

# Anand Balakrishnan

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## EDUCATION

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- **Ph.D. Computer Science** Fall 2018 — Summer 2025 (expected)  
University of Southern California  
Advisor: *Jyotirmoy V. Deshmukh*  
Thesis Title: *From Qualitative to Quantitative Objectives for Neurosymbolic Control*
- **B.S. Computer Engineering** May 2018  
University at Buffalo  
Distinction: *Magna Cum Laude*

## WORK EXPERIENCE

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- **Research Assistant** Aug 2018 — Ongoing  
CPS-VIDA Group, University of Southern California  
Advisor: *Jyotirmoy V. Deshmukh*
- **Teaching Assistant** Fall 2023  
CSCI 699: Mathematical Foundation to Intelligent Autonomy  
Course Instructor: *Lars Lindemann*
- **Technical Intern** Summer 2023  
Siemens Corporation
- **Teaching Assistant** Fall 2021  
CSCI 513: Autonomous Cyber-Physical Systems  
Course Instructor: *Jyotirmoy V. Deshmukh*
- **ADAS Software Engineering Intern** Summer 2021  
INDI EV, Inc.
- **Research Intern** Summer 2020  
Toyota Research Institute, North America
- **Graduate Mentor** Summer 2019  
SURE Program: Summer Undergraduate Research Experience
- **Undergraduate Researcher** Feb 2016 — May 2018  
Distributed Robotics and Networked Embedded Systems Lab, University at Buffalo  
Advisor: *Karthik Dantu*
- **Undergraduate Teaching Assistant** Fall 2017  
CSE 331: Algorithm Analysis and Design, University at Buffalo  
Course Instructor: *Atri Rudra*

## MENTORING

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- **Interns:** Parv Kapoor
- **Master's Students:** Rohit Bernard, Shreeram Narayanan, Yogesh Gajjar
- **Undergraduate Students:** Monali Saraf, Kolby Nottingham

**Journals and Conferences**

1. **A. Balakrishnan**, S. Paul, S. Silveti, L. Nenzi, and J. V. Deshmukh. 2025. Monitoring Spatially Distributed Cyber-Physical Systems with Alternating Finite Automata. In *29th ACM International Conference on Hybrid Systems: Computation and Control (HSCC)*. (May 2025). Accepted.
2. **A. Balakrishnan**, M. Atasever, and J. V. Deshmukh. 2024. Motion Planning for Automata-based Objectives using Efficient Gradient-based Methods. In *2024 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. (Oct. 2024), 13734–13740. DOI: [10.1109/IROS58592.2024.10802177](https://doi.org/10.1109/IROS58592.2024.10802177).
3. S. Paul, **A. Balakrishnan**, X. Qin, and J. V. Deshmukh. 2024. Multi-agent Path Finding for Timed Tasks Using Evolutionary Games. In *Quantitative Evaluation of Systems and Formal Modeling and Analysis of Timed Systems (QEST+FORMATS)*. Vol. 14996. J. Hillston, S. Soudjani, and M. Waga, editors. Springer Nature Switzerland, Cham, (Aug. 2024), 302–321. DOI: [10.1007/978-3-031-68416-6\\_18](https://doi.org/10.1007/978-3-031-68416-6_18).
4. **A. Balakrishnan**, S. Jakšić, E. A. Aguilar, D. Ničković, and J. V. Deshmukh. 2023. Model-Free Reinforcement Learning for Spatiotemporal Tasks Using Symbolic Automata. In *2023 62nd IEEE Conference on Decision and Control (CDC)*. (Dec. 2023), 6834–6840. DOI: [10.1109/CDC49753.2023.10383559](https://doi.org/10.1109/CDC49753.2023.10383559).
5. S. Mallick, S. Ghosal, **A. Balakrishnan**, and J. Deshmukh. 2023. Safety Monitoring for Pedestrian Detection in Adverse Conditions. In *Runtime Verification*. Lecture Notes in Computer Science. Vol. 14245. P. Katsaros and L. Nenzi, editors. Springer Nature Switzerland, Cham, (Oct. 2023), 389–399. DOI: [10.1007/978-3-031-44267-4\\_22](https://doi.org/10.1007/978-3-031-44267-4_22).
6. **A. Balakrishnan**, J. Deshmukh, B. Hoxha, T. Yamaguchi, and G. Fainekos. 2021. PerceMon: Online Monitoring for Perception Systems. In *Runtime Verification (Lecture Notes in Computer Science)*. L. Feng and D. Fisman, editors. Springer International Publishing, Cham, (Oct. 2021), 297–308. DOI: [10.1007/978-3-030-88494-9\\_18](https://doi.org/10.1007/978-3-030-88494-9_18).
7. Z. S. Hashemifar, C. Adhivarahan, **A. Balakrishnan**, and K. Dantu. 2019. Augmenting visual SLAM with Wi-Fi sensing for indoor applications. *Autonomous Robots*, 43, 8, (Dec. 2019), 2245–2260. DOI: [10.1007/s10514-019-09874-z](https://doi.org/10.1007/s10514-019-09874-z).
8. **A. Balakrishnan** and J. V. Deshmukh. 2019. Structured Reward Shaping using Signal Temporal Logic specifications. In *2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*. (Nov. 2019), 3481–3486. DOI: [10.1109/IROS40897.2019.8968254](https://doi.org/10.1109/IROS40897.2019.8968254).
9. **A. Balakrishnan**, A. G. Puranic, X. Qin, A. Dokhanchi, J. V. Deshmukh, H. Ben Amor, and G. Fainekos. 2019. Specifying and Evaluating Quality Metrics for Vision-based Perception Systems. In *2019 Design, Automation Test in Europe Conference Exhibition (DATE)*. (Mar. 2019), 1433–1438. DOI: [10.23919/DATE.2019.8715114](https://doi.org/10.23919/DATE.2019.8715114).

