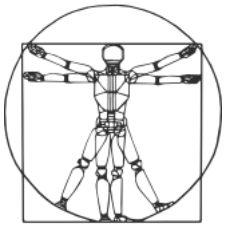
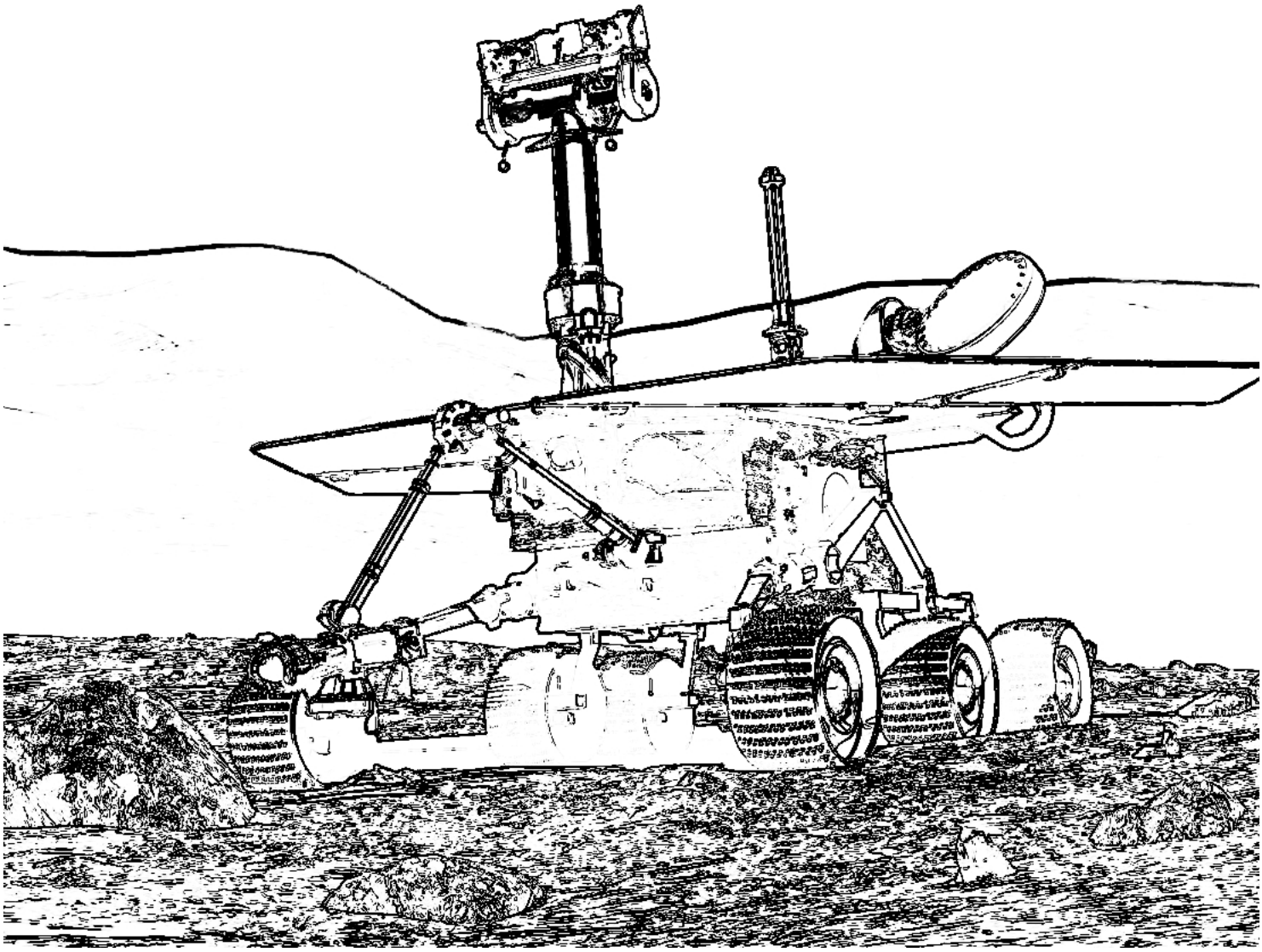
COMP 765: Intelligent Robotics, Winter 2020



Instructor
David Meger
david.meger@X
Office: McConnell 112N
Office Hours: Tuesdays after class (10-11am)
Dave's office MC112N
X = mcgill.ca

Teaching Assistant
Raihan Seraj
raihan.seraj@Y
Office: McConnell 438
Office Hours: Wednesdays (10:30-11:30am)
Y = mail.mcgill.ca



News

- **Feb 27, 2020:** We'll start to assign papers for after Reading Week using this list: (online>
- **Jan 7, 2020:** Welcome to the course!

