

# Sumit Kumar

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## EDUCATION

**CARNEGIE MELLON UNIVERSITY**  
MASTERS OF SCIENCE IN ROBOTICS,  
SCHOOL OF COMPUTER SCIENCE  
Aug 2017 - Present | Pittsburgh, USA  
GPA: 4.11/4.0

**IIT KANPUR**  
BACHELORS OF TECHNOLOGY  
MAJOR: MECHANICAL ENGINEERING  
MINOR: ARTIFICIAL INTELLIGENCE,  
COMPUTER SCIENCE  
Aug 2013 - May 2017 | Kanpur, India  
GPA: 9.4/10

## ACHIEVEMENTS

- S.N. Bose Scholar (amongst 47 students from India) 2016
- Mitacs Globalink Research Internship 2016
- Indian Academy of Science Research Program 2016
- Academic Excellence Award 2014-15 and 2015-16
- Alumni Donor Scholarship 2016
- All India Rank 803 in JEE-Advanced 2013
- All India Rank 340 (State Rank 2) in JEE-Mains 2013
- KVPY Scholar (National Program of Fellowship in Basic Sciences) 2012

## COURSES

Machine Learning  
Deep Reinforcement Learning  
Probabilistic Graphical Models  
Data Structure And Algorithms  
Statistical Techniques in Robotics  
Artificial Intelligence for Robotics  
Probabilistic Mobile Robotics  
Mechanics of Manipulation  
Computer Vision  
Deep Learning for Computer Vision  
Robot Manipulators  
Math Fundamentals for Robotics

## SKILLS

Github: <https://github.com/sumitsk>  
Languages: Python, C++, MATLAB  
Frameworks: PyTorch, Tensorflow  
OS: Linux, Windows

## EXPERIENCE

### AART LAB | GRADUATE RESEARCH ASSISTANT

Advisor: Prof. Katia Sycara, CMU | Aug '17 – Present

- Developing a Bayesian Recurrent Neural network based framework for modelling and predicting mean and uncertainty estimates of a spatiotemporal phenomenon.
- 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 their group.
- Developing graph neural network based deep reinforcement 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 accelerated high throughput phenotyping.

### PERSONAL ROBOTICS LAB | INTERNSHIP

Advisor: Prof. Siddhartha Srinivasa, CMU | May '16 – Aug '16

- The project aimed at reducing the expected number of collision checks in sampling based motion planning techniques for a robot arm by generating a belief model of its configuration space. Performed a detailed comparative analysis of various nearest neighbor (kNN) methods used to generate the belief model for benchmarking.
- Proposed an importance weighting scheme for 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 | BOEING SPONSORED PROJECT

Advisor: Prof. Shantanu Bhattacharya, IIT Kanpur | May '15 – Apr '16

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

## PUBLICATIONS

- **Active Learning with Gaussian Processes for High Throughput Phenotyping [Paper] [Code]**  
Published at AAMAS (International Conference on Autonomous Agents and Multiagent Systems) 2019  
Sumit Kumar, Wenhao Luo, George Kantor, Katia Sycara
- **Estimating Configuration Space Belief from Collision Checks for Motion Planning [Paper]**  
Sumit Kumar, Shushman Choudhary, Siddhartha Srinivasa

## PROJECTS

### LEARNING HIERARCHICAL POLICIES IN DYNAMIC ENVIRONMENTS

Advisor: Prof. Ruslan Salakhutdinov, School of Computer Science, CMU

- 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 reinforcement learning in multi-goal manipulation environments from rewards which are sparse and binary.
- The agent assigns priorities to transitions stored in replay memory based on their temporal difference errors and performs importance sampling of the stored transitions for training its policy network.

### BAYESIAN MODELLING OF SPATIOTEMPORAL PROCESSES

Advisor: Prof. Katia Sycara, School of Computer Science, Carnegie Mellon University

- Developed a KISS-GP based framework for predicting mean and uncertainty estimates of a spatiotemporal phenomena.
- Designing a Bayesian Recurrent neural network model to enable modelling and prediction for large datasets.

### 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 photographic images from computer generated ones.
- Trained 8 classifiers and combined them to build a meta-classifier which achieved accuracy of 88% and AUC of 0.923 compared to the accuracy of 86% and AUC of 0.896 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 small warehouse environment using ROS and Gazebo simulator.
- Used RViz for the simulation of robot's motion from its start location to a 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 was carried out in collaboration with a regional hospital and aimed at reducing the required number of surgeons during throat surgeries in rural areas.
- 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.

### AUTONOMOUS UNDERWATER VEHICLE

Advisor: Prof. K.S. Venkatesh, Dept. of Electrical Engineering, IIT Kanpur

- Designed a camera casing for an underwater vehicle and performed stability and structural integrity tests of the robot.
- Developed a program for detecting multiple objects and line following colored stripes placed under water.

## POSITIONS OF RESPONSIBILITY

### RISS ADMISSIONS COMMITTEE | Robotics Institute, CMU | Jan '19 - Present

- Reviewing candidates' applications and shortlisting Robotics Institute summer interns.

### ACADEMICS CORE TEAM | Counselling Service, IIT Kanpur | Jan '15 - Jan '16

- Selected a team of 104 sophomores for providing academic and emotional support to first year students.
- Organized and took remedial classes, academic sessions and one-to-one mentoring for freshmen and sophomores.

### ACADEMIC MENTOR | Counselling Service, IIT Kanpur | Apr '14 - Mar '15

- Tutored electrodynamics and computer science to first year students in remedial lectures and via one-to-one mentoring.

### STUDENT GUIDE | Counselling Service, IIT Kanpur | Apr '14 - Mar '15

- Assisted four freshmen in dealing with their emotional predicaments while adjusting to the college atmosphere.