Dong-Ki Kim

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Education

Massachusetts Institute of Technology — *Cambridge, MA*

Ph.D. in Autonomous Systems — *Jan. 2020 – Jan. 2023 (Planned)*

- Thesis Committee: Professors Jonathan P. How, Jakob N. Foerster, Pulkit Agrawal
- Major: Artificial Intelligence and Machine Learning
- Minor: Robot Autonomy
- GPA: 5.0 / 5.0

Massachusetts Institute of Technology — *Cambridge, MA*

S.M. in Aeronautics and Astronautics — *Graduated Jan. 2020*

- Thesis: "Learning to Teach and Meta-Learning for Sample-Efficient Multiagent Reinforcement Learning"
- Advisor: Professor Jonathan P. How
- Focus: Reinforcement Learning
- GPA: 5.0 / 5.0

Cornell University — *Ithaca, NY*

B.S. in Electrical and Computer Engineering — *Graduated Jan. 2016*

- Advisor: Professor Tsuhan Chen
- Focus: Computer Vision & Robotics
- Highest Honors: *Summa Cum Laude*

Experience

Laboratory for Information and Decision Systems, MIT — *Cambridge, MA*

Graduate Researcher, Advisor: Professor Jonathan P. How — *Sep. 2017 - Present*

- Developed new game-theoretical objective that maximizes each agent's average reward by directly accounting for impact of its behavior on limiting set of policies that other agents will converge to [17, 1]. **[Video]**
- Derived new meta-multiagent policy gradient theorem that directly models learning processes of all agents within meta-learning optimization, which enables fast adaptation to new fellow agents across spectrum of mixed incentive, competitive, and cooperative multiagent settings [6, 20]. **[Video]**
- Developed hierarchical reinforcement learning framework that considers both temporal abstraction and context-specific representation abstraction to effectively reduce the size of the search over policy space in option learning [3]. **[Video]**
- Contributed to learning robust policy that enables high demonstration-efficiency learning by leveraging properties from robust tube model predictive controller and imitation learning [4]. **[Video]**
- Developed safe reinforcement learning framework by learning neural network-based meta-optimizer with projection onto polytope for optimizing objective while satisfying constraints [7, 19].
- Developed peer-to-peer teaching frameworks for enabling agents to learn to teach or share knowledge in cooperative multiagent reinforcement learning settings [8, 9, 10, 21, 22].
- Built attention-based hierarchical reinforcement learning framework that identifies useful latent features across multiple sensory inputs and accelerates in transfer learning tasks [11, 15, 23].

Air Lab, CMU-Robotics Institute — *Pittsburgh, PA*

Research Intern, Advisor: Professor Sebastian Scherer — *Aug. 2016 - Jul. 2017*

- Developed deep multimodal network that improves segmentation robustness to appearance variations (e.g., Summer vs Winter) by combining image and LiDAR sensor data [12, 24].
- Built ROS-based system that estimates terrain roughness from 3D LiDAR sensor data in real-time. **[Video]**

Robot Intelligence through Perception Lab, TTIC — *Chicago, IL*

Research Intern, Advisor: Professor Matthew R. Walter — *Jan. 2016 - Jul. 2016*

- Developed cross-view localization system that estimates vehicle's pose on georeferenced satellite map given sequence of ground-level images [13]. **[Video]**
- Improved LSD-SLAM's pose estimation by incorporating ORB-SLAM's pose-graph keyframe constraints.

Advanced Multimedia Processing Lab, Cornell University — *Ithaca, NY*

Undergraduate Researcher, Advisor: Professor Tsuhan Chen — *May. 2014 - Jan. 2016*

- Developed indoor localization algorithm based on floor plan and camera [14]. **[Video]**
- Built vision-based system that enables drone to navigate indoors autonomously and find specific target [25]. **[Video]**

Honor & Award

Spotlight Presentation at ICLR-22 workshop *Mar. 2022*

- Gamification and Multiagent Solutions Workshop

Outstanding Student Paper Award Honorable Mention at AAAI-19 *Jan. 2019*

Kwanjeong Education Foundation Scholarship *Sep. 2017 - May. 2021*

- Received $30,000/year for 4 years for graduate studies

Merrill Presidential Scholar *Sep. 2015*

- Nominated for Cornell University's prestigious award given to top 1% graduating undergraduate seniors

Publication

Google Scholar statistics: Total of 454 citations with h-index of 9 and i10-index of 9 as of Feb. 15, 2023

Conference Proceeding

[1] **Influencing Long-Term Behavior in Multiagent Reinforcement Learning**
Dong-Ki Kim, Matthew Riemer, Miao Liu, Jakob N Foerster, Michael Everett, Chuangchuang Sun, Gerald Tesauro, Jonathan P. How
Neural Information Processing Systems (NeurIPS), 2022 **[Paper] [Code] [Video] [MIT News]**

