ROB 537
Learning Based Control
Fall 2017

Week 0, Lecture 1
Introduction

Announcements:
HW 1 Due on 10/2 **at 11:59 PM**

(Yes, Midnight)

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Today

- Syllabus
- About course
  - Expectations
  - Project
  - Topics
- Overlap with other classes:
  - ROB 534: Sequential Decision Making
  - ROB 538: Multiagent Systems
  - CS 533: Intelligent Agents
- Questions ??

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Syllabus

- ME 537: 4 credits
  - 4 lecture hours
  - 3 lecture hours + lab
  - 3 lecture hours + project
- Class time: M W 10-11:15
- Course website:
  - http://classes.engr.oregonstate.edu/mime/fall2017/rob537/
  - Announcements
  - Homework/Project info

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Syllabus

- Prerequisites:
  - Comfort in programming (C/C++, Java, Python)
- Office hours:
  - M W 11:30-12:15
  - By email appointment
- Graduate Teaching Assistant :
  - Shaw Khadka : khadkas@oregonstate.edu
  - Monday PM
  - Location: TBD

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Books

- Biomimicry for Optimization, Control and Automation, Kevin M. Passino, Springer, 2005.
- Artificial Intelligence: A Modern Approach, S. Russell and P. Norvig, Prentice Hall, 2003.
- Reinforcement Learning, R. S. Sutton and A. G. Barto, MIT Press 1998.

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Assignments, Deadlines

Mondays, Mondays, Mondays:

1		Project	
2	HW		
3		Project	
4	HW		
5		Project	
6	HW		
7			Midterm
8	HW		
9		Project	
10			Presentations
11		Project	

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Homework

- All homework due at 11:59pm on Mondays
- Submit by emailing to khadkas@oregonstate.edu
  "safe" format is pdf
  Filename: ROB537_HW1_Lastname.pdf
- Do not be late !

  Conferences have deadlines. If you miss them, you cannot submit a paper

  Agencies have deadlines. If you miss them, you cannot submit a proposal

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Project

- You are writing a technical paper
  - Style files for Latex will be online
  - If not using Latex, format as close to sample file as you can
- Project assignments due at Mondays
- Final paper due at 11:59 on 12/4
- Project constitutes 40% of grade
  - Background paper (10%)
  - Draft paper (20%)
  - Final paper (50%)
  - Final presentation (20%)

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Project

- Topic (1 page)
  - Problem + possible solution + potential impact
- Background paper (3-4 pages)
  - Intro + background + related work + most of the references
- Draft paper (6-8 pages)
  - Background paper + abstract + approach + simulation + full references + partial results
- Final paper (10-12 pages)
  - Draft paper + full results + analysis + conclusion/discussion
- Presentation (15 minutes)
  - Conference style presentation

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This course is about …

You will learn to:

- Understand key concepts in learning
- Read recent papers on key topics
- Code to prototype your idea

- Formulate a research problem (identify a "gap")
- Formulate a solution (research)
- Generate results (algorithm, theory, coding)
- Write a research paper (tell a "story")
- Give a professional presentation

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Why Learning Based Control ?

- Traditional control methods:
  - PID controller
  - Optimal/adaptive/stochastic control
  - Appropriate when mathematical system model exists
- Learning-based control
  - "High" level control (autonomous behavior)
  - No mathematical model of system dynamics
  - Too many variables
  - Complex system behavior or system/environment interactions
  - Examples:
    - Autonomous vehicles (rovers / UAVs)
    - Intelligent robots
    - Interacting intelligent agents

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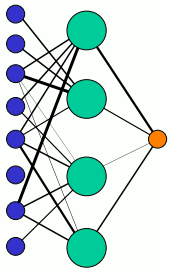
Course Topics: Neural Network

- Classification/ Function Approximation
- Simple input/output mapping
  - Layers
  - Activation Functions
  - Cost functions
  - Simple input/output mapping
- Deep Learning
  - Many layers to process information



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Course Topics: Search/Evolutionary Algorithms

- Search/Optimization
  - Objective function
  - Set of variables
  - Find the set of variables that optimizes the objective function
- Basic heuristic search algorithm:
  1. Generate an initial solution(set of variables)
  2. Generate a new solution by modifying the current solution
  3. Evaluate objective function of new solution
  4. Keep new or old solution based on objective function
  5. Go to step 2 and repeat till you reach stopping criteria

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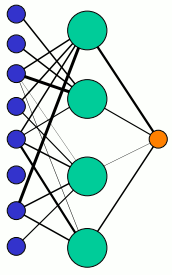
Course Topics: Neural Networks for Control

- Neuro-Control
  - Do we know expected outputs (targets)?
  - How do we training?
  - What is error?
  - Search through weights?
    - Neuro-evolutionary algorithms



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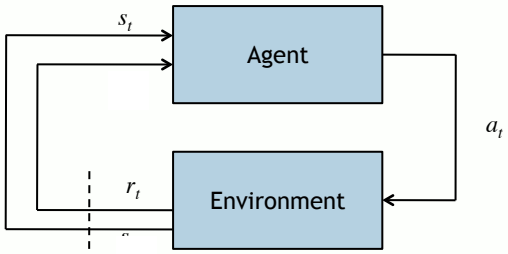
Course Topics: Reinforcement Learning

- No model of system
- Learn from environment
  - Take action, move to new state, receive reward



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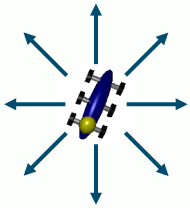
Course Topics: Path Planning

- Define start and goal states
- Define possible actions
- Search sequences of actions that connect start states to goal states:
  - Forward chaining
  - Backward chaining
  - Heuristics
- Key issues:
  - Actions deterministic or not?
  - States discrete of continuous?
  - States observable or not?



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Course Topics: State Estimation

- Previous slides consisted of mapping states to actions
- What is current state ?
- Do I map current sensor readings to actions ?

- Estimate state based on previous state and sensor readings, and use that state to determine actions

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Course Topics: Ethics, policy, law

- A robot in every home
- Autonomous vehicles
- Smart homes

- Who is responsible for
  - Certifying your home AI system
  - Certifying autonomous vehicles
  - Setting up the rules of the road
  - Insuring the vehicles
  - …
  - Protecting your privacy
  - Protecting the airspace
  - Ensuring your patient rights
  - …
  - Managing changes to our society

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