Matthew Wilson

UNDERGRADUATE RESEARCHER

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Education ──────────────────────────────

University of Utah *Salt Lake City, UT*
B.S. IN COMPUTER ENGINEERING *Aug. 2015 - May 2019*
• GPA: 3.82

Research Experience ──────────────────────

University of Utah, Salt Lake City, UT *LL4MA Lab*
UNDERGRADUATE RESEARCHER *January 2018 - Present (10 months)*
• 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 Reason about and Manipulate Object Collections *In progress | RN Implementation*
UNDERGRADUATE RESEARCHER, LL4MA LAB *November 2018 - Present*
• Working on methods to incorporate full-state information and reasoning for more efficient learning policies for robot manipulation
• Implemented Relation Networks (RN) with Mixture Density Network (MDN) head and loss
• Trained RN and Variational AutoEncoder (VAE) on toy unsupervised learning task, using raw state and images, respectively

Sim-to-Real Adaptation via Meta-Learning *GitHub repo of reproducing prior work*
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

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 45 upvotes
- Cited by popular blog post and used in popular YouTube video with 9k 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

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

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

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