[2] **City-wide Street-to-Satellite Image Geolocalization of a Mobile Ground Agent**
Lena M. Downes, **Dong-Ki Kim,** Ted J. Steiner, Jonathan P. How
International Conference on Robotics and Automation (IROS), 2022 **[Paper] [Video]**

[3] **Context-Specific Representation Abstraction for Deep Option Learning**
Marwa Abdulhai, **Dong-Ki Kim,** Matthew Riemer, Miao Liu, Gerald Tesauro, Jonathan P. How
Association for the Advancement of Artificial Intelligence (AAAI), 2022 **[Paper] [Code] [Video]**

[4] **Demonstration-Efficient Guided Policy Search via Imitation of Robust Tube MPC**
Andrea Tagliabue, **Dong-Ki Kim,** Michael Everett, Jonathan P. How
International Conference on Robotics and Automation (ICRA), 2022 **[Paper] [Video]**

[5] **ROMAX: Certifiably Robust Deep Multiagent Reinforcement Learning via Convex Relaxation**
Chuangchuang Sun, **Dong-Ki Kim,** Jonathan P. How
International Conference on Robotics and Automation (ICRA), 2022 **[Paper]**

[6] **A Policy Gradient Algorithm for Learning to Learn in Multiagent Reinforcement Learning**
Dong-Ki Kim, Miao Liu, Matthew Riemer, Chuangchuang Sun, Marwa Abdulhai, Golnaz Habibi, Sebastian Lopez-Cot, Gerald Tesauro, Jonathan P. How
International Conference on Machine Learning (ICML), 2021 **[Paper] [Code] [Video]**

[7] **FISAR: Forward Invariant Safe Reinforcement Learning with a Deep Neural Network-Based Optimizer**
Chuangchuang Sun, **Dong-Ki Kim,** Jonathan P. How
International Conference on Robotics and Automation (ICRA), 2021 **[Paper]**

[8] **Learning Hierarchical Teaching Policies for Cooperative Agents**
Dong-Ki Kim, Miao Liu, Shayegan Omidshafiei, Sebastian Lopez-Cot, Matthew Riemer, Golnaz Habibi, Gerald Tesauro, Sami Mourad, Murray Campbell, Jonathan P. How
International Conference on Autonomous Agents and Multiagent Systems (AAMAS), 2020 **[Paper] [WIRED News]**

[9] **Policy Distillation and Value Matching in Multiagent Reinforcement Learning**
Samir Wadhwania, **Dong-Ki Kim,** Shayegan Omidshafiei, Jonathan P. How
International Conference on Intelligent Robots and Systems (IROS), 2019 **[Paper] [Video]**

[10] **Learning to Teach in Cooperative Multiagent Reinforcement Learning**
Shayegan Omidshafiei, **Dong-Ki Kim,** Miao Liu, Gerald Tesauro, Matthew Riemer, Christopher Amato, Murray Campbell, Jonathan P. How
Association for the Advancement of Artificial Intelligence (AAAI), 2019 **[Outstanding Student Paper Honorable Mention] [Paper] [MIT News]**

[11] **Crossmodal Attentive Skill Learner**
Shayegan Omidshafiei, **Dong-Ki Kim,** Jazon Pazis, Jonathan P. How
International Conference on Autonomous Agents and Multiagent Systems (AAMAS), 2018 **[Paper] [Video] [Code]**

[12] **Season-Invariant Semantic Segmentation with A Deep Multimodal Network**
Dong-Ki Kim, Daniel Maturana, Masashi Uenoyama, Sebastian Scherer
Field and Service Robotics (FSR), 2017 **[Paper]**

[13] **Satellite Image-based Localization via Learned Embeddings**
Dong-Ki Kim, Matthew R. Walter
International Conference on Robotics and Automation (ICRA), 2017 **[Paper] [Video] [NVIDIA News]**

[14] **You Are Here: Mimicking the Human Thinking Process in Reading Floor-Plans**
Hang Chu, **Dong-Ki Kim,** Tsuhan Chen
International Conference on Computer Vision (ICCV), 2015 **[Paper] [Video]**

Journal Article

[15] **Crossmodal Attentive Skill Learner: Learning in Atari and Beyond with Audio-Video Inputs**
Dong-Ki Kim, Shayegan Omidshafiei, Jazon Pazis, Jonathan P. How
Journal of Autonomous Agents and Multiagent Systems (JAAMAS), 2020 **[Paper]**

Book Chapter

[16] **Multiagent Reinforcement Learning**
Jonathan P. How, **Dong-Ki Kim,** Samir Wadhwania
Encyclopedia of Systems and Control, 2nd Ed. **[Chapter]**

Workshop and Symposium Paper

[17] **Game-Theoretical Perspectives on Active Equilibria: A Preferred Solution Concept over Nash Equilibria**
Dong-Ki Kim, Matthew Riemer, Miao Liu, Jakob N Foerster, Gerald Tesauro, Jonathan P. How
Conference on Robot Learning (CoRL) Workshop, 2022 **[Paper]**

