Matthew C. Fontaine

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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 Califonia, 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 study the problem of automatically generating scenarios to evaluate human-robot interaction algorithms.

Independent Researcher
Remote   October 2018 - July 2019
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.

Research Assistant
Interactive Realities Lab, IST, UCF   January 2008 - July 2014
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.

PUBLICATION HONORS

- Spotlight presentation at ICLR 2024
- Oral presentation at CoRL 2023
- Best Paper in Evolutionary Machine Learning Track at GECCO 2023
- IEEE Transactions on Haptics Best Journal Paper Nomination 2022
- Oral presentation at NeurIPS 2021

PEER-REVIEWED JOURNAL PUBLICATIONS

[1] Shihan Zhao, Bryon Tjanaka, Matthew C Fontaine, and Stefanos Nikolaidis. Covariance matrix adaptation map-annealing: Theory and experiments. *ACM Transactions on Evolutionary Learning*, 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. *IEEE Robotics and Automation Letters*, 2023

[3] Shihan Lu, Mianlun Zheng, Matthew C Fontaine, Stefanos Nikolaidis, and Heather Marie Culbertson. Preference-driven texture modeling through interactive generation and search. *IEEE Transactions on Haptics*, 2022

[4] Matthew C. Fontaine and Stefanos Nikolaidis. Evaluating human-robot interaction algorithms in shared autonomy via quality diversity scenario generation. *ACM Transactions on Human-Robot Interaction (THRI)*, 2021

Peer-Reviewed Conference Publications

[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

DOCTORIAL
CONSORTIA

[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

| 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 Louden, 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 pro-
gramming 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. Addition-
ally, 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.