# DJORDJE ZIKELIC (ĐORĐE ŽIKELIĆ)

## PERSONAL INFORMATION

**Email:** dzikelic@smu.edu.sg **Website:** https://djordjezikelic.github.io/

## RESEARCH OVERVIEW

My research is concerned with helping programmers ensure that software and AI systems are correct, safe, and trustworthy. To achieve this, I study **Formal Methods** and their applications to **Program Analysis and Verification** as well as **Trustworthy AI and Safe Autonomy**. The long-term goal of my work is to advance the theory and automation of formal methods for certifying the correctness of software and AI systems in the presence of **probabilistic uncertainty**, going beyond the classical finite-state probabilistic model checking paradigm. My work is concerned with both theoretical aspects of formal reasoning about probabilistic systems as well as the development of automated methods to help programmers build correct software and AI systems in practice. My current research interests include:

- Program Analysis and Verification
  (Probabilistic model and program verification, Numerical program verification)
- Trustworthy AI and Safe Autonomy
  (Certification for learning-enabled control, Safe reinforcement learning, Verification and planning in Markov models)
- Broader Applications of Probabilistic System Verification
  (Bidding games on graphs, Blockchain protocols)

## EMPLOYMENT

**Singapore Management University** *Jan 2024 - Present*
**School of Computing and Information Systems (SCIS)**
Assistant Professor of Computer Science

## EDUCATION

**Institute of Science and Technology Austria (ISTA)** *2018 - 2023*
Ph.D. in Computer Science
Advisors: Krishnendu Chatterjee, Petr Novotný
Thesis committee: Thomas A. Henzinger, Andreas Podelski
Thesis: *Automated Verification and Control of Infinite State Stochastic Systems*
**Outstanding PhD Thesis 2024** and **Outstanding Scientific Achievement 2023** awards at ISTA

**University of Cambridge, UK** *2014 - 2018*
Mathematical Tripos, Gonville & Caius College
Bachelor of Arts (BA) and Master of Mathematics (MMath)
Part III essay: *Lagrangians of Hypergraphs*

**Mathematical Grammar School, Belgrade, Serbia** *2010 - 2014*

## PRIOR EMPLOYMENT

**Amazon, UK** *Aug 2022 - Oct 2022*
Applied Scientist Intern, Prime Video Automated Reasoning
Project: On-line Automated Threshold Analysis for Time-series Anomaly Detection

**Amazon, UK (virtual)** *Oct 2020 - Jan 2021*
Applied Scientist Intern, Prime Video Automated Reasoning
Project: Differential Cost Analysis in Programs
Results featured in the **Amazon Science blog**, invited for presentation at the **Infer Practitioners Workshop 2021** organized by Meta and published at **PLDI 2022**, the premier venue in programming languages research.

## PUBLICATIONS

**Summary:** 3xCAV, 2xTACAS, 2xFM, 3xPLDI, 1xPOPL, 1xOOPSLA, 8xAAAI, 3xIJCAI, 2xNeurIPS, 1xSODA, 1xPODC, 1xMFCS, 1xATVA, 1xFSTTCS, 1xECAI, 1xL4DC
(21 papers in CSRankings)

**Conference proceedings**

1. S. Akshay, Supratik Chakraborty, Soroush Farokhnia, Amir Goharshady, Harshit J Motwani, Đorđe Žikelić†.
*LP-Based Weighted Model Integration over Non-Linear Real Arithmetic.*
34th International Joint Conference on Artificial Intelligence (**IJCAI 2025**), to appear

2. Thomas A. Henzinger, Kaushik Mallik, Pouya Sadeghi, Đorđe Žikelić†.
*Supermartingale Certificates for Quantitative Omega-regular Verification and Control.*
35th International Conference on Computer Aided Verification (**CAV 2023**), to appear

3. Thomas A. Henzinger, Fabian Kresse, Kaushik Mallik, Emily Yu, Đorđe Žikelić†.
*Predictive Monitoring of Black-Box Dynamical Systems.*
7th Annual Learning for Dynamics & Control Conference (**L4DC 2025**), to appear

