

# Kishor Jothimurugan

Levine 513, 3330 Walnut St, Philadelphia, PA – 19104 – USA

✉ kishor@seas.upenn.edu • 🌐 keyshor.github.io

## Research Interests

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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

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### University of Pennsylvania

Philadelphia, USA

*Ph.D. candidate in Computer and Information Science, Current GPA 4.0/4.0*

2017–2023

Thesis Topic: Specification-Guided Reinforcement Learning

Committee: Osbert Bastani, Thomas A. Henzinger, Sampath Kannan, and George J. Pappas

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

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First (co)author in all publications; names are listed alphabetically in some papers

\* equal contribution, † authors in alphabetical order

### Refereed Conference Publications.....

#### [Festschrift 22] A Framework for Transforming Specifications in Reinforcement Learning

R. Alur, S. Bansal, O. Bastani and K. Jothimurugan<sup>†</sup>

*Springer Festschrift in honor of Prof. Tom Henzinger (Invited), 2022*

#### [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*

Acceptance rate: 24.4%

#### [NeurIPS 21] Compositional Reinforcement Learning from Logical Specifications

K. Jothimurugan, S. Bansal, O. Bastani and R. Alur

*Advances in Neural Information Processing Systems, 2021*

Acceptance rate: 25.7%

#### [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*

Acceptance rate: 25.2%

**[AISTATS 21]** [Abstract Value Iteration for Hierarchical Reinforcement Learning](#)

K. Jothimurugan, O. Bastani and R. Alur

*International Conference on Artificial Intelligence and Statistics, 2021*

Acceptance rate: 29.8%

**[LICS 20]** [Space-efficient Query Evaluation over Probabilistic Event Streams](#)

R. Alur, Y. Chen, K. Jothimurugan<sup>†</sup> and S. Khanna

*Symposium on Logic in Computer Science, 2020*

Acceptance rate: 39.6%

**[NeurIPS 19]** [A Composable Specification Language for Reinforcement Learning Tasks](#)

K. Jothimurugan, R. Alur and O. Bastani

*Advances in Neural Information Processing Systems, 2019*

Acceptance rate: 21.1%

[Selected \(Refereed\) Workshop Papers.....](#)

**[DeepRL 22]** [Robust Subtask Learning for Compositional Generalization](#)

K. Jothimurugan, S. Hsu, O. Bastani and R. Alur

*Deep RL Workshop, NeurIPS, 2022*

Under review at ICML 2023

[Preprints and Technical Reports.....](#)

[Policy Synthesis and Reinforcement Learning for Discounted LTL](#)

R. Alur, O. Bastani, K. Jothimurugan<sup>†</sup>, M. Perez, F. Somenzi and A. Trivedi

Under review at CAV 2023

[Learning Algorithms for Regenerative Stopping Problems with Logistics Applications](#)

K. Jothimurugan, M. Andrews, J. Lee and L. Maggi

*Nokia Bell Labs Intern Report*

## [Tutorials](#)

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**[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](#)

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**DIRL** — [Github link](#)

Compositional RL algorithm for learning from temporal specifications

**HIGH-NASH** — [Github link](#) (CAV Artifact Evaluation Badge: Functional)

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

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### Guest Lecturer.....

Computer-Aided Verification, CIS 673 (Class of  $\sim 20$ ) *Fall 2021*  
Graduate Course, University of Pennsylvania  
Topic: Techniques for Verifying Robustness of Neural Networks

### Teaching Assistant.....

Principles of Embedded Systems, CIS 540 (Class of  $\sim 20$ ) *Spring 2019*  
Graduate Course, University of Pennsylvania

Automata, Computability and Complexity, CIS 262 (Class of  $\sim 150$ ) *Fall 2018*  
Undergraduate Course, University of Pennsylvania

Discrete Mathematics (Class of  $\sim 30$ ) *Spring 2017*  
Undergraduate Course, Chennai Mathematical Institute

Design and Analysis of Algorithms *Fall 2016*  
Online Course offered by Indian Institute of Technology, Madras

## Mentoring and Outreach

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**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 first-year students

## Awards

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**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

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### Invited Talks.....

**University of Illinois Urbana-Champaign (upcoming)** *Spring 2023*  
Title: Specification-Guided Reinforcement Learning

**University of Virginia** *Spring 2023*  
Title: Specification-Guided Reinforcement Learning

**NYU Formal Methods Group** Fall 2022  
Title: Specification-Guided Reinforcement Learning

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

**Thomas Henzinger's Group, 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

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**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

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**Conferences:** NeurIPS 2022, AAAI 2023, AISTATS 2023, ESOP 2023, L4DC 2023, ICML 2023, CAV 2023.

**Journals:** IEEE TCAD.