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)

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 ??
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

• 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
Books


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
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

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%)
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

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
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

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
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

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
Course Topics: Reinforcement Learning

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

![Diagram of reinforcement learning process](image)

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 or continuous?
  - States observable or not?
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

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