4. Krishnendu Chatterjee, Ehsan Kafshdar Goharshady, Petr Novotný, Đorđe Žikelić†.
*Refuting Equivalence in Probabilistic Programs with Conditioning.*
31st International Conference on Tools and Algorithms for the Construction and Analysis of Systems (**TACAS 2025**), (2) 279-300
https://doi.org/10.1007/978-3-031-90653-4_14

5. Emily Yu, Đorđe Žikelić, Thomas A. Henzinger.
*Neural Control and Certificate Repair via Runtime Monitoring.*
39th AAAI Conference on Artificial Intelligence (**AAAI 2025**), 26409-26417
https://doi.org/10.1609/aaai.v39i25.34840

6. Krishnendu Chatterjee, Ehsan Kafshdar Goharshady, Mehrdad Karrabi, Harshit J Motwani, Maximilian Seeliger, Đorđe Žikelić†.
*Quantified Linear and Polynomial Arithmetic Satisfiability via Template-based Skolemization.*
39th AAAI Conference on Artificial Intelligence (**AAAI 2025**), 11158-11166
https://doi.org/10.1609/aaai.v39i11.33213

7. Krishnendu Chatterjee, Amir Kafhsdar Goharshady, Ehsan Kafshdar Goharshady, Mehrdad Karrabi, Đorđe Žikelić†.
*Sound and Complete Witnesses for Template-based Verification of LTL Properties on Polynomial Programs.*
27th International Symposium on Formal Methods (**FM 2024**), (1) 600–619
https://doi.org/10.1007/978-3-031-71162-6_31
**Distinguished Paper Award**

8. S. Akshay, Krishnendu Chatterjee, Tobias Meggendorfer, Đorđe Žikelić†.
*Certified Policy Verification and Synthesis for MDPs under Distributional Reach-Avoidance Properties.*
33rd International Joint Conference on Artificial Intelligence (**IJCAI 2024**), 3–12
https://doi.org/10.24963/ijcai.2024/1

9. Krishnendu Chatterjee, Ehsan Kafshdar Goharshady, Mehrdad Karrabi, Petr Novotný, Đorđe Žikelić†.
*Solving Long-run Average Reward Robust MDPs via Stochastic Games.*
33rd International Joint Conference on Artificial Intelligence (**IJCAI 2024**), 6707–6715
https://doi.org/10.24963/ijcai.2024/741

10. Krishnendu Chatterjee, Ehsan Kafshdar Goharshady, Petr Novotný, Đorđe Žikelić†.
*Equivalence and Similarity Refutation for Probabilistic Programs.*
46th ACM SIGPLAN Conference on Programming Language Design and Implementation (**PLDI 2024**), 2098–2122
https://doi.org/10.1145/3656462

11. Krishnendu Chatterjee, Amirali Ebrahim-Zadeh, Mehrdad Karrabi, Krzysztof Pietrzak, Michelle Yeo, Đorđe Žikelić†.
*Fully Automated Selfish Mining Analysis in Efficient Proof Systems Blockchains.*
43rd ACM Symposium on Principles of Distributed Computing (**PODC 2024**), 268–278
https://doi.org/10.1145/3662158.3662769

12. Krishnendu Chatterjee, Amir Kafshdar Goharshady, Tobias Meggendorfer, Đorđe Žikelić†.
*Quantitative Bounds on Resource Usage of Probabilistic Programs.*

ACM Conference on Object-Oriented Programming, Systems, Languages, and Applications (**OOPSLA 2024**), 362–391
https://doi.org/10.1145/3649824

13. Đorđe Žikelić*, Mathias Lechner*, Abhinav Verma, Krishnendu Chatterjee, Thomas A. Henzinger.
*Compositional Policy Learning in Stochastic Control Systems with Formal Guarantees.*
37th Conference on Neural Information Processing Systems (**NeurIPS 2023**), 47849–47873
https://dl.acm.org/doi/10.5555/3666122.3668197

14. Matin Ansaripour, Krishnendu Chatterjee, Thomas A. Henzinger, Mathias Lechner, Đorđe Žikelić†.
*Learning Provably Stabilizing Neural Controllers for Discrete-Time Stochastic Systems.*
21st International Symposium on Automated Technology for Verification and Analysis (**ATVA 2023**), (1) 357–379
https://doi.org/10.1007/978-3-031-45329-8_17

