

Matthew C. Fontaine

CONTACT	Email: mfontain@usc.edu Twitter: @tehqn17
INTERESTS	I study the problem of algorithmically generating scenarios to evaluate human-robot interaction and collaboration algorithms. My research blends the areas of discrete optimization, generative models, quality diversity optimization, neuroevolution, procedural content generation, and human-robot interaction (HRI) into powerful scenario generation systems that enhance safety when robots interact with humans.
EDUCATION	University of Southern California , Los Angeles, CA Ph.D., Computer Science, August 2019 - December 2024 Major advisor: Dr. Stefanos Nikolaidis University of Central Florida , Orlando, FL M.S., Computer Science, August 2011 - December 2013 B.S., Computer Science, August 2007 - May 2011
RESEARCH EXPERIENCE	Graduate Research Assistant ICAROS Lab August 2019 - Present <i>I study the problem of automatically generating scenarios to evaluate human-robot interaction algorithms.</i> Independent Researcher Remote October 2018 - July 2019 <i>In collaboration with Dr. Amy Hoover (NJIT) and Dr. Julian Togelius (NYU), I implemented the MAP-Elites quality diversity algorithm to explore the deckspace of the Blizzard game Hearthstone. My work introduced the sliding boundaries augmentation to MAP-Elites, enabling the application of MAP-Elites to this domain.</i> Research Assistant Interactive Realities Lab, IST, UCF January 2008 - July 2014 <i>I developed a variety of game-based training tools for all stages of a human-training pipeline. This includes after-action review (AAR) systems in a distributed setting, prototype scenario generation systems, visualization and editing tools for manually authoring training scenarios, and server and client software for pre-AAR coordination.</i>
PEER-REVIEWED JOURNAL PUBLICATIONS	[1] Shihan Zhao, Bryon Tjanaka, Matthew C Fontaine, and Stefanos Nikolaidis. Covariance matrix adaptation map-annealing: Theory and experiments. <i>ACM Transactions on Evolutionary Learning</i> , 2024 [2] Bryon Tjanaka, Matthew C Fontaine, David H Lee, Aniruddha Kalkar, and Stefanos Nikolaidis. Training diverse high-dimensional controllers by scaling covariance matrix adaptation map-annealing. <i>IEEE Robotics and Automation Letters</i> , 2023 [3] Shihan Lu, Mianlun Zheng, Matthew C Fontaine, Stefanos Nikolaidis, and Heather Marie Culbertson. Preference-driven texture modeling through interactive generation and search. <i>IEEE Transactions on Haptics</i> , 2022 [4] Matthew C. Fontaine and Stefanos Nikolaidis. Evaluating human-robot interaction algorithms in shared autonomy via quality diversity scenario generation. <i>ACM Transactions on Human-Robot Interaction (THRI)</i> , 2021