Overview

COMP 765 is a research seminar on Intelligent Robotics. We will see how classical ideas starting from Gauss and Newton intersect with the latest machine learning on-board systems that can sense the world and act upon it. The class will begin with lectures on definitional problems and algorithms in robotics. We will then transition to mixed student-lead and instructor-lead discussions of recent developments in research and in practice. The emphasis is on algorithms, probabilistic reasoning, learning to improve behaviors using data, and decision making under uncertainty, as opposed to electromechanical systems design. We will broadly cover the following areas:

- **Models** for the geometry and motions of robots
- **Simulation** to predict movements over time
- **Control** that produces desired behavior
- **Planning** safe and effective paths through the environment
- **Decision making under uncertainty** which unites perception with planning and control
- **Learning** to perceive the world and predict motions
- **Interaction** including learning from human demonstrators and working with teams of humans and robots

Assignments

- **Assignment 1: Dynamics and Control** (pdf)

Schedule

Lectures will be on Tuesdays and Thursdays in McConnell Engineering Room 103, 8:35-9:55am each week from Jan 7th until April 9th except March 2-6, McGill's study break.

Week	Topics	Slides	References
1	**Introduction** **Kinematics and Dynamics**	Lecture 1 - (pdf) (pptx) Lecture 2 - (pdf) (pptx)	PR Chapter 1. Craig Chapters 1-4.
2	**Optimal Control Formulation** **LQR and DDP**	Lecture 3 - (pdf) (pptx) Lecture 4 - (pdf) (pptx)	
3	**Optimal Control** Formulation and algorithms	Lecture 5 - (pdf) (pptx) Lecture 6 - (pdf) (pptx)	
4	**Planning**	Lecture 7 & 8 - (pdf) (pptx)	
5	**Perception and Estimation** Probabilistic estimation: particle and Kalman filters	Lecture 8 - (pdf) (pptx) Lecture 9 - (pdf) (pptx)	
6	**SLAM** EKF, graph SLAM, visual navigation	Lecture 10 - (pdf) (pptx)	
7	**Decisions Under Uncertainty** POMDP, black-box optimization for robotics, coverage and exploration	Lecture 11 - (pdf) (pptx) Lecture 12 - (pdf) (pptx)	
8	**Model Learning** Model-based RL, Gaussian Processes for robotics, black-box optimization	Lecture 14 - (pdf) (pptx)	Probabilistic Inference and Learning for Control (PILCO) GP-BayesFilters
9	**Imitation Learning and Interaction** Inverse Optimal Control, active imitation, Dagger. Multi-agent systems of robots and humans.		
10	**Student project proposals**		
11	**Research talks and papers** Presented by students and guests		
12	**Research talks and papers** Presented by students and guests		
13	**Project presentations** Final demos and show-and-tell		

Marking scheme

- Assignments- 20%
- Midterm - 10%
- Research paper presentations - 20%
- Project - 50% split between proposal, final presentation and final report

Textbooks

These are all optional, but give great background on the subject. We will sometime assign readings from the material that is available freely on the web.

- Planning Algorithms, by Lavalle (PLAN in outline)
- Probabilistic Robotics, by Thrun, Fox, and Burgard (PR in the outline)
- Introduction to Robotics, Dynamics and Control, by Craig (Craig in the outline)
- Gaussian Processes for Machine Learning, by Rasmussen and Williams (GPforML in the outline)
- Computational Principles of Mobile Robotics, 2nd edition, by Dudek and Jenkin
- Robotics, Vision, and Control, by Corke
- Introduction to Autonomous Mobile Robots, by Siegwart, Nourbakhsh, Scaramuzza

Related courses

- Pieter Abbeel's course
- Optimal and Learning-based Control @ Stanford by Marco Pavone
- Related sections from Russ Tedrake's underactuated robotics course
- Sebastian Thrun's Udacity course
- Related sections from Stephen Boyd's linear systems course

Diversity and Inclusion

Robotics is one of the most imporant technologies in our world today and will be one of the most important skill-sets that people will use to influence the world in our lifetimes. This knowledge should be shared equally by all agents. Our goal is to make this content equally accessible to students of all backgrounds and we work to pro-actively acknowledge and address any bias that may occur during the term. Equal treatment of students from every gender, race and orientation is a top priority. We openly welcome suggestions on how to improve inclusion, by contacting the TAs or instructor either with your name or anonymously.

Disclaimers

McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offenses under the Code of Student Conduct and Disciplinary Procedures (see (this link) for more information). In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded. In the event of extraordinary circumstances beyond the University's control, the content and/or evaluation scheme in this course is subject to change.