15. Guy Avni, Tobias Meggendorfer, Suman Sadhukhan, Josef Tkadlec, Đorđe Žikelić†.
*Reachability Poorman Discrete-Bidding Games.*
26th European Conference on Artificial Intelligence (**ECAI 2023**), 141–148
https://doi.org/10.3233/FAIA230264

16. S. Akshay, Krishnendu Chatterjee, Tobias Meggendorfer, Đorđe Žikelić†.
*MDPs as Distribution Transformers: Affine Invariant Synthesis for Safety Objectives.*
35th International Conference on Computer Aided Verification (**CAV 2023**), (3) 86–112
https://doi.org/10.1007/978-3-031-37709-9_5

17. Krishnendu Chatterjee, Thomas A. Henzinger, Mathias Lechner, Đorđe Žikelić†.
*A Learner-Verifier Framework for Neural Network Controllers and Certificates of Stochastic Systems.* (invited)
29th International Conference on Tools and Algorithms for the Construction and Analysis of Systems (**TACAS 2023**), (1) 3–25
https://doi.org/10.1007/978-3-031-30823-9_1

18. Đorđe Žikelić*, Mathias Lechner*, Krishnendu Chatterjee, Thomas A. Henzinger.
*Learning Control Policies for Stochastic Systems with Reach-avoid Guarantees.*
37th AAAI Conference on Artificial Intelligence (**AAAI 2023**), 11926–11935
https://doi.org/10.1609/aaai.v37i10.26407

19. Mathias Lechner, Đorđe Žikelić, Krishnendu Chatterjee, Thomas A. Henzinger, Daniela Rus.
*Quantization-aware Interval Bound Propagation for Training Certifiably Robust Quantized Neural Networks.*
37th AAAI Conference on Artificial Intelligence (**AAAI 2023**), 14964–14973
https://doi.org/10.1609/aaai.v37i12.26747

20. Guy Avni, Ismaël Jecker, Đorđe Žikelić†.
*Bidding Graph Games with Partially-Observable Budgets.*
37th AAAI Conference on Artificial Intelligence (**AAAI 2023**), 5464–5471
https://doi.org/10.1609/aaai.v37i5.25679

21. Ali Ahmadi, Krishnendu Chatterjee, Amir Kafshdar Goharshady, Tobias Meggendorfer, Roodabeh Safavi, Đorđe Žikelić†.
*Algorithms and Hardness Results for Computing Cores of Markov Chains.*
42nd IARCS Annual Conference on Foundations of Software Technology and Theoretical Computer Science (**FSTTCS 2022**), 29:1–29:20
https://doi.org/10.4230/LIPIcs.FSTTCS.2022.29

22. Krishnendu Chatterjee, Amir Kafshdar Goharshady, Tobias Meggendorfer, Đorđe Žikelić†.
*Sound and Complete Certificates for Quantitative Termination Analysis of Probabilistic Programs.*
34th International Conference on Computer Aided Verification (**CAV 2022**), (1) 55–78
https://doi.org/10.1007/978-3-031-13185-1_4

23. Đorđe Žikelić, Bor-Yuh Evan Chang, Pauline Bolignano, Franco Raimondi.
*Differential Cost Analysis with Simultaneous Potentials and Anti-potentials.*
44th ACM SIGPLAN Conference on Programming Language Design and Implementation (**PLDI 2022**), 442–457
https://doi.org/10.1145/3519939.3523435
**Featured in the Amazon Science blog**

24. Mathias Lechner*, Đorđe Žikelić*, Krishnendu Chatterjee, Thomas A. Henzinger.
*Stability Verification in Stochastic Control Systems via Neural Network Supermartingales.*

36th AAAI Conference on Artificial Intelligence (**AAAI 2022**), 7326–7336
https://doi.org/10.1609/aaai.v36i7.20695

25. Mathias Lechner*, Đorđe Žikelić*, Krishnendu Chatterjee, Thomas A. Henzinger.
*Infinite Time Horizon Safety of Bayesian Neural Networks.*
35th Conference on Neural Information Processing Systems (**NeurIPS 2021**), 10171–10185
https://dl.acm.org/doi/10.5555/3540261.3541039

