Michael Amir

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Profile

My research focuses on applications of Multi-Agent Reinforcement Learning (MARL) and the mathematical foundations of cooperative multi-agent systems (MAS). I develop algorithms with mathematically provable performance guarantees for large-scale decentralized systems, such as cooperating robots, analyzing their cooperation dynamics and emergent behavior.
I am currently exploring fundamental questions in learning dynamics and MAS design, such as: How can we use learning to co-design agent policies and their environments or the tools they have access to? How can we integrate classical search methods with imitation learning/RL in decentralized systems? My work uses Graph Neural Networks (GNNs) for learned, decentralized, scalable communication between agents. Recent research includes:

- The first principled mathematical theory analyzing when heterogeneous learning methods outperform homogeneous methods in cooperative MARL.
- The first learning-based multi-agent pathfinding algorithm to surpass SOTA, non-learning search-based methods (a longstanding challenge; learning has traditionally lagged behind search in this domain).
- Resolving a well-known, 2-decades-old algorithmic open problem in decentralized uniform multi-robot dispersion.

Professional Experience

2024– **Research Associate**, *Prorok Lab at University of Cambridge*
I lead several research thrusts in our lab in multi-agent reinforcement learning: How can we simultaneously optimize, using learning, the agent's policy and the tools it has access to or its environment? When should cooperative agents pursue diverse, rather than homogeneous strategies?

2023 **Postdoctoral Fellow**, *Technion*
Investigated fundamental mathematical problems in collective intelligence, swarm robotics, and emergent behavior. Focused on the theoretical limits of decentralized coordination and learning for capability-constrained agents.

2022–2023 **Research Scientist**, *metha.ai/Technion Collaboration with MIT*
Developed novel machine learning and statistical methods for complex data analysis (metagenomic data), attaining significant accuracy improvements over the state of the art.

Education

2018–2023 **PhD in Computer Science**, *Technion*, Haifa, Israel, GPA: 98.7
Thesis Title: "Multi-A(ge)nt Systems on Graphs"
Advised by Prof. Alfred M. Bruckstein

2015–2017 **MSc. in Computer Science**, *Technion*, Haifa, Israel, Thesis grade: 96
Thesis Title: "Ant-like Probabilistic Pursuits on Graphs"
Advised by Prof. Alfred M. Bruckstein

2009–2014 **B.A. in Mathematics and Philosophy**, *The Open University*, Haifa, Israel, Magna cum Laude (GPA: 92.5)
Began studies concurrent to middle school as part of the Open University's young students excellence program

Awards

2024 Postdoctoral Affiliate of Trinity College. Trinity College, University of Cambridge

2022 Runner-up for Rothschild Fellowship. Yad Hanadiv

2021 National Excellence Award in Smart Transportation Research. Israeli Smart Transportation Center

2021 Graduate Student Research Excellence Award. Technion, Computer Science Faculty

2020 Graduate Student Research Excellence Award. Technion, Computer Science Faculty

2019 Best Poster Award (2nd place). Technion, Open Research Day

2018–2023 Excellence Scholarship. Technion

2011 Presidential Excellence Award. The Open University

2010–2014 Dean's List of Distinguished Students. The Open University

Mentorship and Supervision

Samuel Ratnam — Title: *Inverse Constitutional AI for Identifying Divergent Behavior in LLMs.* ERA Fellowship in AI Safety.

Hao Xiang Li — Title: *Scaling Co-design with Diffusion Models.* Co-supervised with Professor Amanda Prorok. Part III Thesis, University of Cambridge.

Tali Motzkin — Title: *Covert Steering of Multi-Agent Systems via Hypergraph Neural Networks.* MPhil Thesis, University of Cambridge.

Alon Shats — Title: *Ant-like Competitive Coverage.* MSc., Bar-Ilan University.

Teaching

- Seminar on Multi-Agent Systems · Theory of Computation · Introduction to Computing

Publications

Journal Articles

Michael Amir and Alfred M. Bruckstein. "Time, Travel, and Energy in the Uniform Dispersion Problem". *IEEE Transactions on Robotics* (2025).

Dmitry Rabinovich*, Michael Amir*, and Alfred M. Bruckstein. "Optimally Reordering Mobile Agents on Parallel Rows". *Theoretical Computer Science* 985 (2024).

Michael Amir, Noa Agmon, and Alfred M. Bruckstein. "A Locust-Inspired Model of Collective Marching on Rings". *Entropy* 24.7 (2022), 918.

Michael Amir and Alfred M. Bruckstein. "Probabilistic pursuits on graphs". *Theoretical Computer Science* 795 (2020), 459–477.

