

CS4246/CS5446 AI Planning and Decision Making

Introduction

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AI Planning and Decision Making

- An intelligent agent needs to make rational decisions.
 - What does *rational* mean?
- An intelligent agent needs to take a sequence of actions to achieve some objective.
 - How to scale it up to large problems?
 - How to do that optimally when there is uncertainty?
 - How to *learn* to do take the appropriate actions in such environments?
- An intelligent agent needs to act appropriately when there are other agents around.
 - How to act appropriately when the other agent is also thinking and optimizing for itself?

Syllabus

You will learn about:

- Classical planning
- Decision theory
- Markov decision processes
- Reinforcement learning
- Game theory

CS4246/CS5446 is a mezzanine module.

- Two hours of lectures are common for both CS4246 and CS5446.
- Additional video material for CS5446 covering topics such as:
 - Planning Graphs
 - von Neumann and Morgenstern Theorem
 - Exploration vs Exploitation
 - Off-Policy Reinforcement Learning
 - Trust Region Policy Optimization

Additional depth and theoretical material. Discussion on LumiNUS forum.

IkeaBot



Figure: Video from

<http://people.csail.mit.edu/rak/www/?q=node%2F20>

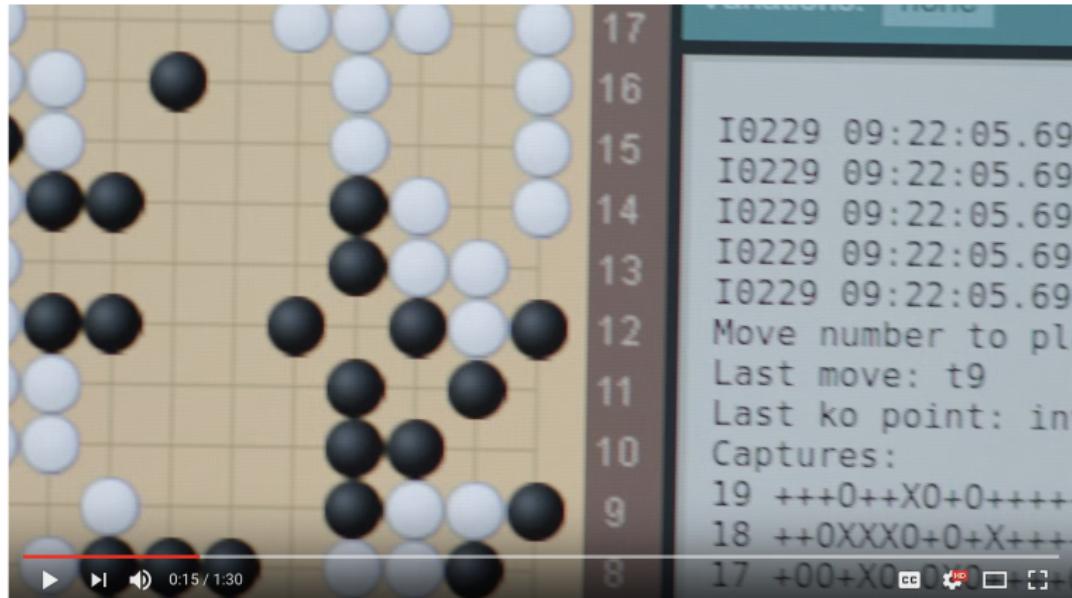
Planning problem specified in PDDL, **classical planning** specification which you will learn.

Autonomous Driving through NUS UTown crowd using POMDP



Figure: Video from https://www.youtube.com/watch?v=y_9VMD_sQhw
Problem formulated as a **partially observable Markov decision process (POMDP)** which you will learn about.

Defeating the World Champion in Go



AlphaGo uses learning and Monte Carlo Tree Search (which you will learn about) to defeat world champion Lee Sedol

<https://www.youtube.com/watch?v=8tq1C8spV-g>.