**Presentations**

1. **A. Balakrishnan**, R. Bernard, S. Narayanan, V. Kudalkar, Y. Zhao, P. Nagaraja, G. Markov, C. Budnik, H. Degen, L. Lindemann, and J. V. Deshmukh. 2024. Safety Assurance for Autonomous Systems with Multiple Sensor Modalities. In *2024 22nd ACM-IEEE International Symposium on Formal Methods and Models for System Design (MEMOCODE)*. (Oct. 2024), 108–113. DOI: [10.1109/MEMOCODE63347.2024.00018](https://doi.org/10.1109/MEMOCODE63347.2024.00018).
2. **A. Balakrishnan** and J. V. Deshmukh. 2024. Differentiable Weighted Automata. In *ICML 2024 Workshop on Differentiable Almost Everything: Differentiable Relaxations, Algorithms, Operators, and Simulators*. (June 2024). <https://openreview.net/forum?id=k2hIQYqHTh>.
3. **A. Balakrishnan**, S. Jaksic, E. Aguilar, D. Nickovic, and J. Deshmukh. 2022. Poster Abstract: Model-Free Reinforcement Learning for Symbolic Automata-encoded Objectives. In *25th ACM International Conference*

on Hybrid Systems: Computation and Control (HSCC). Association for Computing Machinery, New York, NY, USA, (May 2022), 1–2. DOI: [10.1145/3501710.3524734](https://doi.org/10.1145/3501710.3524734).

4. A. Balakrishnan and J. V. Deshmukh. 2019. Structured reward functions using STL: Poster abstract. In 22nd ACM International Conference on Hybrid Systems: Computation and Control (HSCC). Association for Computing Machinery, New York, NY, USA, (Apr. 2019), 270–271. DOI: [10.1145/3302504.3313355](https://doi.org/10.1145/3302504.3313355).
5. A. Balakrishnan, P. Behara, Z. Hashemifar, and K. Dantu. 2017. Poster: Dataset for Experimental Validation of Wi-Fi Sensing. In 6th Annual Northeastern Robotics Colloquium (NERC). Boston, MA, USA, (Oct. 2017).

### Preprints

1. P. Kapoor, A. Balakrishnan, and J. V. Deshmukh. Model-based Reinforcement Learning from Signal Temporal Logic Specifications. (Nov. 2020). arXiv: [2011.04950](https://arxiv.org/abs/2011.04950) [cs, eess].
2. K. Nottingham, A. Balakrishnan, J. Deshmukh, C. Christopherson, and D. Wingate. Using Logical Specifications of Objectives in Multi-Objective Reinforcement Learning. (Oct. 2019). arXiv: [1910.01723](https://arxiv.org/abs/1910.01723) [cs, stat].

