Christopher P. Bradley

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

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Education

MIT Computer Science and Artificial Intelligence Lab — Cambridge, MA
SM, 2019. PhD, 2024. Department: AeroAstro — 2017 - 2024
- Advisor: Professor Nicholas Roy
- Thesis: Reasoning over Hierarchical Abstractions for Long-Horizon Planning in Robotics

California Institute of Technology (Caltech) — Pasadena, CA
BS Mechanical Engineering, minor Aerospace Engineering — 2013 - 2017

Research / Industry Experience

Boston Dynamics | Atlas Team — Jan. '22 - July '22
- Contributed toward building a system for hierarchical planning on Atlas in the context of bi-manual humanoid manipulation problems. I helped build both low level tools like inverse kinematics solvers as well as an integrated bi-level planner. I gained experience with industry development practices, working with a fast moving team on a shared robotic platform.

MIT | Robust Robotics Group — Sept. '17 - TODAY
- Research under Nicholas Roy in the area of hierarchical planning under uncertainty. Outside of research, during my PhD, I have mentored several students, 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, continuing ongoing research with a focus on mentorship.

Caltech | McKeon Research Group — June '16 - Sept. '16
- Designed, fabricated, and integrated synthetic jets for use on an unmanned aerial vehicle with Beverley McKeon.

Air Force Research Labs | Wright-Patterson AFB — June '15 - Sept. '15
- Worked with a group involved in the engineering of various aerial vehicles.

Caltech | Blanquart Lab — June '14 - Nov. '14
- Research under Guillaume Blanquart on turbulent combustion. Presented work at APS Div. of Fluid Dynamics conference 2014.

Selected Publications

(* denotes equivalent contributions)

Aaron Ray* **Christopher Bradley***, Luca Carlone, Nicholas 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 domain of provably superfluous information that is not relevant to finding satisficing plans. Tested on a Spot robot. Ongoing work involves integrating foundation models to enable humans to give commands which can be translated to PDDL and accelerate planning. https://arxiv.org/pdf/2403.08094

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

We proposed 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

Christopher Bradley, Adam Pacheck, Gregory J. Stein, Sebastian Castro, Hadas Kress-Gazit, Nicholas 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

Gregory J. Stein*, **Christopher Bradley***, Victoria Preston*, Nicholas 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

Gregory J. Stein*, **Christopher Bradley***, Nicholas Roy. Learning over Subgoals for Efficient Navigation of Structured, Unknown Environments. *Conference on Robotic Learning (CoRL)*, 2018. **[Best Paper Finalist]**

We presented 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

Additional publications (including thesis) listed here: cpbradley.github.io

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Mentorship and Collaboration

Collaboration: During my PhD, I have contributed to several large-scale collaborative projects spanning multiple labs and universities. Some have produced publications included in those listed above, and some have resulted in demonstrations in the field. One such example involved designing a multi-agent system wherein different robots each build hierarchical scene graphs of a large scale outdoor environment. Our system then fuses these maps, extracts a representation which enables efficient task and motion planning, and presents an interface where a human operator can express commands via natural language. These instructions are then interpreted by an LLM, and converted into goals for our planner. This work is ongoing, and preliminary trials were conducted within Camp Buckner at West Point.

Mentorship: As a member of the Robust Robotics group, I have had the privilege of mentoring Undergraduate, Masters, and PhD students on various projects related to robotics. Mentorship has involved designing and scoping both engineering and research efforts. A major part of my work as a Postdoc involves collaborating with new PhD students to continue ongoing research projects related to hierarchical planning in large environments.

Technical Skills

Task and Motion Planning Frameworks: PDDLStream, OMPL.

Machine Learning Frameworks: Pytorch, Tensorflow.

Programming Languages: Python, Julia, C++.

Simulators: IsaacLab, MuJoCo, PyBullet, Unity.

Platforms: Boston Dynamics Spot and Hydraulic Atlas, Franka Emika Panda, Clearpath Jackal and Husky, Toyota HSR, MIT Racecar.

Other Skills and Tools: ROS, Linux, Git, Mechanical Prototyping (Solidworks, 3D Printer, Laser-Cutter, Waterjet, etc).

Academic Services

Reviewer for the following venues:

- *IEEE Transactions on Robotics (T-RO)*,
- *IEEE Robotics and Automation Letters (RA-L)*,
- *Conference on Robot Learning (CoRL)*,
- *International Conference on Robotics and Automation (ICRA)*,
- *International Conference on Intelligent Robots and Systems (IROS)*,
- *International Symposium of Robotics Research (ISRR)*

Miscellanea

Best Paper Finalist | Conference on Robot Learning 2018
- Top 3 finalist for best paper out of 300 submissions

Caltech Waterpolo | 2013-2017
- Captain: 2014 - 2017
- CoSIDA Academic All American: 2015 - 2017

Caltech UAV Club | 2014-2017
- Co-founder
- Presented actuated landing gear at Drone Data X Conference 2016