26. Krishnendu Chatterjee, Ehsan Kafshdar Goharshady, Petr Novotný, Jiři Zárevúcky, Đorđe Žikelić†.
*On Lexicographic Proof Rules for Probabilistic Termination.*
24th International Symposium on Formal Methods (**FM 2021**), 619–639
https://doi.org/10.1007/978-3-030-90870-6_33
**Invited to the Special Collection from FM 2021**, dedicated to best papers

27. Krishnendu Chatterjee, Ehsan Kafshdar Goharshady, Petr Novotný, Đorđe Žikelić†.
*Proving Non-termination by Program Reversal.*
43rd ACM SIGPLAN Conference on Programming Language Design and Implementation (**PLDI 2021**), 1033–1048
https://doi.org/10.1145/3453483.3454093

28. Thomas A. Henzinger, Mathias Lechner, Đorđe Žikelić†.
*Scalable Verification of Quantized Neural Networks.*
35th AAAI Conference on Artificial Intelligence (**AAAI 2021**), 3787–3795
https://doi.org/10.1609/aaai.v35i5.16496

29. Guy Avni, Ismaël Jecker, Đorđe Žikelić†.
*Infinite-Duration All-Pay Bidding Games.*
ACM-SIAM Symposium on Discrete Algorithms (**SODA 2021**), 617–636
https://doi.org/10.1137/1.9781611976465.38

30. Guy Avni, Thomas A. Henzinger, Đorđe Žikelić†.
*Bidding Mechanisms in Graph Games.*
44th International Symposium on Mathematical Foundations of Computer Science (**MFCS 2019**), 11:1-11:13
https://doi.org/10.4230/LIPIcs.MFCS.2019.11

31. Krishnendu Chatterjee, Petr Novotný, Guillermo A. Perez, Jean-Francois Raskin, Đorđe Žikelić†.
*Optimizing Expectation with Guarantees in POMDPs.*
31st AAAI Conference on Artificial Intelligence (**AAAI 2017**), 3725–3732
https://doi.org/10.1609/aaai.v31i1.11046

32. Krishnendu Chatterjee, Petr Novotný, Đorđe Žikelić†.
*Stochastic invariants for probabilistic termination.*
44th ACM SIGPLAN Symposium on Principles of Programming Languages (**POPL 2017**), 145–160
https://doi.org/10.1145/3009837.3009873

**Journal publications**

1. Krishnendu Chatterjee, Ehsan Kafshdar Goharshady, Petr Novotný, Jiři Zárevúcky, Đorđe Žikelić†.
*On Lexicographic Proof Rules for Probabilistic Termination.*
Formal Aspects of Computing 35(2): 11:1–11:25 (**2023**)
https://doi.org/10.1145/3585391

2. Krishnendu Chatterjee, Jakub Svoboda, Đorđe Žikelić, Andreas Pavlogiannis, Josef Tkadlec.
*Social balance on networks: Local minima and best-edge dynamics.*
Physical Review E 106(3): 1–13 (**2022**)
https://doi.org/10.1103/PhysRevE.106.034321

3. Guy Avni, Thomas A. Henzinger, Đorđe Žikelić†.
*Bidding Mechanisms in Graph Games.*
Journal of Computer and System Sciences 119: 133–144 (**2021**)
https://doi.org/10.1016/j.jcss.2021.02.008

4. Đorđe Baralić, Branko Grbić, Đorđe Žikelić†.
*Theorems about quadrilaterals and conics.*
International Journal of Computer Mathematics 91(7): 1407–1421 (**2014**)
https://doi.org/10.1080/00207160.2013.844338

**Workshop publications**

1. Vignesh Subramanian, Đorđe Žikelić, Suguman Bansal.
   *Certification-Guided Evaluation of Reinforcement Learning Generalization.*
   8th Workshop on Generalization in Planning (**GenPlan@AAAI 2025**)
2. Đorđe Žikelić*, Mathias Lechner*, Krishnendu Chatterjee, Thomas A. Henzinger.
   *Learning Stabilizing Policies in Stochastic Control Systems.*
   ICLR 2022 Workshop on Socially Responsible Machine Learning (**SRML@ICLR 2022**)

## HONOURS AND AWARDS

**FM 2024 Distinguished Paper Award** *2024*
For "Sound and Complete Witnesses for Template-based Verification of LTL Properties on Polynomial Programs".

