Mohak Bhardwaj

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Education

2019– **University of Washington, School of Computer Science**, *Seattle*,
Ph.D. Computer Science, *Advisor: Dr. Byron Boots*.

2018–2019 **Georgia Institute of Technology, College of Computing**, *Atlanta*,
Ph.D. Robotics, *Advisor: Dr. Byron Boots*, *GPA:4.0/4.0*.
Relevant Coursework: Introduction to Robotics Research; Linear Systems and Control; Nonlinear Systems; Mathematical Foundations for Machine Learning

2015–2016 **Carnegie Mellon University, School of Computer Science**, *Pittsburgh*,
Master of Science In Robotic Systems Development, *QPA:3.83/4.0*.
Relevant Coursework: Planning, Execution and Learning; Mobile Robots; Computer Vision; Robot Autonomy; Dynamic Optimization; Statistical Techniques in Robotics; Manipulation Algorithms

2011–2015 **Indian Institute of Technology (BHU), Varanasi**, *India*,
B.Tech in Mechanical Engineering.

Publications

Bhardwaj, M., Choudhury S., Boots B., Srinivasa S. "Leveraging Experience in Lazy Search", Robotics Science and Systems 2019 **Proceedings**: bit.ly/2T13MKt

Bhardwaj, M., Boots B., Mukadam M., "Differentiable Gaussian Process Motion Planning" **Preprint**: bit.ly/337l6lZ

Choudhury S., **Bhardwaj M.**, Arora S., Kapoor A., Ranade G., Scherer S., Dey D., "Data-driven Planning via Imitation Learning", International Journal of Robotics Research(IJRR), 2018 **Link**: goo.gl/sgG7LJ **(Paper of the Year Finalist)**

Bhardwaj, M., Choudhury S., Scherer S., "Learning Heuristic Search via Imitation", Conference on Robotic Learning 2017 **Proceedings**: goo.gl/cPo2yQ

Mithun, P., Anurag, V. V., **Bhardwaj, M.**, Shah, S. V., "Real-Time Dynamic Singularity Avoidance while Visual Servoing of a Dual-Arm Space Robot", Advances in Robotics 2015 **Proceedings**: goo.gl/j1uVLg

Work Experience

May 2019-Aug 2019 **NVIDIA Seattle Robotics Lab**, *Research Intern*, Mentors: B. Boots, A. Handa, D. Fox.
A framework for combining model predictive control with entropy-regularized reinforcement learning.

Aug 2018-May 2019 **Robot Learning Lab, Gatech**, *Research Assistant*.
Imitation and self-supervised learning for search based motion planning and trajectory optimization.

Dec 2017-July 2018 **Near Earth Autonomy**, *Robotics Engineer*.
Adaptive motion planning under uncertainty for real-world UAVs.

Mar 2017-Dec 2017 **Air Lab, CMU**, *Extern*, Advisor: Dr. Sebastian Scherer.
Reinforcement and imitation learning applied to search based planning; Planning under uncertainty.

May 2016-Aug 2016 **Qualcomm R&D**, *Intern, Autonomous Driving*, Manager:Sebastian Mounier.
S.L.A.M and multi-sensor calibration for autonomous cars.

May 2014-Aug 2014 **Robotics Research Institute, IIIT-Hyderabad**, *Intern*, Advisor: Dr. Suril V Shah.
Research on optimal control algorithms for space manipulators.

Research Work

May 2019-Oct 2019 **Information Theoretic Model Predictive Q-Learning**, *NVIDIA/University of Washington*.
Developed a principled framework for combining information theoretic MPC and entropy regularized RL for efficient learning in robotics tasks.

Sep 2018-Jan 2019 **Leveraging Experience in Lazy Search for Accelerated Motion Planning**, *Gatech*.
Formulated lazy search as a Markov Decision Process and developed an approach for learning edge evaluation policies by imitating oracular selectors.

Sep 2018-Aug 2019 **Differentiable Continuous Time Trajectory Optimization**, *Gatech*.
Developed a structured learning framework for learning factor graph parameters by representing Gaussian Process Motion Planning as a differentiable computation graph.

Dec 2016-July 2017 **Learning Heuristic Search via Imitation**, *Carnegie Mellon University*.
Proposed formulation of heuristic search as sequential decision making and developed an algorithmic framework to learn heuristic policies via self-supervised imitation learning.

May 2014-July 2014 **Visual Servoing and Singularity Avoidance for Dual Arm Space Robot**, *IIIT-Hyderabad*.
Developed IK based optimal control algorithms for visual servoing of space manipulators with real-time singularity avoidance in a coupled arm-base dynamic system.

Project Work

Aug 2015-May 2016 **Motion Planning and Online Learning for Autonomous Driving** , *Master's Capstone*.
Developed state lattice based motion planner for autonomous cars with differential constraints using ROS-C++ and devised an online reinforcement learning method for dynamically allocating parking spots to cars using a multi-armed bandit approach.

May 2016-Aug 2016 **Multi-sensor calibration using S.L.A.M for Autonomous Cars**, *Qualcomm R&D*.
Created a full-vehicle calibration room and developed software for multi-camera intrinsic calibration using factor graph SLAM and lidar to camera registration.

Aug 2014-May 2015 **Stable Walking of a Quadrupedal Robot**, *B.Tech Final Year Project*.
Led a four member team to design, simulate and implement statically stable crawl gait on a quadrupedal robot with 3DOF legs.

Open-Source Code

Search as Imitation Learning: Tensorflow pipeline for learning heuristic policies for search based motion planning. Link: goo.gl/YXkQAC

Python Motion Planning: Easy-to-use motion planning library geared towards planning and ML research Link: goo.gl/88shhJ

Deep RL with OpenAI Gym: Modular pipeline for developing and testing RL agents with OpenAI gym environments. Link: goo.gl/8tkFC4

Achievements and Honors

2011 Secured a rank in 0.6 % out of 480,000 students from all over India in the IIT Joint Entrance Examination

2015 Received Institute Color Award from IIT,Varanasi for outstanding extra-curricular achievements.

Technical Skills

Languages C++,Python

Software ROS, TensorFlow, Pytorch, OMPL, OpenCV