- [5] David H Lee, Anishalakshmi Palaparthi, Matthew C Fontaine, Bryon Tjanaka, and Stefanos Nikolaidis. Density descent for diversity optimization. In *Proceedings of the Genetic and Evolutionary Computation Conference*, pages 674–682, 2024. Acceptance rate: 36%
- [6] Sumeet Batra, Bryon Tjanaka, Matthew Christopher Fontaine, Aleksei Petrenko, Stefanos Nikolaidis, and Gaurav S. Sukhatme. Proximal policy gradient arborescence for quality diversity reinforcement learning. In *The Twelfth International Conference on Learning Representations*, 2024. **Spotlight Presentation, Acceptance rate: 6.2%**
- [7] Allen Chang, Matthew C Fontaine, Serena Booth, Maja J Matarić, and Stefanos Nikolaidis. Quality-diversity generative sampling for learning with synthetic data. In *Proceedings of the AAAI Conference on Artificial Intelligence*, volume 38, pages 19805–19812, 2024. Acceptance rate: 23.75%
- [8] Varun Bhatt, Heramb Nemlekar, Matthew Fontaine, Bryon Tjanaka, Hejia Zhang, Ya-Chuan Hsu, and Stefanos Nikolaidis. Surrogate assisted generation of human-robot interaction scenarios. *Conference on Robot Learning (CoRL)*, 2023. **Oral Presentation, Acceptance rate: 6.63%**
- [9] Yulun Zhang, Matthew C Fontaine, Varun Bhatt, Stefanos Nikolaidis, and Jiaoyang Li. Arbitrarily scalable environment generators via neural cellular automata. *Advances in Neural Information Processing Systems*, 36, 2023. Acceptance rate: 26.1%
- [10] Yulun Zhang, Matthew C. Fontaine, Varun Bhatt, Stefanos Nikolaidis, and Jiaoyang Li. Multi-robot coordination and layout design for automated warehousing. In Edith Elkind, editor, *Proceedings of the Thirty-Second International Joint Conference on Artificial Intelligence, IJCAI-23*, pages 5503–5511. International Joint Conferences on Artificial Intelligence Organization, 8 2023. Acceptance rate: 14.1%
- [11] Matthew C Fontaine and Stefanos Nikolaidis. Covariance matrix adaptation map-annealing. In *Proceedings of the 2020 Genetic and Evolutionary Computation Conference (GECCO)*, 2023. **Best paper in the Evolutionary Machine Learning (EML) track.**
- [12] Bryon Tjanaka, Matthew C Fontaine, David H Lee, Yulun Zhang, Nivedit Reddy Balam, Nathaniel Dennler, Sujay S Garlanka, Nikitas Dimitri Klapsis, and Stefanos Nikolaidis. pyribs: A bare-bones python library for quality diversity optimization. In *Proceedings of the 2020 Genetic and Evolutionary Computation Conference (GECCO)*, 2023. Acceptance rate: 35.1%
- [13] Varun Bhatt, Bryon Tjanaka, Matthew C Fontaine, and Stefanos Nikolaidis. Deep surrogate assisted generation of environments. In *Advances in Neural Information Processing Systems*, 2022. Acceptance rate: 25.6%
- [14] Sam Earle, Justin Snider, Matthew C Fontaine, Stefanos Nikolaidis, and Julian Togelius. Illuminating diverse neural cellular automata for level generation. In *Proceedings of the Genetic and Evolutionary Computation Conference*, pages 68–76, 2022. Acceptance rate: 37%
- [15] Yulun Zhang, Matthew C Fontaine, Amy K Hoover, and Stefanos Nikolaidis. Deep surrogate assisted map-elites for automated hearthstone deckbuilding. In *Proceedings of the Genetic and Evolutionary Computation Conference*, pages 158–167, 2022. Acceptance rate: 37%

- [16] Bryon Tjanaka, Matthew C. Fontaine, Julian Togelius, and Stefanos Nikolaidis. Approximating gradients for differentiable quality diversity in reinforcement learning. In *Proceedings of the Genetic and Evolutionary Computation Conference, GECCO '22*, page 1102–1111, New York, NY, USA, 2022. Association for Computing Machinery. Acceptance rate: 37%
- [17] Matthew C. Fontaine and Stefanos Nikolaidis. Differentiable quality diversity. *Advances in Neural Information Processing Systems*, 34, 2021. **Oral Presentation, Acceptance rate: <1%**
- [18] Matthew C. Fontaine*, Ya-Chuan Hsu*, Yulun Zhang*, Bryon Tjanaka, and Stefanos Nikolaidis. On the importance of environments in human-robot coordination. In *Robotics Science and Systems (RSS)*, 2021. Acceptance rate: 27%
- [19] Matthew C. Fontaine and Stefanos Nikolaidis. A quality diversity approach to automatically generating human-robot interaction scenarios in shared autonomy. In *Robotics Science and Systems (RSS)*, 2021. Acceptance rate: 27%
- [20] Matthew C. Fontaine, Ruilin Liu, Ahmed Khalifa, Jignesh Modi, Julian Togelius, Amy K. Hoover, and Stefanos Nikolaidis. Illuminating mario scenes in the latent space of a generative adversarial network. In *35th AAAI Conference on Artificial Intelligence (AAAI)*, 2021. Acceptance rate: 21%
- [21] Hejia Zhang*, Matthew C. Fontaine*, Amy K. Hoover, Julian Togelius, Bistra Dilkina, and Stefanos Nikolaidis. Video game level repair via mixed integer linear programming. In *Proceedings of the AAAI Conference on Artificial Intelligence and Interactive Digital Entertainment (AIIDE)*, 2020. (oral presentation), Acceptance rate: 25%
- [22] Matthew C. Fontaine, Julian Togelius, Stefanos Nikolaidis, and Amy K. Hoover. Covariance matrix adaptation for the rapid illumination of behavior space. In *Proceedings of the 2020 Genetic and Evolutionary Computation Conference (GECCO)*, 2020. Acceptance rate: 36%
- [23] Fernando de Mesentier Silva, Rodrigo Canaan, Scott Lee, Matthew C. Fontaine, Julian Togelius, and Amy K Hoover. Evolving the hearthstone meta. In *2019 IEEE Conference on Games (CoG)*, pages 1–8. IEEE, 2019. Acceptance rate: 40%
- [24] Matthew C Fontaine, Scott Lee, Lisa B Soros, Fernando de Mesentier Silva, Julian Togelius, and Amy K Hoover. Mapping hearthstone deck spaces through map-elites with sliding boundaries. In *Proceedings of The Genetic and Evolutionary Computation Conference*, pages 161–169, 2019. Acceptance rate: 35%
- [25] Matthew C. Fontaine. Tidal flow: A fast and teachable maximum flow algorithm. In *Olympiads in Informatics*, pages 25–41, 2018
- [26] Matthew C. Fontaine. Quality diversity scenario generation for evaluating human-robot interaction. *RSS Pioneers*, 6, 2023
- [27] Matthew C. Fontaine. Towards automating the generation of human-robot interaction scenarios. *AAAI Doctoral Consortium*, 27, 2022