**SETTA 2024 Distinguished Reviewer Award** *2024*
Awarded to 4 distinguished reviewers for SETTA 2024.

**Outstanding PhD Thesis** *2024*
Awarded annually to best PhD theses by the Institute of Science at Technology Austria.

**Outstanding Scientific Achievement** *2023*
Together with Mathias Lechner, for our work on developing the first framework for learning and verifying neural controllers in stochastic dynamical systems. Awarded annually by the Institute of Science at Technology Austria.

**Meta PhD Research Fellowship - finalist** *2022*
Shortlisted as one of the 4 finalists worldwide for the programming languages category.

**Gonville & Caius College Scholarship** and **Cambridge Trust Scholarship** *2014-2018*
Full university fees, tuition fees, and maintenance costs.

**Stephen Hawking Fund Award** *2017*
Awarded by Gonville & Caius College, Cambridge to mathematics students proceeding to Part III.

**Scholar of the Gonville & Cauis College, Cambridge** *2015, 2016*
High performance in the examinations of the Mathematical Tripos.

**International High School Olympiads** *2010-2014*
Participated in international high school olympiads in mathematics, physics, and astronomy. Most notable results:

- International Olympiad in Astronomy and Astrophysics (IOAA) 2014 (bronze medal)
- International Mathematical Competition Arhimede 2013 (gold medal), 2012 (silver medal)
- International Junior Science Olympiad (IJSO) 2010 (bronze medal)
- International Astronomy Olympiad (IAO) 2010 (bronze medal)
- International Mathematical Olympiad (IMO) 2014 (first reserve for the Serbian team)

**National High School Competitions** *2010-2014*

- Serbian Mathematical Olympiad: second prize in 2014, third prize in 2013, 2012
- Mathematics (national): **first overall** in my year in 2014, 2012, 2010, **second overall** in 2013
- Physics (national): first prize in 2013, second prize in 2012, 2011, third prize in 2014
- Astronomy (national): second prize in 2014, 2012

## TEACHING

**Teaching at SMU**

- CS423: Heuristic Search and Optimisation *Term 2, 2024-2025*
  Overall course rating: **6.9**/**7.0** (highest student rating across all courses in the School)
  Overall instructor rating: **7.0**/**7.0** (highest student rating across all courses in the School and the University)
- CS423: Heuristic Search and Optimisation *Term 2, 2023-2025*
  Overall course rating: **6.6**/**7.0**
  Overall instructor rating: **6.8**/**7.0** (highest student rating across all non-compulsory courses in the School)

**Teaching at ISTA**

- Computer Science Track Core Course, TA *Spring, 2021*
- Formal Methods, TA *Spring, 2020*
- Computer Science Track Core Course, TA *Spring, 2020*

- Mathematics Track Core Course, 4 lectures on Brownian motion and aspects of probability *Spring, 2019*

## SUPERVISION

**Supervision of visiting research students and interns at SMU**

- Pouya Sadeghi, University of Tehran *Aug 2024 - Feb 2025*
  *Supermartingale Certificates for Quantitative Omega-regular Verification and Control* (CAV 2025)
- Ouldouz Neysari, University of Tehran *Jul 2024 - Jan 2025*
  *Omega-regular Verification and Control for Distributional Specifications in MDPs* (under submission)

**Supervision of undergraduate student projects at SMU**

- Maaruni Pandithurai, SMU *May 2024 - Jul 2024*
  *Safe Reinforcement Learning under Probabilistic Constraints*
- Sarah Ann Hogan, SMU *May 2024 - Jul 2024*
  *Safe Reinforcement Learning under Probabilistic Constraints*

**Supervision of interns at ISTA**

- Amirali Ebrahim-zadeh, Sharif University *Summer 2022*
  *Analyzing Selfish Mining in Proof of Space-based Blockchain Protocols* (PODC 2024)
- Matin Ansaripour, Sharif University *Spring 2022*
  *Learning Control Policies for Region Stabilization in Stochastic Systems* (ATVA 2023)
- Roodabeh Safavi, Sharif University *Spring 2022*
  *Algorithms and Hardness Results for Computing Cores of Markov Chains* (FSTTCS 2022)
- Ehsan Kafshdar Goharshady, Ferdowsi University of Mashhad *Summer 2020*
  *Proving Non-termination by Program Reversal* (PLDI 2021)
  *On Lexicographic Proof Rules for Probabilistic Termination* (FM 2021)

