# Matthew Wilson

Undergraduate Researcher

*Salt Lake City, UT*

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## Education

**University of British Columbia** — *Vancouver, BC, CA*

M.S. in Computer Science — *Sep. 2019 -*

**University of Utah** — *Salt Lake City, UT, USA*

B.S. in Computer Engineering — *Aug. 2015 - May 2019 (4 years)*

- GPA: 3.82

## Research Experience

**University of British Columbia, Vancouver, BC**

Graduate Researcher (Master's Program) — *September 2019 -*

**University of Utah, Salt Lake City, UT** — *LL4MA Lab*

Undergraduate Researcher — *January 2018 - August 2019 (1.5 years)*

- Advisor: Tucker Hermans

**Carnegie Mellon University, Pittsburgh, PA** — *MSL Lab*

Roboitcs Institute Summer Scholar (REU) — *June 2017 - August 2017 (3 months)*

- Advisors: Ralph Hollis, Jean Oh

## Research Projects

**Learning to Manipulate Object Collections Using Grounded State Representations** — *Unpublished*

Undergraduate Researcher, LL4MA Lab — *November 2018 - June 2019 (7 months)*

- Details soon

**Sim-to-Real Adaptation via Meta-Learning** — *GitHub repo*

Undergraduate Researcher, LL4MA Lab — *July 2018 - November 2018 (4 months)*

- Worked on applying meta-learning to improve performance for simulation to real adaptation in robotics vision tasks
- Successfully reproduced results of domain randomization for object localization as in [Tobin et al. 2017]
- Implemented Model Agnostic Meta-Learning (MAML) and domain randomization to train object localization model to handle greater scene variation (e.g., camera view point and varied table configurations)
- Learned a lot, but unfortunately saw negative results of my approach over a baseline

**Guided Policy Search Reproducing**

Undergraduate Researcher, LL4MA Lab — *Jan 2018 - Jul 2018 (5 months, as side-project)*

- Adapted Guided Policy Search algorithm code to work on LL4MA Lab KUKA robot in simulation
- Learned about trajectory optimization and model-based reinforcement learning

**Go, Look, and Tell: Natural Language Communication with a Ballbot** — *Paper | Poster*

Robotics Institute Summer Scholar, MSL Lab — *June 2017 - August 2017 (3 months)*

- Developed system for a user to give natural language commands and ask questions of dynamically balancing mobile robot (Ballbot)
- Integrated vision system, natural language processing via Amazon Echo, world model (database), and mobile robot navigation system
- Communicated work as a paper and poster

## Open Source and Engineering Projects

**Implementation of Model-Agnostic Meta-Learning (MAML) algorithm** — *https://github.com/matwilso/maml_numpy*

algorithm implementation — *June 2018*

- Derived forward and backward passes of MAML (meta-learning algorithm) and implemented them in raw numpy

### Reinforcement Learning (RL) Implementations

*https://github.com/matwilso/rl-implementations*

ALGORITHM IMPLEMENTATION — *Spring 2018*

- Implemented deep reinforcement learning algorithms, mainly REINFORCE, in both numpy and TensorFlow

### Utah Student Robotics Team

*Website | GitHub*

ELECTRICAL & PROGRAMMING TEAM MEMBER — *Nov 2015 - Aug 2018 (2 years 8 months)*

- Helped design, build, and program robots to compete in NASA Robotic Mining Competitiong for 3 years of competition
- Started on the mechanical subteam, but contributed most to electrical and software
- Developed simulation of robot for testing, using Gazebo and ROS
- Was software team lead in 2017-18 year and developed low-level motor controller code and autonomy components such as vision system, position controllers for actuators, and finite state machine
- Wrote technical paper on Systems Engineering for NASA competition, getting 3rd and 4th places in 2017, 2018
- Worked well with team
- Attended outreach events for K-12 students. Talked to kids about robotics and space exploration

