# CMPS 140 Artificial Intelligence
Winter 2019

Instructor: Yang Liu*
Teaching Assistants: Jiaqi Wu†, Can (Molly) Zhang ‡

Meeting time: MWF 2:40p - 3:45p, 01/07/19 - 03/15/19
Meeting Location: Steven Acad 175

January 2019

## 1 Introduction

Artificial Intelligence (AI) is the new electricity that powers up a wide range of cutting-edge technology, from driverless cars to grandmaster-beating Go programs. It is a broad area that covers topics from agent system to machine learning. The goal of this course is to introduce the ideas and techniques underlying the design of intelligent computer systems. Topics covered in this course are broadly divided into

- planning and search algorithms
- decision making (including reinforcement learning)
- machine learning.

Within each area, the course will also present practical AI algorithms being used in the wild and, in some cases, explore the relationship to state-of-the-art techniques. The class will include lectures connecting the models and algorithms we discuss to applications in robotics, computer vision, and related domains. Specific topics covered include classical search methods, constraint satisfaction problems, Markov decision processes, reinforcement learning, probability theory, Bayes nets, hidden Markov models, filtering, basic optimization, classification, regression and other more recent machine learning topics.

The course will provide a good foundation for topics covered in advanced AI courses (e.g., CMPS 240), and prepares the students for taking them. CMPS 142 complements CMPS 140, which emphasizes machine learning. Students who take both CMPS 140 and CMPS 142, will have a solid background for understanding and contextualizing modern AI research and experience implementing algorithms in several key areas of the field.

**Expected outcomes** Students completing this course should be able to:

- choose the appropriate representation for an AI problem or domain model,
- choose the appropriate algorithm for reasoning within an AI problem domain,
- implement and debug core AI algorithms in a clean and structured manner,
- design and analyze the performance of an AI system or component,
- describe AI algorithms and representations and explain their performance,
- and critically read papers on AI systems.

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## 2 Preilminaries

**Prerequisites** CMPS 101, experience with programming and systems building, and familiarity with probability.

Students should also have some exposure to complexity (big-O notation, basic algorithm analysis). No previous exposure to AI is assumed. Talk to the teaching staff or skim the future readings if you are concerned about your preparation. All programming assignments will be in Python.

**Textbook** Throughout the course, we will be using:

*Russell, Stuart, and Peter Norvig. 2010. Artificial Intelligence: A Modern Approach. 3rd ed. Pearson. (Also called AIMA).*

During the RL part of the course we will use:

*Sutton, Richard S, and Andrew G Barto. 2016. Reinforcement Learning: An Introduction 2nd Edition (Draft). MIT Press. (Also called RLAI)*

which is available for free online at:

`https://web.stanford.edu/class/psych209/Readings/SuttonBartoIPRLBook2ndEd.pdf`.

**Support resources** We will be using Piazza for questions. Unless your question would reveal confidential information or give away answers to homework questions, please post there publicly. Otherwise, send us a private message via either Piazza or email. We also strongly encourage you to answer each others questions.

**Office hours and email**

- **Yang Liu**: Wednesday 4p - 5:30p
- **Jiaqi Wu**: Tuesday 4p - 5p
- **Molly Zhang**: Monday 4p - 5p

You are welcome to come to office hours with specific questions about the material, to discuss final project ideas, or just to chat about things you find interesting and want to explore further. To avoid duplication of questions and keep the email load manageable and centralized, please use Piazza for all questions.

**Discussion sections** There will be biweekly discussion sections with our teaching assistants:

- Session 1 (Jiaqi Wu): F 12p -1:05p, Loc: Earth & Marine B214
- Session 2 (Jiaqi Wu): Th 3:20p - 4:25p, Loc: Earth & Marine B214
- Session 3 (Molly Zhang): W 5:20p - 6:25p, Loc: Earth & Marine B210
- Session 4 (Molly Zhang): W 6:40p - 7:45p, Loc: Earth & Marine B210

You can use these sections to review material covered in the previous weeks lectures (except before midterms, when a more comprehensive review will take place, and to review your course project progress. Attendance at section is strongly encouraged.

