Udari Madhushani

AI Research Scentist
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Research Interest

My research vision is to embed AI agents with the ability to enhance their capabilities through collective intelligence, ultimately enabling them to seamlessly coexist with humans, augmenting their cognitive and physical capabilities. In my research work I primarily focus on Reinforcement Leaning, Foundation models and Robotics.
Key Topics: Multi-agent reinforcement learning (zero-shot generalization, quality diversity, evolution of cooperation, communication), Generative AI (LLMs - alignment and multi-step reasoning, Vision models - Knowledge distillation), Game theory, Deep reinforcement learning, Sequential decision making, Robotics, Bandit theory, Control theory.
PhD thesis: Learning through social interactions and learning to socially interact in multi-agent learning

Education

Degree	Institution	Years
Ph.D. (Reinforcement Learning & Robotics)	Princeton University, USA	2017 - 2023
M.A. (Reinforcement Learning & Robotics)	Princeton University, USA	2017 - 2019
B.Sc. (Robotics & Control Theory)	University of Peradeniya, Sri Lanka	2011 - 2015

Honors

Graduate Honors (Princeton University)

- Harold W. Dodds Fellowship (prestigious honorific fellowship from Graduate School) 2021-22
- Britt and Eli Harari Fellowship 2020-21
- Larisse Rosentweig Klein Memorial Award Fall 2019
- Martin Summerfield Graduate Fellowship 2018-19
- Athena-Feron Prize for Mathematical Excellence Fall 2018
- Elliotte Robinson Little '25 Student Aid Fund Fellowship 2017-18

Other Awards

- Presidential Award for Scientific Research (Sri Lanka) 2019
- Best Undergraduate Project Award (IEEE Sri Lanka Section) December 2015

Experience

Research Scientist

- JPMorgan AI Research, New York, USA July 2023 - Present
  Focus: Alignment in foundation models, multi-step reasoning and self-improving in LLMs, Mechanism design

Research Internships

- Google Deepmind, London, UK May 2022 - Sep 2022
  Mentors: Daniel Hennes and Edgar Duenez-Guzman
  Project: Zero-shot Generalization in Mixed Motive Games
- Facebook AI Research, Menlo Park, California, USA May 2021 - August 2021
  Mentors: Kalesha Bullard and Roberto Calandra
  Project: Incentivizing Coordination in Multi-Agent Reinforcement Learning

- Siemens, Princeton, New Jersey, USA — May 2020 - August 2020
  Mentors: Biswadip Dey and Amit Chakraborty
  Project: Using Hamiltonian Monte Carlo Sampling for Reinforcement Learning Problems in High-dimension

Assistant in Research

- Princeton University — September 2017 - May 2023
- Sri Lanka Technological Campus (SLTC), Sri Lanka — January 2016 - August 2017

Guest Lectures

- MAE 545 Collective Intelligence: Dynamics and Control of Multi-Agent Systems (Princeton University) — Fall 2022

Assistant in Teaching

- MAE 542 Advanced Dynamics (Princeton University) — Fall 2020
- MAE 502/APC 506 Mathematical Methods of Engineering Analysis (Princeton University) — Spring 2020
- MAE 345/MAE 549 Introduction to Robotics (Princeton University) — Fall 2019
- EE 554 Microwave Techniques (University of Peradeniya), Sri Lanka — October 2015 - December 2015

Outreach

Mentoring

Princeton University

- Justin Lidard (Ph.D. Mechanical Engineering) — 2021-Present
- Kathryn Wantlin (M.Sc. Computer Science) — 2021-Present
- Sarah Dillender (B.S.E. Mechanical Engineering) — 2020-21
  Thesis: Message passing structures for improved policy finding in decentralized multi-agent Q-learning.
- Gargi Sadalgekar, Samarie Wilson and Jacob Walrath (B.S.E. Mechanical Engineering) — 2020-21
  Thesis: Decision making and task allocation in a multi-robot system.

Peradeniya University, Sri Lanka

- Lasitha Weerakon (Post graduate, Mechanical Engineering) — 2016-17
  Published in American Control Conference **(ACC)**, *2018.*
- Isuru Basnayake (Post graduate, Mechanical Engineering) — 2016-17
  Published in International Conference of Industrial and Information Systems, **(ICIIS)**, *2017.*
- Kusal Tennakoon (Post graduate, Mechanical Engineering) — 2016-17
  Published in International Conference of Industrial and Information Systems, **(ICIIS)**, *2017.*

Commitment to Diversity and Inclusion

- Co-organized "Re-education Monthly Book Club" aimed towards improving awareness of implicit biases (Princeton University) — 2020-Present
- Co-organized the workshop "Diversity and Mentorship" at American Control Conference — May 2021
- Co-organized the workshop "Inclusive Teaching" (Princeton University) — Jan 2021