DOCTORIAL
CONSORTIA

SHORT PAPERS,
WORKSHOPS, AND
SYMPOSIA

- [28] Ryan Boldi, Matthew Fontaine, Sumeet Batra, Gaurav Sukhatme, and Stefanos Nikolaidis. Generating diverse critics for conditioned policy distillation. In *Proceedings of the Genetic and Evolutionary Computation Conference Companion*, pages 167–170, 2024
- [29] Ya-Chuan Hsu, Matthew Fontaine, Sam Earle, Maria Edwards, Julian Togelius, and Stefanos Nikolaidis. Generating diverse indoor furniture arrangements. In *ACM SIGGRAPH 2022 Posters*, pages 1–2. 2022
- [30] Robert Loudon, Matt Fontaine, Glenn A. Martin, Jason Daly, and Sae Schatz. User interface and information management of scenarios. In Michael J. Smith and Gavriel Salvendy, editors, *Human Interface and the Management of Information. Interacting with Information*, pages 30–39, Berlin, Heidelberg, 2011. Springer Berlin Heidelberg
- [31] Matthew Fontaine, Glenn A. Martin, Jason Daly, and Casey Thurston. Technological and usability-based aspects of distributed after action review in a game-based training setting. In Don Harris, editor, *Engineering Psychology and Cognitive Ergonomics*, pages 522–529, Berlin, Heidelberg, 2011. Springer Berlin Heidelberg

EMPLOYMENT,
TEACHING, AND
INTERNSHIPS

Author	
France’s International Olympiad in Informatics	2018 - 2019
Instructor and Content Creator	
Interview Kickstart, Sunnyvale, CA	2017 - 2019
Software Engineer in Simulation	
Drive.ai, Mountain View, CA	2017 - 2018
Instructor	
Department of Computer Science, University of Central Florida	2014 - 2017
Intern	
Font and Text Team, Google, Mountain View, CA	Summer 2013
Problem Author	
Topcoder	2012 - 2017

INVITED TALKS

- *Quality Diversity Scenario Generation for Robust Autonomy* at University College London (virtual), DARK Lab, London, England, September 15, 2022
- *Differentiable Quality Diversity: From MAP-Elites to CMA-ME to MEGA* at New York University (virtual), Game Innovation Lab, New York City, NY, June 17, 2021
- *Automatic Scenario Generation: From Human Training to Games to Robotics.* at New York University, Game Innovation Lab, New York City, NY April 8, 2019