## Writing

### Explanation of Proximal Policy Optimization (PPO) on Stack Overflow

*https://stackoverflow.com/questions/46422845*

STACK OVERFLOW — *June 2018*

- Wrote explanation of a popular reinforcement learning algorithm, Proximal Policy Optimization (PPO)
- Top answer on Stack Overflow, with 75+ upvotes
- Cited by popular blog post and used in popular YouTube video with 25k+ views

### Systems Engineering Paper

*NASA Robotic Mining Competition*

UNIVERSITY ROBOTICS TEAM MEMBER — *2017,2018*

- Wrote technical paper describing the team's approach to systems engineering in constructing our robot
- Earned 3rd place in 2017, with large improvement over previous year

## Honors & Awards

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|---|---|---|
| **Presidential Scholarship** | *University of Utah* | 2015-2019 |
| **Dean's List** | *College of Engineering* | 2015-2018 |
| **UROP Undergraduate Research Award** | *University of Utah* | Summer 2018 |
| **3rd Place / 50**, NASA Robotic Mining Competition (RMC) | *NASA Kennedy Space Center* | May 2018 |
| **3rd Place / 50**, NASA Robotic Mining Competition (RMC) | *NASA Kennedy Space Center* | May 2017 |
| **3rd Place / 50**, Systems Engineering Paper, NASA RMC | *NASA Kennedy Space Center* | May 2017 |
| **Judges' Innovation Award**, NASA RMC | *NASA Kennedy Space Center* | May 2016 |
| **3rd Place**, Hackathon | *HackTheU Hackathon* | Nov 2016 |

## Relevant coursework

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| Stanford's CS231n (self-study) | Convolutional Neural Networks for Visual Recognition |
| CS 6450 | Distributed Systems |
| CS 6370 | Motion Planning (robotics) |
| CS 5350 | Machine Learning |
| CS 5140 | Data Mining |
| CS 4400 | Computer Systems |
| CS 4300 | Artificial Intelligence |
| CS 4150 | Algorithms |
| CS 3505 | Software Practice II |
| CS 3500 | Software Practice I |
| CS 3130 | Engineering Probability and Statistics |
| ECE 5780 | Embedded System Design |
| ECE 3810 | Computer Organization |
| ECE 3710 | Computer Design Lab |
| MATH 5080 | Statistical Inference |
| MATH 2250 | Differential Equations and Linear Algebra |

# Course projects

### Domain Randomization for Training an Obstacle Detector

*GitHub Page*

CS 5350: Machine Learning — *Fall 2017 - Spring 2018*

- Trained a convolutional neural network (CNN) using TensorFlow to predict 3D coordinates of rock obstacles for NASA Robotic Mining Competition using Domain Randomization

### Visualizing Content Clusters in Personal YouTube History

*GitHub Page*

CS 5140: Data Mining — *Spring 2018*

- Wrote scraper and parser to collect captions from YouTube viewing history
- Ran tf-idf and t-SNE on YouTube captions to cluster videos by content, and got interesting results

### Reinforcement Learning Tutorial Project

CS 3505: Software Practice II — *Fall 2017*

- Implemented reinforcement learning environments in C++ to match OpenAI Gym interface
- Implemented REINFORCE algorithm in C++ and trained it on LunarLander env
- Wrote tutorial materials to teach others about reinforcement learning formalization and REINFORCE algorithm

### Functioning CPU Core on FPGA

ECE 3710: Computer Design Lab — *Fall 2017*

- Helped design custom CPU core logic (instruction fetch, decode, execute, jump, handling registers) and implementation using Verilog (digital logic language)
- Wrote our assembler (in Python) to convert custom assembly instructions to binary format for core
- Wrote maze game in our custom assembly language

# Outreach

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| **Girl Scout Night** | *College of Engineering* | Spring 2017 |
| **FIRST Robotics Competition Tabling** | *Maverik Center* | Fall 2017 |
| **Letting kids drive the robot and talking to them about space exploration** | *Salt Lake City Library* | Summer 2016 |