Kishor Jothimurugan

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Research Interests

My areas of interest lie at the intersection of **Formal Methods** and **Machine Learning**. In particular, I have worked on applying formal methods to improve reinforcement learning (RL), verification of neural networks (NN), and machine learning (ML) for program synthesis and analysis.

Education

University of Pennsylvania **Philadelphia, USA**
PhD candidate in Computer and Information Science, Current GPA 4.0/4.0 *2017–2023*
Thesis Topic: Specification-Guided Reinforcement Learning
Committee: Thomas A. Henzinger, George J. Pappas, Sampath Kannan and Osbert Bastani
Advised by Prof. Rajeev Alur

Chennai Mathematical Institute **Chennai, India**
B.Sc. (Honors) Mathematics and Computer Science, CGPA 9.77/10 *2014–2017*
Ranked among top 3 students

Publications

First (co)author in all publications; names are listed alphabetically in some papers
* equal contribution, † authors in alphabetical order

Refereed Conference Publications

[CAV 22] Specification-Guided Learning of Nash Equilibria with High Social Welfare
K. Jothimurugan, S. Bansal, O. Bastani and R. Alur
International Conference on Computer Aided Verification, 2022
Awarded Artifact Evaluation Badge: Functional

[Invited 22] A Framework for Transforming Specifications in Reinforcement Learning
R. Alur, S. Bansal, O. Bastani and *K. Jothimurugan*†
Springer Festschrift in honor of Prof. Tom Henzinger (Invited), 2022
Shows theoretical impossibility results for PAC RL from logical specifications

[NeurIPS 21] Compositional Reinforcement Learning from Logical Specifications
K. Jothimurugan, S. Bansal, O. Bastani and R. Alur
Advances in Neural Information Processing Systems, 2021

[EMSOFT 21] Compositional Learning and Verification of Neural Network Controllers
R. Ivanov*, *K. Jothimurugan**, S. Hsu, S. Vaidya, R. Alur and O. Bastani
International Conference on Embedded Software, 2021

[AISTATS 21] Abstract Value Iteration for Hierarchical Reinforcement Learning
K. Jothimurugan, O. Bastani and R. Alur
International Conference on Artificial Intelligence and Statistics, 2021

[LICS 20] Space-efficient Query Evaluation over Probabilistic Event Streams
R. Alur, Y. Chen, *K. Jothimurugan*† and S. Khanna
Symposium on Logic in Computer Science, 2020

[NeurIPS 19] A Composable Specification Language for Reinforcement Learning Tasks
K. Jothimurugan, R. Alur and O. Bastani
Advances in Neural Information Processing Systems, 2019

Unpublished Work

Robust Option Learning for Compositional Generalization
K. Jothimurugan, S. Hsu, O. Bastani and R. Alur
Under review at AISTATS, 2023
Accepted for presentation at Deep RL Workshop, NeurIPS, 2022

Discounted LTL for Task Specification in Reinforcement Learning
R. Alur, O. Bastani, *K. Jothimurugan*†, M. Perez, F. Somenzi and A. Trivedi
In preparation

Learning Algorithms for Regenerative Stopping Problems with Logistics Applications
K. Jothimurugan, M. Andrews, J. Lee and L. Maggi
Nokia Bell Labs Intern Report

Tutorials

[AAAI 23] Specification-Guided Reinforcement Learning
Presenters: *K. Jothimurugan*, S. Bansal, R. Alur and O. Bastani
AAAI Conference on Artificial Intelligence, 2023
A comprehensive tutorial on RL algorithms for learning control policies from logical specifications

Open Source Tools

DIRL — Github link
Compositional RL algorithm for learning from temporal specifications

HIGH-NASH — Github link
Multi-agent RL algorithm for learning Nash equilibria with high social welfare

SARL — Github link
Hierarchical RL algorithm leveraging user provided state abstractions

SPECTRL — Github link
Generating shaped rewards from temporal specifications

Teaching Experience

Guest Lecturer

Computer-Aided Verification, CIS 673 (Class of ~ 20) *Fall 2021*
Topic: Techniques for Verifying Robustness of Neural Networks

Teaching Assistant

Principles of Embedded Systems, CIS 540 (Class of ~ 30) *Spring 2019*
Responsibilities: Grading, Office Hours, Project Design and Online Forum

Automata, Computability and Complexity, CIS 262 (Class of ~ 150) *Fall 2018*
Responsibilities: Grading, Office Hours, Assignment Prep. and Online Forum

Discrete Mathematics, Undergraduate (Class of ~ 30) *Spring 2017*
Responsibilities: Grading, Office Hours, Assignment Prep. and Online Forum

Design and Analysis of Algorithms, Online Course offered by IIT-M *Fall 2016*
Responsibilities: Grading, Online Forum and Lecture Transcription

Mentoring and Outreach

Graduate Student Mentoring 2020–2022
Steve Hsu, Masters Student, University of Pennsylvania
Topic: Compositional reinforcement learning for multi-task generalization
Co-authored two papers

Penn CIS Mentorship Program 2022
Participated as a mentor
Department-wide effort to connect early career PhD students with senior PhD students
Attracted participation from 34 students

Awards

CTL Teaching Certificate *Spring 2022*
Awarded by Center for Teaching and Learning, University of Pennsylvania

CMI Undergraduate Scholarship *2014–2017*
Awarded by CMI to undergraduate students for excellence in academics

Research Presentations

Invited Talks

NYU *Fall 2022*
Title: Specification-Guided Reinforcement Learning

Microsoft PROSE Group *Fall 2022*
Title: Specification-Guided Reinforcement Learning

IST Austria *Fall 2021*
Title: Reinforcement Learning from Logical Specifications

Simons Institute, UC Berkeley *Spring 2021*
Workshop on Games and Equilibria in System Design and Analysis
Title: Abstract Value Iteration for Hierarchical Reinforcement Learning

Presentations and Posters (from publications)

Conferences: NeurIPS 2019 and 2021, LICS 2020, AISTATS 2021, EMSOFT 2021, CAV 2022

Workshops: DeepRL @ NeurIPS 2020 and 2022, SafeRL @ NeurIPS 2021, SYNT @ CAV 2022

Internships

Amazon Web Services Summer 2022
Applied Science Intern, AI Labs
Incorporating program semantics in transformer-based code generation models
Mentors: Nathan Fulton, Siddhartha Jain and Baishakhi Ray (Columbia University)

Nokia Bell Labs Summer 2020
Research Intern, Data and AI Lab
An application of deep RL to regenerative stopping problems
Mentors: Matthew Andrews, Jeongran Lee and Lorenzo Maggi

Amazon Web Services Summer 2019
Software Development Engineering Intern, Automated Reasoning Group
Using machine learning to improve usability of taint analysis
Mentors: Andrew Gacek and Lee Pike

ENS Paris-Saclay Summer 2017
Research Intern, Formal Methods Group
Models for distributed reactive synthesis
Mentor: Dietmar Berwanger

Review Service

Conferences: NeurIPS 2022, AAAI 2023, AISTATS 2023

Journals: IEEE TCAD

Other Achievements

Placed among **top 3 students** in CMI

Qualified for **ACM ICPC India Regionals** 2016 (Chennai and Coimbatore)