AWARDS AND
HONORS

- USC PhD Achievement Award 2025 (awarded to 6 students university-wide)
- Spotlight presentation at ICLR 2024
- Oral presentation at CoRL 2023
- Best Paper in Evolutionary Machine Learning Track at GECCO 2023
- Robotics: Science and Systems Pioneer 2023
- IEEE Transactions on Haptics Best Journal Paper Nomination 2022
- AAAI Doctorial Consortium 2022
- Oral presentation at NeurIPS 2021
- 2012 ACM ICPC Southeast USA Regional Programming Contest 2nd Place
- 2012 ACM ICPC World Finals 36th place

- 2011 ACM ICPC Southeast USA Regional Programming Contest 2nd Place
- 2011 Upsilon Pi Epsilon Honor Society Inductee
- 2011 Best AI Award. Ken Stanley's AI for Game Programming Course
- 2011 IEEE Southeast Conference Programming Contest 1st place
- 2010 ACM ICPC Southeast USA Regional Programming Contest 3rd Place

REVIEWING SERVICE

- The Genetic and Evolutionary Computation Conference (GECCO 2022)
- 36th AAAI Conference on Artificial Intelligence (AAAI 2022)
- 35th AAAI Conference on Artificial Intelligence (AAAI 2021)

VOLUNTEER SERVICE

Lead Designer

Pyribs 2021 - Present
I designed and help maintain the pyribs quality diversity optimization library.

Programming Contest Judge

ACM ICPC World Finals 2019
Authored and prepared problems for the International Collegiate Programming Contest (ICPC) world finals.

YouTuber

Algorithms Live! 2016 - Present
I'm the creator and host of the Algorithms Live! YouTube channel on competitive programming with over 30,000 subscribers.

SHINE Mentor at the University of Southern California

Summer High School Intensive in Next-Generation Engineering (SHINE) 2020
Mentored Nikitas Klapsis, a Los Angeles high school student, on his summer research project "Generalized Robot Learning from One Scenario". His project became the first pyribs tutorial "Using CMA-ME to Land a Lunar Lander Like a Space Shuttle".

USACO Coach

United States of America Computing Olympiad (USACO) 2017 - Present
Each year I prepare the top high school students in algorithms for the International Olympiad in Informatics (IOI). In 2018 I attended the IOI as the United States deputy team leader in Tsukuba, Japan.

Programming Contest Judge

ICPC North American Championship 2020 - Present
Authored and prepared problems for the International Collegiate Programming Contest's super-regional for North America.

Programming Contest Judge

ICPC North American Invitational Programming Contest (NAIPC) 2015 - 2019
Authored and prepared problems for the NAIPC contest, a precursor to the ICPC North American Championship.

Programming Contest Judge

ICPC South East USA Regional (SER) Programming Contest 2017 - Present
Authored and prepared problems for the International Collegiate Programming Contest's Southeast Regional Contest.

ICPC Algorithms Coach

University of Central Florida 2013 - 2017
Trained several UCF teams including the world finals team. I regularly hosted individual and team meetings with a focus on honing algorithmic problem-solving skills. Additionally, I hosted problem review sessions and Saturday algorithms lectures. UCF placed first among teams in the United States in 2017 and first among all teams from North

America in 2018 at the ICPC World Finals. During my tenure as algorithms coach, a UCF team placed first every year in the South East USA Regional Programming contest, defeating our regional rival Georgia Tech every year.

Instructor for SI@UCF Programming Contest Summer Camp

University of Central Florida

2014 - 2017

I co-ran the first three years of UCF's residential algorithms camp. The camp aimed at preparing high school students for IOI-style programming competitions such as USACO. Several students advanced to the USACO training camp and one student earned a gold medal at the IOI in 2018. I ran lectures for the advanced student group and prepared problems for daily programming contests.

T-Shirt Designer

United States of America Computing Olympiad (USACO)

2014 - Present

I've served as the official "Cow Artist" for USACO working with Brian Dean from Clemson University. Each year I design a T-shirt that draws USACO's cow mascot Bessie in the garb of the host country. I hand draw all designs and convert them to SVG in Inkscape for final shirt printing.

Editorialist

Google Code Jam

2013

Presented the solution to the computational geometry problem "Rural Planning". I created diagrams and explanations for the editorial as volunteer service during my Google internship.