# SUMIT KUMAR

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## EDUCATION

**Carnegie Mellon University, USA** *Aug 2017 - Present*
Masters of Science in Robotics Research
Advisors: Prof. Katia Sycara, Prof. George Kantor
GPA: 4.11/4.33

**Indian Institute of Technology Kanpur, India** *Aug 2013 - May 2017*
Bachelors of Technology in Mechanical Engineering
Minor: Artificial Intelligence, Computer Science
GPA: 9.4/10

## EXPERIENCE

**Advanced Agent - Robotics Technology Lab, CMU** *Aug 2017 - Present*
Graduate Research Assistant | Advisor: Prof. Katia Sycara

- Developing a Bayesian Neural network based framework for modelling and predicting mean and uncertainty estimates of a spatio-temporal phenomena.
- Designing graph neural network based multi-agent reinforcement learning algorithms to enable a team of agents to adapt to addition or removal of members from the group.
- Developing graph neural network based deep learning algorithms for solving multi-agent combinatorial optimization problems.
- Proposed an active learning algorithm to enable an autonomous system to collect the most informative samples from a sorghum field in order to accurately learn the distribution of phenotypes in the field with the help of a Gaussian Process model. The proposed algorithm outperformed the current practices on sorghum phenotype data collection and further accelerated high throughput phenotyping.

**Personal Robotics Lab, CMU** *May 2016 - Aug 2016*
Intern | Advisor: Prof. Siddhartha Srinivasa

- The project aimed at reducing the expected number of collision checks in sampling based motion planning techniques for robot arm by generating a belief model of its configuration space. Performed a comparative analysis of nearest neighbor (kNN) methods used to generate the model for benchmarking.
- Proposed a relative importance weighting of all the arm joints in evaluating similarity between configurations which improved the collision prediction accuracy of kNN methods from 80% to 84%.
- Proposed a Delaunay triangulation based topological method in a 4D projected space which outperformed the kNN methods by achieving an accuracy of 86% while also being computationally efficient.

**Abhyast Phase VI, IIT Kanpur** *Apr 2015 - Mar 2016*
BOEING sponsored Institute project | Advisor: Prof. Shantanu Bhattacharya

- Built a robotic system comprising of a quadrotor and a ground robot to be used by rescue forces and bomb squads for mapping an unknown environment and localizing suspicious objects in it.
- Developed a feature-based cascade classifier for detecting bags using OpenCV.
- Accomplished autonomous navigation of the robotic system using laser scanner and GPS.

## PUBLICATIONS

- Active Learning with Gaussian Processes for High Throughput Phenotyping [AAMAS 2019]
  **Sumit Kumar**, Wenhao Luo, George Kantor, Katia Sycara
- Estimating Configuration Space Belief from Collision Checks for Motion Planning [arxiv pre-print]
  **Sumit Kumar**, Sushman Choudhary, Siddhartha Srinivasa

## PROJECTS

**Learning Hierarchical Policies in Dynamic Environments**
Advisor: Prof. Ruslan Salakhutdinov, School of Computer Science, Carnegie Mellon University
Proposed a hierarchical RL and meta RL based framework for solving sparse rewards tasks in dynamic environments. The agent first learns a generic representation of a set of skills over a distribution of environments using meta learning. These skills are then fine-tuned to the given environment with a few gradient updates and a high level policy over these skills is learned for solving the required task.

**Deep Reinforcement Learning for Sparse-Reward Manipulation Problems**
Advisor: Prof. Matt Mason, School of Computer Science, Carnegie Mellon University
Proposed Prioritized Hindsight Experience Replay for sample efficient learning of multi-goal manipulation problems from sparse binary rewards. The agent assigns priorities to transitions stored in replay memory based on temporal difference error and performs importance sampling of these transitions while training.

**A Reality Check of Images**
Advisor: Prof. Piyush Rai, Dept. of Computer Science and Engineering, IIT Kanpur
Built a feature-based classifier for distinguishing real and computer generated images. Combined 8 individual classifiers to build a meta-classifier which achieved accuracy of 88% and AUC of .923 compared to accuracy of 86% and AUC of .896 as attained by the best classifier on the same validation set.

**Optimal Path Planning in a Dynamic Environment**
Advisor: Prof. Gaurav Pandey, Dept. of Electrical Engineering, IIT Kanpur.
Built a simulation model of a wheeled robot and a warehouse-like environment using ROS and Gazebo simulator. Used RViz for the simulation of robot's motion from its start location to user-defined goal location in the environment while locally modifying path in the presence of any unseen obstacles.

**Design and Fabrication of a throat surgery holder and retractor**
Advisor: Prof. Bishakh Bhattacharya, Dept. of Mechanical Engineering, IIT Kanpur
The project aimed at reducing the required number of surgeons during throat surgeries in rural hospitals. Designed a throat retractor which can hold tissues and flesh at the site of incision. Ensured wide area coverage and easy assembling of the system with the help of custom designed lever-operated cam locks.

## COURSES AND SKILLS

- Python, C, C++, Matlab, PyTorch, Tensorflow
- **Computer Science**: Machine Learning, Data Structure And Algorithms, Deep Reinforcement Learning, Probabilistic Graphical Models, Statistical Techniques in Robotics, Computer Vision, Probabilistic Mobile Robotics, Robot Manipulators: Mechanics and Control
- **Mathematics**: Math Fundamentals for Robotics, Calculus, Matrix Algebra, Differential Equations

## SCHOLASTIC ACHIEVEMENTS

- Among the 47 students from India to be selected for the prestigious S.N. Bose Scholars Program 2016.
- Selected for Mitacs Globalink Research Internship and Indian Academy of Science Research Program.
- Received Academic Excellence Award and Donor Scholarship in 2014-15 and 2015-16.
- Achieved All India Rank 803 in JEE-Advanced and All India Rank 340 in JEE-Mains, 2013.
- Awarded KVPY Scholarship, 2012 (All India Rank 638) by IISc, Government of India.

## POSITIONS OF RESPONSIBILITY

**Academics Core Team Member, Institute Counselling Service** *Jan 2015 - Jan 2016*
Selected a team of 104 sophomores for providing academic mentoring to freshmen. Organized and took remedial classes, academic sessions and one-to-one mentoring for freshmen and sophomores.

**Academic Mentor and Student Guide, Institute Counselling Service** *Apr 2014 - Mar 2015*
Tutored electrodynamics to first year students in remedial lectures and via one-to-one mentoring. Assisted four freshmen in dealing with their emotional predicaments while adjusting to the college atmosphere.