Leadership Roles

- Committee member of Women in STEM Leadership Council (Princeton University) — 2020-Present
- Committee member of Graduate Women in Science & Engineering (Princeton University) — 2020-Present
- Future Digileaders Training (Stockholm, Sweden) — November 2019
- Founder of EE Instructors Scholarship (Peradeniya University, Sri Lanka) — 2016

Volunteer for

- World Maker Faire — September 2018
- American Control Conference — June 2018

Academic Services

Program committee Member of

- Games Agents and Incentives Workshop **(GAIW)** at International Conference on Autonomous Agents and Multi Agent Systems **(AAMAS)** 2023

- Adaptive and Learning Agents Workshop **(ALA)** at International Conference on Autonomous Agents and Multi Agent Systems **(AAMAS)** 2023
- Adaptive and Learning Agents Workshop **(ALA)** at International Conference on Autonomous Agents and Multi Agent Systems **(AAMAS)** 2022
- Cooperative AI Workshop at Conference on Neural Information Processing Systems **(NeurIPS)** 2021

Co-organizer of

- Special issue on "Collective Artificial Intelligence and Evolutionary Dynamics" at Proceedings of National Academy of Science **(PNAS)** 2023
- Proceedings of National Academy of Science **(PNAS)** special issue symposium on "Collective Artificial Intelligence" 2022

Reviewer for

Journal: Automatica, IEEE Transactions on Automatic Control, IEEE Control Systems Letters, Journal of Field Robotics

Conference: Conference on Neural Information Processing Systems, International Conference on Machine Learning, IEEE Conference on Decision and Control, American Control Conference, International Conference on Intelligent Robots and Systems, European Control Conference, International Conference of Industrial and Information Systems

Student Member of

IEEE (Institute of Electrical and Electronics Engineers), IEEE Young Professionals, IEEE Women in Engineering, APS (American Physical Society)

Publications

Pre-prints

[P5] Delving Deeper into Reasoning Capabilities of Large Language Models
Udari Madhushani, Vikash Sehwag
(In preperation)

[P4] Metagrad Sampling: Task Aware Knowledge Distillation from Diffusion Models
Vikash Sehwag, **Udari Madhushani**, Mung Chiang, Prateek Mittal
(In preperation)

[P3] Heterogeneous Social Value Orientation Leads to Meaningful Diversity in Sequential Social Dilemmas
Udari Madhushani, Kevin McKee, John Agapiou, Joel Z Leibo, Thomas Anthony, Richard Everett, Edward Hughes, Karl Tuyls, Edgar Duéñez-Guzmán
(Work done while interning at DeepMind - short version pblished in Adaptive and Learning Agents Workshop **(ALA)** at International Conference on Autonomous Agents and Multi Agent Systems **(AAMAS)** 2023)

[P2] Autocratic Learning and Unilateral Incentive Alignment in Two-player Stochastic Games
Alex McAvoy, **Udari Madhushani**, Christian Hilbe, Wolfram Barfuss, Krishnendu Chatterjee, Qi Su, Naomi Ehrich Leonard, Joshua B. Plotkin
(Proceedings of National Academy of Science - special issue on Collective Artificial Intelligence and Evolutionary Dynamics)

[P1] Collective Cooperative Intelligence
Wolfram Barfuss, Jessica Flack, Chaitanya S. Gokhale, Lewis Hammond, Christian Hilbe, Joel Leibo, Tom Lenaerts, Naomi Leonard, Simon Levin, **Udari Madhushani**, Alex McAvoy, Janusz M. Meylahn, Fernando P. Santos
(Proceedings of National Academy of Science - special issue on Collective Artificial Intelligence and Evolutionary Dynamics)

Technical Reports

[T1] Melting Pot 2.0
John Agapiou, Alexander Vezhnevets, Duéñez-Guzmán, Jayd Matyas, Yiran Mao, Peter Sunehag, Raphael Köster, **Udari Madhushani**, Kavya Kopparapu, Ramona Comanescu, DJ Strouse, Michael B. Johanson, Sukhdeep Singh, Julia Haas, Igor Mordatch, Dean Mobbs, Joel Z Leibo

Peer-reviewed Journal Articles

[J2] Heterogeneous Explore-Exploit Strategies on Multi-Star Networks
Udari Madhushani, Naomi Leonard
IEEE Control Systems Letters, 2021.

[J1] Semi-globally Exponential Trajectory Tracking for a Class of Spherical Robots
Udari Madhushani, Sanjeeva Maithripala, Janaka Wijayakulasooriya, Jordan Berg
Automatica, 2017.

Peer-reviewed Conference Articles

[C13] On Using Hamiltonian Monte Carlo Sampling for Reinforcement Learning
Udari Madhushani, Biswadip Dey, Naomi Leonard, Amit Chakraborty
Conference on Decision and Control, **(CDC)** 2022. **(Invited Paper)**

[C12] A Regret Minimization Approach to Multi-Agent Control
Udaya Ghai, **Udari Madhushani**, Naomi Leonard, Elad Hazan
International Conference on Machine Learning, **(ICML)** 2022.

