Anand Balakrishnan

✉ anandbal [at] usc [dot] edu % anandb.dev ⌥ github.com/anand-bala

EDUCATION

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

PROFESSIONAL EXPERIENCE

- **Postdoctoral Fellow**   Aug 2025 — Ongoing
  Department of Computer Science, University of Texas at Austin
  Advisor: *Swarat Chaudhuri*
- **Research Assistant**   Aug 2018 — Jul 2025
  CPS-VIDA Group, University of Southern California
  Advisor: *Jyotirmoy V. Deshmukh*
- **President**   Apr 2024 — Jul 2025
  UAW 872: Academic Workers at the University of Southern California
- **Technical Intern**   Summer 2023
  Siemens Corporation
- **ADAS Software Engineering Intern**   Summer 2021
  INDI EV, Inc.
- **Research Intern**   Summer 2020
  Toyota Research Institute, North America
- **Undergraduate Researcher**   Feb 2016 — May 2018
  Distributed Robotics and Networked Embedded Systems Lab, University at Buffalo
  Advisor: *Karthik Dantu*

TEACHING AND MENTORING

Teaching Assistant	CSCI 699: Mathematical Foundation to Intelligent Autonomy	Fall 2023 (USC)
	CSCI 513: Autonomous Cyber-Physical Systems	Fall 2021 (USC)
Graduate Mentor	SURE Program: Summer Undergraduate Research Experience	Summer 2019 (USC)
Undergraduate Teaching Assistant	CSE 331: Algorithm Analysis and Design	Fall 2017 (UB)

[*The following are students and interns I have supervised or worked with on a mentoring capacity.*]

- **Interns:** Parv Kapoor

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

PUBLICATIONS

Journals and Conferences

1. **A. Balakrishnan**, S. Paul, S. Silvetti, L. Nenzi, and J. V. Deshmukh. 2025. Monitoring Spatially Distributed Cyber-Physical Systems with Alternating Finite Automata. In *28th ACM International Conference on Hybrid Systems: Computation and Control (HSCC)*. **Best Paper Award.** (May 2025). DOI: 10.1145/3716863.3718033.

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.

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.

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.

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.

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.

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.

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.

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.

Presentations and Posters

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.

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.
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.
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 [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 [cs, stat].

Honors and Awards

• **Best Paper Award** at the International Conference on Hybrid Systems: Computation and Control	HSCC 2025
• 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

Volunteering and Services

Web and Publicity Chair	Learning for Dynamics and Control Conference (L4DC)	2026
Referee	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
Student Organizer	International Conference on Runtime Verification (RV)	2020

Research

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

Argus [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]

- 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]

- 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]

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