Patrick Callaghan

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Research Experience

Model human teachers using second-order Theory of Mind Nov 2023 - Present

Human and Robot Partners Lab, Reliable Autonomous Systems Lab

Carnegie Mellon University. Pittsburgh, PA

Co-Advisors: Profs. Henny Admoni & Reid Simmons

– Aiming to increase efficacy of human teacher by endowing robot learner with computational structures that enable it to (1) model the teacher's beliefs about the learner, and (2) communicate in ways that correct teacher *and* learner misunderstandings

Featurizations for human interactive robot learning Nov 2021 - Oct 2023

Human and Robot Partners Lab, Intelligent Autonomous Manipulation Lab

Carnegie Mellon University. Pittsburgh, PA

Co-Advisors: Profs. Henny Admoni & Oliver Kroemer

– Studied different reward function representations' abilities to capture human preferences taught via diverse interaction types (e.g. demonstrations, preference queries, corrections, binary critiques)

– Mathematically formalized a particle filter approach to update its belief state through observations of human-provided feedback

– Quantified effects of four different resampling approaches in two domains and four interaction types

– Thoroughly tested and analyzed effects of different task featurizations and reward function structures

– Designed and conducted a formal user study with 11 participants

– Work accepted to 2nd Workshop on Human Interactive Robot Learning (HRI '23)

Actively select interaction types to learn a human's reward function Nov 2021 - June 2022

Human and Robot Partners Lab, Intelligent Autonomous Manipulation Lab

Carnegie Mellon University. Pittsburgh, PA

Co-Advisors: Profs. Henny Admoni & Oliver Kroemer

– Used information gain to model and actively select among demonstrations, preference queries, corrections, and binary critiques to learn a simulated human's reward function

– Implemented baseline methods

– Implemented three domains in which our method was compared against various baselines

– Collected and analyzed various performance data in simulation

– Work accepted for publication at the 6th Conference on Robot Learning (CoRL)

MoonRanger Sep 2019 - Dec 2020

Field Robotics Center

Carnegie Mellon University. Pittsburgh, PA

Principal Investigators: Profs. Red Whittaker & David Wettergreen

- Student-lead of software team (May 2020-August 2020)
- Planning and navigation sub-team lead (September 2019-August 2020)
- Developed motion-planning software using motion primitives, forward simulation, and cost-reward tradeoffs
- Led field tests of rover mapping, planning, and navigation
- Presented to over 50 people from NASA and CMU during official NASA Preliminary Design Review
- Analyzed stereo and navigation data from simulated and real-world autonomous traversals
- Developed ROS/C++ global-to-local planning and navigation prototype
- Spent 7 days in Utah's remote West Desert collecting imagery data for novel methods of 3D modeling of lunar pits

CubeRover Dec 2018 - Dec 2019

Field Robotics Center

Carnegie Mellon University. Pittsburgh, PA

Principal Investigator: Prof. Red Whittaker

- Led systems-engineering efforts of avionics documentation, coordination, fault analysis, and software/hardware implementations
- Assisted in physical testing for wheel actuation and grouser efficiency

Advanced Wireless Research Experience (REU) May 2019 - July 2019

Wireless Institute

University of Notre Dame. South Bend, IN

Principal Investigator: Prof. Thomas Pratt

Education

Aug 2028 (anticipated)	PhD (Robotics) at **Carnegie Mellon University**
Nov 2023	MS (Robotics) at **Carnegie Mellon University**
May 2016	BA (English & Economics) at **University of Virginia**

Publications & Dissertations

Callaghan, P. (2023). Exploring diverse interaction types for human-in-the-loop robot learning. *Masters of Science in Robotics Dissertation*, (CMU-RI-TR-23-81).

Callaghan, P., Kroemer, O., & Admoni, H. (2023). Understanding reward representations for human interactive robot learning. *2nd Workshop on Human Interactive Robot Learning (HRI '23)*.

Fitzgerald, T., Koppol, P., **Callaghan, P.**, Wong, R. Q., Simmons, R., Kroemer, O., & Admoni, H. (2022). INQUIRE: Interactive querying for user-aware informative reasoning. *6th Conference on Robot Learning*. https://openreview.net/forum?id=3CQ3Vt0v99

Ford, J., **Callaghan, P.**, Wong, U., Jones, H., Whittaker, W. C., & Whittaker, W. L. (2020). Dataset of the west desert sinkhole: An analog for steep-walled planetary pits. *3rd International Planetary Caves Conference*. https://www.hou.usra.edu/meetings/3rdcaves2020/pdf/1062.pdf

Honors, Awards, & Presentations

MoonRanger/NASA Preliminary Design Review (PDR) presenter	Aug 2020
Presented poster at Notre Dame Undergraduate Research Symposium	Aug 2019
1 of 2 research projects selected to present at annual CCAC Honors forum	May 2019
Allegheny County Council Endowed Scholarship	Fall 2019
NASA Community College Aerospace Scholar	Fall 2019 - Spring 2019
Daniel B. Krochmal Endowed Scholarship	Spring 2019

Professional Experience

Teaching Fellow Aug 2017 - June 2018

Culver Academies, Culver, Indiana, USA

- Spent 85 minutes/day leading section of 16 students through new material pertaining to Humanities; taught elements of writing basic analytical essay
- Planned lessons and course trajectory through evaluative assessments of class' current understandings
- Identified students' struggles; subsequently prioritized research and teaching of certain skills and content

Freelance Copywriter May 2016 - Nov 2016

Various USA cities (Remote)

Service

CMU Voices Against Violence Volunteer	Jan 2023 - Jan 2024
CMU HRI Social Organizer	June 2022 - March 2024
CMU HRI Reading Group Co-Organizer	Sep 2022 - May 2023

Programming Skills

Languages Python, C++, Java
Frameworks Frankapy, Torch, ROS