## SERVICE

- **Program Committee:**
  2026: TACAS 2026
  2025: AAAI 2025, CAV 2025, IJCAI 2025, ECAI 2025, VMCAI 2025, ASE 2025, SAIV 2025, SETTA 2025
  2024: AAAI 2024, IJCAI 2024, ECAI 2024, ATVA 2024, SETTA 2024 (**Distinguished Reviewer Award**)
  2023: AAAI 2023, ECAI 2023, CAV AEC 2023
  2022: CAV AEC 2022
- **Organizing Committee:**
  Programming Languages Mentoring Workshop (PLMW) @ PLDI 2025
- **Reviewer/Subreviewer/External Reviewer:**
  LICS 2024, TACAS 2024, POPL 2024, ISSAC 2024, FSTTCS 2023, CONCUR 2023, CDC 2023, ATVA 2023, LPAR 2023, FoSSaCS 2022, AAMAS 2022, ICML 2022

## INVITED TALKS

- Institute of Science and Technology Austria, Klosterneuburg, Austria May 2025
  *MDPs as Distribution Transformers: Formal Verification and Synthesis*
- East China Normal University, Shanghai, China May 2025
  *Neural Controller Synthesis and Verification with Guarantees*
- Nanyang Technological University, Singapore, Singapore Nov 2024
  *Neural Controller Synthesis and Verification with Guarantees*
- IIT Bombay, Mumbai, India Oct 2024
  *Certified Policy Verification and Synthesis for MDPs under Distributional Properties*
- Hong Kong University of Science and Technology, Hong Kong, China Jul 2024
  *Neural Controller Synthesis and Verification with Guarantees*
- 20th International Summer School on Trustworthy Software, Shanghai, China Jul 2024
  *Trustworthy AI through Neural Certificates, Runtime Monitoring, and Multi-Agent Reasoning*
  (series of 4 lectures together with Tom Henzinger)
- IIT Bombay, Mumbai, India May 2024
  *A Learner-verifier Framework for Certifying Neural Controllers in Stochastic Systems*
- National University of Singapore, Singapore, Singapore May 2024
  *A Learner-verifier Framework for Certifying Neural Controllers in Stochastic Systems*

- Mathematical Institute of the Serbian Academy of Science and Arts, Belgrade, Serbia — Dec 2023
  *A Learner-verifier Framework for Learning and Certifying Neural Controllers*
- École Normale Supérieure, Paris, France — Jul 2023
  *A Learner-verifier Framework for Learning and Certifying Neural Controllers in Stochastic Systems*
- (**keynote**) The Workshop on Verification of Probabilistic Programs (VeriProP), Paris, France — Jul 2023
  *A Learner-verifier Framework for Learning and Certifying Neural Controllers in Stochastic Systems*
- Nissan Research, virtual — Jun 2023
  *A Learner-verifier Framework for Learning and Certifying Neural Controllers in Stochastic Systems*
- TU Delft, Delft, Netherlands — Jun 2023
  *Formal Verification and Learning-based Control of Infinite State Stochastic Systems*
- Masaryk University, Brno, Czech Republic — Jun 2023
  *Formal Verification and Learning-based Control of Infinite State Stochastic Systems*
- EPFL, Lausanne, Switzerland — Jul 2022
  *Martingale-based Methods for Formal Verification and Certified Control of Stochastic Systems*
- Masaryk University, Brno, Czech Republic — Apr 2022
  *Proving Non-termination by Program Reversal*
- Infer Practitioners Workshop, virtual — Jun 2021
  *Differential Cost Analysis with Infer and Possible Extensions for Concrete Cost Analysis*
- Mathematical Institute of the Serbian Academy of Science and Arts, Belgrade, Serbia — Dec 2019
  *Static Analysis of Probabilistic Programs with Martingales* (in Serbian)

## ORGANIZATION

- Co-organized **Young Scientist Symposium 2019** at ISTA — May, 2019
- President of the **Cambridge University Serbian Society** — 2017-2018