### VOLUNTEERING AND SERVICES

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<b>Reviewer</b>	IEEE Transactions on Robotics (T-RO)	
	IEEE Robotics and Automation Letters (RA-L)	
	ACM Transactions on Cyber-Physical Systems (TCPS)	
	Learning for Dynamics and Control Conference (L4DC)	2025
	IEEE International Conference on Robotics and Automation (IRCA)	2025
	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	2024
	International Conference on Concurrency Theory (CONCUR)	2024
	ACM International Conference on Hybrid Systems: Computation and Control (HSCC)	2024
	International Conference on Verification, Model Checking, and Abstract Interpretation (VMCAI)	2024
	International Conference on Runtime Verification (RV)	2023
	IEEE Conference on Decision and Control (CDC)	2022
	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	2022
	IEEE International Conference on Robotics and Automation (ICRA)	2022
	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	2021
	Design Automation Conference (DAC)	2021
	IEEE Conference on Decision and Control (CDC)	2020
	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)	2020
	ACM International Conference on Hybrid Systems: Computation and Control Repeatability Evaluation (HSCC-RE)	2020
	ACM/IEEE International Conference on Cyber-Physical Systems (ICCPs)	2019
<b>Student</b>	International Conference on Runtime Verification (RV)	2020
<b>Organizer</b>		

### HONORS AND AWARDS

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- Selected as an NSF Cyber-Physical Systems (CPS) Rising Star (*Awarded to 30 out of 174 applicants*) 2025
- University at Buffalo CURCA Undergraduate Grant for Multi-robot Systems Research Fall 2017

### Logical Specifications for Neurosymbolic Control

[IROS '19, CDC '23, ICML Diff. Almost Everything '24, IROS '24, HSCC '25]

- Investigate use of Formal Methods (including temporal logics and automata theory) in the training and validation of safe controllers for autonomous systems.
- Developed techniques to use Signal Temporal Logic formulas and weighted automata along with a choice of quantitative semantics to produce rewards for reinforcement learning agents.
- Developed frameworks to enable the use of automata in gradient-based optimization by constructing differentiable weighted automata.

### Safety evaluation and monitoring of perception algorithms

[DATE '19, RV '21, RV '23, MEMOCODE '24]

- Develop monitoring algorithms for data streams that are generated by perception algorithms like object tracking and object detection.
- Developed a toolbox to specify logical specifications on perception algorithms and monitor their output when run on various datasets.
- Develop algorithm and tool to efficiently monitor perception algorithms at runtime.
- Develop logical consistency checkers for streams of data originating from multiple different sensor modalities, especially visual sensors.

### RELATED PROJECTS

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#### Argus

[[github.com/anand-bala/argus](https://github.com/anand-bala/argus)]

- Using: Rust, Python
- A Rust library (with Python bindings) for efficiently working with Signal Temporal Logic (STL) and its quantitative semantics.

#### Automatix

[[github.com/anand-bala/automatix](https://github.com/anand-bala/automatix)]

- Using: Python, Jax
- A library for creating and manipulating symbolic automata.
- Defines monitors over algebraic semirings.
- Enables the use of differentiable (weighted) automata on GPUs using matrix operators and polynomials.

#### PerceMon

[[github.com/anand-bala/PerceMon](https://github.com/anand-bala/PerceMon)]

- Using: C++
- A tool for online monitoring of Spatio-Temporal Quality Logic specifications.
- The logic is used to generate monitors for topological entities in streams of perception data.

#### Probabilistic Timed Automata Library

[[github.com/anand-bala/probabilistic-timed-automata](https://github.com/anand-bala/probabilistic-timed-automata)]

- Using: Python
- Python library for building and simulating probabilistic timed automata.

#### Persephone

[[github.com/cps-vida/Persephone](https://github.com/cps-vida/Persephone)]

- Using: Matlab, C
- A MATLAB toolbox to monitor data streams generated by perception systems.
- Uses Timed Quality Temporal Logic specifications to build monitors for perception algorithms, including object tracking, bounding box detection, etc.