Christopher Bradley

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I am a Postdoc in CSAIL at MIT interested in enabling autonomous robots to act intelligently, particularly in the context of planning hierarchically in the presence of uncertainty. Specifically, I work on developing/learning representations to enable long-horizon decision making for multi-modal problems in partially observable, real-world domains.

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Education

MIT Computer Science & Artificial Intelligence Lab Sep. 2017 - Dec. 2024
SM, Aeronautics and Astronautics, 2019. *Field: Autonomy.*
PhD, 2024. *Thesis: Reasoning over Hierarchical Abstractions for Long-Horizon Planning in Robotics*

California Institute of Technology (Caltech) Aug. 2013 - June 2017
BS Mechanical Engineering, minor in Aerospace Engineering.

Research/ Industry Experience

Boston Dynamics / Atlas Team Jan. 2022 - July 2022
- Working on task and motion planning in the context of bimanual humanoid manipulation problems.

MIT / Robust Robotics Group Sep. 2017 - PRESENT
- Research under Nicholas Roy in the area of hierarchical planning under uncertainty. Outside of research, during my PhD, I have mentored multiple undergraduate researchers, participated in both inter and intra university collaborations leading to publications, and have contributed to ongoing engineering efforts to support lab robotic platforms. I am currently a PostDoc with the group.

Caltech / McKeon Research Group June 2016 - Sep. 2016
- Designed, fabricated, and integrated synthetic jets for use on an unmanned aerial vehicle.

Selected Publications
(* denotes equivalent contributions)

Aaron Ray*, **C Bradley***, Luca Carlone, N Roy. *Task and Motion Planning in Hierarchical 3D Scene Graphs.* International Symposium of Robotics Research (ISRR) 2024

We developed a method for decomposing large-scale, hierarchical scene-graphs (built from perception) into tractable planning domains. One contribution of this approach is a method for pruning the scene of superfluous information that is not relevant to finding satisficing plans. Tested on a Spot robot. Ongoing work involves integrating an LLM to enable humans to give commands which can be translated to PDDL.
https://arxiv.org/pdf/2403.08094

C Bradley, N Roy. *Learning Feasibility and Cost to Guide TAMP.* International Symposium on Experimental Robotics (ISER), 2023

We propose a novel approach for Task and Motion Planning (TAMP), learning task agnostic models to predict the feasibility and cost of attempting to solve sub-problems in a task plan. Our algorithm uses these models to guide search, and we demonstrate improvement in planning and execution time over traditional TAMP approaches on both real and simulated agents.
https://groups.csail.mit.edu/rrg/papers/cbradley_iser_2023.pdf

C Bradley, A Pacheck, G Stein, S Castro, H Kress-Gazit, N Roy. *Learning and Planning for Temporally Extended Tasks in Unknown Environments.* International Conference on Robotics and Automation (ICRA), 2021

We formulated an algorithm for solving complex navigation tasks specified by temporal logic in partially revealed environments. We use monte-carlo tree-search and a learned model to find the optimal policy for sequential navigation problems, which can generalize across different tasks. We demonstrated our method in both simulated and real environments on a real robot.
https://groups.csail.mit.edu/rrg/papers/cbrad_icra_21.pdf

GJ Stein*, **C Bradley***, V Preston*, N Roy. *Enabling topological planning with monocular vision*. International Conference on Robotics and Automation (ICRA), 2020

We developed a novel topological map representation built directly from panoramic, monocular vision. We learn to identify geometric features of an environment which we combine to define traversable regions using stitched dual-fisheye images to test the approach on a mobile robot.
https://groups.csail.mit.edu/rrg/papers/stein_bradley_preston_icra20.pdf

GJ Stein*, **C Bradley***, N Roy. *Learning over subgoals for efficient navigation of structured, unknown environments*. Conference on Robotic Learning (CoRL), 2018

We present a technique for navigating large, unobserved environments by training a model to predict the outcome of high-level actions which enter unknown space. We showed improvement in navigation time and data efficiency compared to previous approaches, and implemented our approach in a simulated unity environment and on a small mobile robot.
https://proceedings.mlr.press/v87/stein18a/stein18a.pdf

Skills

Implementation: I primarily use Python, Pytorch, and ROS in my research, but have experience with C++, Tensorflow, and Julia. I have extensive experience with open source TAMP libraries such as PDDLStream, using motion planning libraries like OMPL. In my research, I first implement and test in simulated environments like Unity, MuJoCo, or IsaacSim, before moving to real robots. I have implemented my work on multiple different robotic platforms, including: MIT Racecar, Toyota HSR, Clearpath Jackal/Husky, Franka Emika Panda, and the Boston Dynamics Spot and Hydraulic Atlas.

Collaboration: I've worked on large codebases with contributors across multiple universities, and have been a part of numerous collaborative paper-writing efforts. While at Boston Dynamics, I developed experience in industry with development practices, integrating contributions for a shared robotic platform on a fast moving team. While there I worked on developing a system for hierarchical planning on Atlas, building low level tools like inverse kinematics solvers as well as the planner itself. I've also mentored four undergraduate researchers over my PhD.

Awards

Best Paper Finalist | Conference on Robotic Learning 2018

- Top 3 finalist for best paper out of 300 submissions.