation Systems Society) 2024
Harold L. Hazen Teaching Award (MIT) 2022
NeurIPS Scholar Award (NeurIPS) 2022, 2023
Migara Ranathunga Trust Award (Insititute of Engineers Sri Lanka) 2017/2018
Digital Mobility Solutions Lanka Fellowship (Digital Mobility Solutions Lanka) 2018
Dean's Honor List (University of Moratuwa) 2017
Finalist at NASA International Space Apps (NASA) 2017
Gold Award at National Best Quality ICT Awards (Sri Lanka Sector of British Computer Society) 2017
Silver Medal, Junior Science Olympiad Sri Lanka (Sri Lankan Junior Science Olympiad) 2010

Research Talks

MIT CEE Annual Research Day, Cambridge, USA *2024*
LIDS Climate Tea Talks, Cambridge, USA *2023*
Toyota R&D, Mountain View, USA *2023*
MIT CEE Annual Research Day, Cambridge, USA *2023*
Neural Information Processing Systems Conference, New Orleans, USA *2022*
European Control Conference, London, UK *2022*
Robotics for Climate Change (**Spotlight talk**), Philadelphia, USA *2022*
MIT CEE Annual Research Day, Cambridge, USA *2022*
University of Moratuwa, Moratuwa, Sri Lanka *2021*
MIT-IBM Watson AI Lab Open House, Cambridge, USA *2021*
Data Drives - Data science applications in technology-based industries, Colombo, Sri Lanka *2019*
Innovative Computing Technology Conference, London, UK *2017*

Services

International Conference on Machine Learning (ICML) - Reviewer *2024*
Transactions on Robotics (T-RO) - Reviewer *2023*
Neural Information Processing Systems Conference (NeurIPS)- Reviewer (**Top 10% Reviewer**) *2023*
AAAI Conference on Artificial Intelligence (AAAI) - Reviewer *2023*
Physica A: Statistical Mechanics and its Applications (Physica A) - Reviewer *2023*
International Conference on Robotics and Automation (ICRA) - Reviewer *2020, 2022*
Transactions on Intelligent Systems and Technology (T-IST) - Reviewer *2022*
Transportation Research Board (TRB) - Reviewer *2022*
Moratuwa Engineering Research Conference (MERCon) - Reviewer *2020, 2021*
NeurIPS Tackling Climate Change with Machine Learning - Reviewer *2023*
AAAI When Machine Learning meets Dynamical Systems: Theory and Applications - Reviewer *2022*
Representation Learning for Responsible Human-Centric AI - Area Chair (**Top Area Chair**) *2022*

MIT CEE faculty hiring student committee 2023
President, Sri Lankan Students' Association at MIT 2019-2023
Volunteer, Neural Information Processing Systems Conference 2023
Director, Rotaract Club of Alumni of the University of Moratuwa 2017-2019
Director, Old Royalists Engineering Professionals' Association Student Chapter 2015-2018
Volunteer, Rotaract Club of University of Moratuwa 2014-2016

Teaching

Teaching Assistant

1.041/1.200 - Transportation: Foundations and Methods **(MIT EECS Teaching Excellence Award)** *MIT Fall 2020, 2021*

CS2022 - Data Structures and Algorithms *UoM Spring 2019*

CS4622 - Machine Learning *UoM Fall 2018*

CS3042 - Database Systems *UoM Fall 2018*

CS2052 - Computer Architecture *UoM Spring 2018*

CS2062 - Object Oriented Software Development *UoM Spring 2018*

CS3962 - Research and Report Writing *UoM Fall 2017*

Mentorship

Graduate Students

Jessica Ding: MIT

- Co-authoring a paper on residual transfer learning for traffic control.

Baptiste Freydt: ETH Zurich (Now: software engineer)

- Co-authored a paper on large-scale eco-driving using deep reinforcement learning [R1].

Undergraduates

Anna Landler: MIT (Now: software engineer at Crusoe)

- Co-authored paper on autonomous traffic signal supervision [8].

Catherine Tang: MIT (Now: sophomore at MIT)

- Co-authored papers on task underspecification in deep reinforcement learning [3].

Anirudh Valiveru: MIT (Now: sophomore at MIT)

- Co-authored paper on data processing pipeline for open street maps.

Ammar Fayad: MIT (Now: junior at MIT)

Jiaxin He: Vanderbilt University (Now: master student at UC San Diego)

- Co-authored a paper on large-scale eco-driving using deep reinforcement learning [R1].

Sunera Chandrasiri: University of Moratuwa (Now: co-founder of iXD Labs)

- Co-authored a paper on large-scale eco-driving using deep reinforcement learning [R1].

Sanjula Jayawardana: University of Westminster (Now: software engineer at IFS)

- Co-authored a paper on socially compatible autonomous driving [5].

Media

MIT News **spotlight**: On the road to cleaner, greener, and faster driving

Techcrunch: Perceptron: Risky teleoperation, Rocket League simulation, and zoologist multiplication

National Public Radio (NPR): Green Driving

ADAS & Autonomous Vehicle International Magazine: A greener way to negotiate traffic lights