Conference Proceedings

Rishabh Jain, Keisuke Okumura, Michael Amir, and Amanda Prorok. "Graph Attention-Guided Search for Dense Multi-Agent Pathfinding". 2025. Accepted as **ORAL PAPER** at AAAI2026. arXiv: 2510.17382 [cs.AI].

Michael Amir, Guang Yang, Zhan Gao, Keisuke Okumura, Heedo Woo, and Amanda Prorok. "ReCoDe: Reinforcement Learning-based Dynamic Constraint Design for Multi-Agent Coordination". Proceedings of 2025 Conference on Robot Learning (CoRL2025). 2025. arXiv: 2507.19151 [cs.RO].

Michael Amir*, Dmitry Rabinovich*, and Alfred M. Bruckstein. "Patrolling Grids with a Bit of Memory". *Proc. of the Intl. Workshop on the Algorithmic Foundations of Robotics (WAFR)*. Chicago, USA, 2024.

Michael Amir, Yigal Koifman, Yakov Bloch, Ariel Barel, and Alfred M. Bruckstein. "Multi-Agent Distributed and Decentralized Geometric Task Allocation". *Proc. of the IEEE Conference on Decision and Control (CDC)*. 2023.

Ori Rappel*, Michael Amir*, and Alfred M. Bruckstein. "Stigmergy-based, Dual-Layer Coverage of Unknown Indoor Regions". *Proc. of the Intl. Conf. on Autonomous Agents and MultiAgent Systems (AAMAS)*. London, United Kingdom, 2023.

Alon Shats, Michael Amir, and Noa Agmon. "Competitive Ant Coverage: The Value of Pursuit". *Proc. of the IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*. Detroit, United States, 2023.

Michael Amir, Noa Agmon, and Alfred M. Bruckstein. "A Discrete Model of Collective Marching on Rings". *Proc. of the Intl. Symposium on Autonomous Robotic Systems (DARS)*. 2021.

Michael Amir and Alfred M. Bruckstein. "Fast Uniform Dispersion of a Crash-Prone Swarm". *Robotics: Science and Systems (RSS)*. 2020.

Michael Amir and Alfred M. Bruckstein. "Minimizing Travel in the Uniform Dispersal Problem for Robotic Sensors". *Proc. of the Intl. Conf. on Distributed Autonomous Agents and MultiAgent Systems (AAMAS)*. Montreal, Canada, 2019.

Under Review (Preprints available upon request)

Michael Amir*, Matteo Bettini*, and Amanda Prorok. *When Is Diversity Rewarded in Cooperative Multi-Agent Learning?* 2025. Under review. arXiv: 2506.09434 [cs.MA].

Michael Amir*, Manon Flageat*, and Amanda Prorok. *Remotely Detectable Robot Policy Watermarking*. 2025. Under review.

Rishabh Jain, Keisuke Okumura, Michael Amir, and Amanda Prorok. *Pairwise is Not Enough: Hypergraph Neural Networks for Multi-Agent Pathfinding*. 2025. Under review.

Hao Xiang Li, Michael Amir, and Amanda Prorok. *Scaling Co-design with Diffusion Models*. 2025. Under review.

Academic Activities

Invited Presentations

2025 UK Multi-Agent Symposium. "Learning Dynamic Constraints for Multi-Agent Optimization-based Controllers". Alan Turing Institute.

2023 Human Dynamics Group at MIT Media Lab. Talk title: "Natural Algorithms". MIT.

2022 Swarm-Smart Conference at the Weizmann Institute of Science. Talk title: "Locust-inspired Models of Collective Marching". Weizmann Institute.

2020 Technion Graduate Student Open Research Day. One of a handful of graduate students specially selected to represent the university's research. Technion.

2018 "Ant-like Probabilistic Pursuits on Graphs". 18th Workshop on Interdisciplinary Applications of Graph Theory, Combinatorics, and Algorithms. Haifa, Israel.

Peer Review, Program Committees

Journal of Autonomous Agents and Multi-Agent Systems (JAAMAS) • IEEE Transactions on Robotics (T-RO) • European Conference on Artificial Intelligence (ECAI) • Conference on Robot Learning (CoRL) • International Symposium on Multi-Robot and Multi-Agent Systems (MRS) • IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) • The 2023 ACM/SIGAPP Symposium on Applied Computing (SAC) • The 15th International Symposium on Distributed Autonomous Robotic Systems (DARS) • Robotics: Science and Systems (RSS) • International Conference on Learning Representations (ICLR).