[18] **Influencing Long-Term Behavior in Multiagent Reinforcement Learning**
Dong-Ki Kim, Matthew Riemer, Miao Liu, Jakob N Foerster, Michael Everett, Chuangchuang Sun, Gerald Tesauro, Jonathan P. How
International Conference on Learning Representations (ICLR) Workshop, 2022 **[Spotlight] [Paper]**

[19] **Set-Invariant Constrained Reinforcement Learning with a Meta-Optimizer**
Chuangchuang Sun, **Dong-Ki Kim,** Jonathan P. How
International Conference on Machine Learning (ICML) Workshop, 2020 **[Paper]**

[20] **A Policy Gradient Theorem for Learning to Learn in Multiagent Reinforcement Learning**
Dong-Ki Kim, Miao Liu, Matthew Riemer, Golnaz Habibi, Sebastian Lopez-Cot, Samir Wadhwania, Gerald Tesauro, Jonathan How
Association for the Advancement of Artificial Intelligence (AAAI) Spring Symposium, 2020 **[Paper]**

[21] **Heterogeneous Knowledge Transfer via Hierarchical Teaching in Cooperative Multiagent Reinforcement Learning**
Dong-Ki Kim, Miao Liu, Shayegan Omidshafiei, Sebastian Lopez-Cot, Matthew Riemer, Gerald Tesauro, Murray Campbell, Golnaz Habibi, Jonathan P. How
Association for the Advancement of Artificial Intelligence (AAAI) Workshop, 2019

[22] **Learning to Teach in Cooperative Multiagent Reinforcement Learning**
Shayegan Omidshafiei, **Dong-Ki Kim,** Miao Liu, Gerald Tesauro, Matthew Riemer, Christopher Amato, Murray Campbell, Jonathan P. How
International Conference on Machine Learning (ICML) Workshop, 2018

[23] **Crossmodal Attentive Skill Learner**
Shayegan Omidshafiei, **Dong-Ki Kim,** Jazon Pazis, Jonathan P. How
Neural Information Processing Systems (NeurIPS) Symposium, 2017

[24] **Online Semantic Mapping for Autonomous Navigation and Scouting**
Daniel Maturana, Sankalp Arora, Po-Wei Chou, **Dong-Ki Kim,** Masashi Uenoyama, Sebastian Scherer
Robotics: Science and Systems (RSS) Workshop, 2017 **[Paper]**

Technical Report

[25] **Deep Neural Network for Real-Time Autonomous Indoor Navigation**
Dong-Ki Kim, Tsuhan Chen
arXiv preprint arXiv:1511.04668, 2015 **[Paper] [Video]**

Skill

Tools/Library/Software: PyTorch, TensorFlow, Theano, Caffe, Keras, OpenCV, ROS, Point Cloud Library
Programming Language: Python, C/C++, Matlab

Invited Talk

Mila-MARL Meeting: Effective Learning in Non-Stationary Multiagent Environments *Jun. 2022*
Mila-RL Sofa Meeting: Learning to Learn in Multiagent Reinforcement Learning to Address Non-Stationarity *Jul. 2022*
IBM Research-Zurich: Learning to teach for collective intelligence *Jul. 2019*
Northeastern University: Learning to Teach in Cooperative Multiagent Reinforcement Learning *Feb. 2019*

Media Coverage

MIT News: A Far-Sighted Approach to Machine Learning **[Link]** *Nov. 2022*
WIRED News: The Robotic Future: Where Bots Operate Together and Learn From Each Other **[Link]** *Jun. 2019*
MIT News: Learning to Teach to Speed Up Learning **[Link]** *Jan. 2019*
NVIDIA News: Satellite Images Help Track a Vehicle **[Link]** *Apr. 2017*

Academic Service

Reviewer of Machine Learning Conference: ICML, NeurIPS, ICLR, AAMAS, AAAI, IEEE TNNLS
Reviewer of Robotics Conference: ICRA, IROS, RA-L

Student Mentoring

Ammar Fayad: Currently B.S. in MIT EECS
Lena M. Downes: Currently Ph.D. in MIT Aero/Astro
Lucy Halperin: Currently Ph.D. in MIT Aero/Astro
Marwa Abdulhai: B.S. and M.Eng in EECS (currently Ph.D. at UC Berkeley EECS)
Sebastian Lopez-Cot: B.S. and M.Eng in EECS (currently self-driving engineer at Aurora)
Samir Wadhwania: B.S. and M.S. in MIT Aero/Astro (currently senior research engineer at EpiSci)

Reference

Professor Jonathan P. How

- **Affiliation:** Laboratory for Information and Decision Systems, MIT
- **Title:** Richard Cockburn Maclaurin Professor
- **Email:** jhow@mit.edu

Dr. Shayegan Omidshafiei

- **Affiliation:** Google Research
- **Title:** Senior Research Scientist
- **Email:** somidshafiei@google.com