Learning to Play Atari Games using Reinforcement Learning

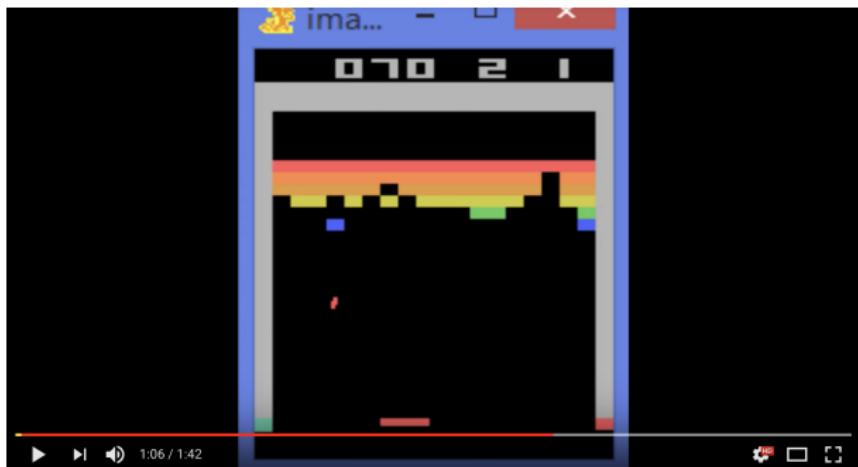


Figure: Video from

<https://www.youtube.com/watch?v=V1eYniJ0Rnk&vl=en>

A deep neural network learns to play Atari games by itself using **reinforcement learning** which you will learn about.

Doomsday Machine



Learn how to analyse situations like those seen in the video
<https://www.youtube.com/watch?v=ozg7gEchjuM> using game theory.

Exercise:

The Doomsday Machine scenario can be analysed using a two player game, commonly called Mutually Assured Destruction (MAD).

	USSR: attack	USSR: peace
USA: attack	A, A	C, B
USA: peace	B, C	USA utility = -1, USSR utility = -1

What values should A , B , and C be for MAD to work properly?

- A. $A = -900, B = -1000, C = 1000$
- B. $A = -\infty, B = -\infty, C = -\infty$
- C. $A = -\infty, B = -1000, C = 1000$

Discussion: What went wrong in the movie?

If USA and USSR set up their Doomsday Machine game properly, theoretically things would work. But what are the possible things that could go wrong in practice?

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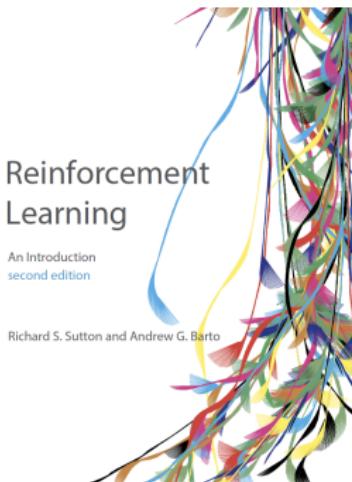
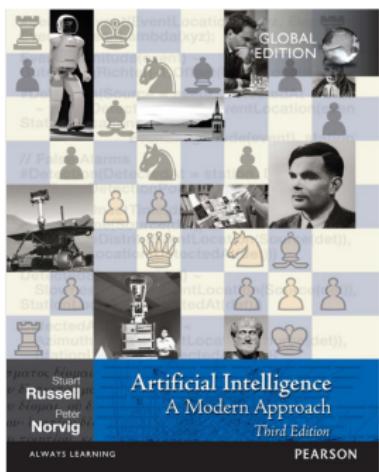
Lecturer

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Textbook



- Textbook: *Artificial Intelligence: A Modern Approach*, Third Edition, Stuart Russell and Peter Norvig
- Reference book: *Reinforcement Learning: An Introduction*, Second Edition. Sutton and Barto. Draft book available at <https://mitpress.mit.edu/books/reinforcement-learning-second-edition>

Assessment

- Homeworks: 45%
 - 3 homeworks at 15% each
- Mini-Project: 20%
- Exam: 35%

All components are the same for CS4246 and CS5446 except the exam.

- For the exam, CS5446 covers the additional material.
- Exam (to be held online) Sat, 21 Nov 2020.

Tutorials and Homeworks

- Tutorials and homeworks cover common material in CS4246/CS5446.
- For tutorials, read through questions before coming to class. Discuss questions with TA in class.
- Homeworks consist of written parts and programming parts.

Programming: Homeworks and Mini-Project

- Each homework will have a small programming part.
 - All on the same problem: simplified lane changing problem in driving
 - Implement different techniques in each homework in Python.
- Mini-project on more difficult version of the problem.
 - No restriction on the techniques used.