[C11] Provably Efficient Multi-Agent Reinforcement Learning with Fully Decentralized Communication
Justin Lidard, **Udari Madhushani**, Naomi Leonard
American Control Conference, **(ACC)** 2022.

[C10] One More Step Towards Reality: Cooperative Bandits with Imperfect Communication
Udari Madhushani, Abhimanyu Dubey, Naomi Leonard, Alex Pentland
Conference on Neural Information Processing Systems, **(NeurIPS)** 2021.

[C9] Multi-robot Learning and Coverage of Unkown Fields
Maria Santos, **Udari Madhushani**, Alessia Benevento, Naomi Leonard
IEEE International Symposium on Multi-Robot and Multi-Agent Systems, **(MRS)** 2021.

[C8] Distributed Bandits: Probabilistic Communication on d-regular Graphs
Udari Madhushani, Naomi Leonard
European Control Conference, **(ECC)** 2021.

[C7] A Dynamic Observation Strategy for Multi-agent Multi-armed Bandit Problem
Udari Madhushani, Naomi Leonard
European Control Conference, **(ECC)** 2020.

[C6] Heterogeneous Stochastic Interactions for Multiple Agents in a Multi-armed Bandit Problem
Udari Madhushani, Naomi Leonard
European Control Conference, **(ECC)** 2019. **(Invited Paper)**

[C5] Feedback Regularization and Geometric PID Control for Robust Stabilization of a Planar Three-link Hybrid Bipedal Walking Model
Lasitha Weerakon, **Udari Madhushani**, Sanjeeva Mathripala, Jordan Berg
American Control Conference, **(ACC)** 2018.

[C4] Multi-armed Bandit Based Approach for Performance Enhancement of Window Intensity Test (WIT) Detector
Kusal Tennakoon, **Udari Madhushani**, Sanjeeva Mathripala
International Conference of Industrial and Information Systems, **(ICIIS)** 2017.

[C3] Intrinsic PID Controller for a Segway Type Mobile Robot
Isuru Basnayake, **Udari Madhushani**, Sanjeeva Mathripala
International Conference of Industrial and Information Systems, **(ICIIS)** 2017.

[C2] Feedback Regularization and Geometric PID Control for Trajectory Tracking of Mechanical Systems: Hoop Robots on an Inclined Plane
Udari Madhushani, Sanjeeva Mathripala, Jordan Berg
American Control Conference, **(ACC)** 2017.

[C1] WIT: Window Intensity Test Detector and Descriptor
Udari Madhushani, Sanjeeva Mathripala, Janaka Wijayakulasooriya
International Conference of Industrial and Information Systems, **(ICIIS)** 2016.

Peer-reviewed Workshop Articles

[W7] Multi-robot Learning and Coverage of Unkown Fields
Maria Santos, **Udari Madhushani**, Alessia Benevento, Naomi Leonard
Autonomous Robots and Multirobot Systems **(ARMS)**, International Conference on Autonomous Agents and Multiagent Systems **(AAMAS)** 2022.

[W6] A Regret Minimization Approach to Multi-Agent Control
Udaya Ghai, **Udari Madhushani**, Naomi Leonard, Elad Hazan
Workshop on Gamification and Multiagent Solutions **(GMS)**, International Conference on Learning Representations, **(ICLR)** 2022. **(Oral - Won the best poster award)**

[W5] Provably Efficient Decentralized Communication for Multi-Agent RL
Justin Lidard, **Udari Madhushani**, Naomi Leonard
Reinforcement Learning in Games **(RLG)**, AAAI Conference on Artificial Intelligence, **(AAAI)** 2022. **(Oral)**

[W4] On Using Hamiltonian Monte Carlo Sampling for Reinforcement Learning Problems in High-dimension
Udari Madhushani, Biswadip Dey, Naomi Leonard, Amit Chakraborty
Deep Reinforcement Learning Workshop **(Deep RL)**, Conference on Neural Information Processing Systems, **(NeurIPS)** 2021.

[W3] When to Call Your Neighbor? Strategic Communication in Cooperative Stochastic Bandits
Udari Madhushani, Naomi Leonard
Learning and Decision-Making with Strategic Feedback **(StratML)**, Conference on Neural Information Processing Systems, **(NeurIPS)** 2021.

[W2] It Doesn't Get Better and Here's Why: A Fundamental Drawback in Natural Extensions of UCB to Multi-agent Bandits
Udari Madhushani, Naomi Leonard
I can't Believe It's Not Better! Workshop **(ICBINB)**, Conference on Neural Information Processing Systems, **(NeurIPS)** 2020. **(Spotlight)**

[W1] Distributed Learning: Sequential Decision Making in Resource-Constrained Environments
Udari Madhushani, Naomi Leonard
Practical ML for Developing Countries Workshop **(PML4DC)**, International Conference on Learning Representations, **(ICLR)** 2020. **(Oral)**

Skills

Computer Skills: Python, PyTorch, TensorFlow, JAX, Matlab, LaTeX
Language Skills: Sinhala (Native), English (Fluent)