## 3 Course requirement

The evalution of this course consists of the following three components:

- Two midterms (30%): each contributes to 15% of your final grade.
- Course project (35%): proposal (3%) + progress check (5%) + project report (20%) + final presentation (7%). You are expected to form groups of 2 - 3.
- Assignments (30%): 4 assignments contributing equally to your final grade, each consists of a writing component and a programming component.
- Participation (5%): in classroom and online.

**Late days** Each student is allotted a total of **five late days** for use on problem sets only. They extend the due date by **24 hours** and a maximum of **2 late days** can be used towards any individual assignment. Late days may not be used on any part of the final project. Grading Written assignments will be hand graded. Programming assignments can be submitted and autograded an unlimited amount of times until the due date (or late due date). If you have used up your 5 late days, you will be penalized 25% per day, up to two days max, with no credit after two days. In cases of medical or other emergencies which interfere with your work, have your Resident Dean contact the instructor. Any grading disputes on written assignments must be submitted as Piazza private messages within one week of the grades being posted after which the grade is final. Except in extraordinary circumstances, no regrades will be accepted on programming assignments.

**Readings** Each class meeting is preceded by a reading assignment, which will be assumed during the lecture and discussion in class. You should set aside 2 hours to compete each reading. We do not expect you to fully understand everything before coming to class, but the goal is to prepare for class, familiarize yourself with new terminology and definitions, and to determine which part of the subject you want to hear more about. We encourage you to bring questions to class about material that is confusing. Other students might share your confusion.

**In-class Exams** There are two in-class exams (closed book, no notes), one covering the first half of the course material and the second covering the second half of the course material. See the schedule for dates and topics covered. Reviews will be held preceding each exam.

**Final Project** Throughout the course students will design and carry out a final project in groups of 2-3 students. The final project is of your choosing: it can describe a system you have built or discuss more theoretical issues or even survey cutting edge work in an active area of AI research. We will provide a list of potential topics. Most people who have taken the course consider this one of the most fun and rewarding parts of the course, and we hope you'll have fun with it too. Students will have to submit a proposal, an update, and give a poster presentation, which will all allow the teaching staff to provide feedback before submission of the final report at the end of reading period. Attendance at the poster session is mandatory.

The project will be something that you work on throughout the course and we have set up some milestones to help you along the way:

- Forming teams and 1-page proposal (due on 1/23/2019): Describe your project idea, the dataset you will be working on, input-output behavior of your system, and your evaluation metric for success.
- Progress report (due on 2/15/2019): (3 - 4 pages) Propose a model and an algorithm for tackling your task. You should describe the model and algorithm in details and use concrete examples to demonstrate how the model and algorithm work.
- Poster presentation (3/14/2019), joint with CMPS 144 & CMPS 240.
- Final project report (due on 3/17/2019): (5 - 7 pages) You should have completed everything (task definition infrastructure, approach, literature review, error analysis). Instructions will be posted later in the quarter.

**Collaboration Policy** The University Code of Academic Integrity is central to the ideals of this course. Students are expected to be independently familiar with the Code and to recognize that their work in the course is to be their own original work that truthfully represents the time and eort applied. Violations of the Code are most serious and will be handled in a manner that fully represents the extent of the Code and that befits the seriousness of its violation.

**Diversity and Inclusion** UC Santa Cruz is committed to creating an academic environment that supports its diverse student body. If you are a student with a disability who requires accommodations to achieve equal access in this course, please submit your Accommodation Authorization Letter from the Disability Resource Center (DRC) to me privately during my office hours or by appointment, preferably within the first two weeks of the quarter. At this time, I would also like us to discuss ways we can ensure your full participation in the course. I encourage all students who may benefit from learning more about DRC services to contact DRC by phone at 831-459-2089, or by email at drc@ucsc.edu.

# 4 Schedule

| Meeting Dates | # | Topic | Reading | Assignments | Cluster |
|---|---|---|---|---|---|
| Mon., Jan. 7 | 1 | Intro+AI | AIMA 1,2 | Python tutorial (non grading) | Intro |
| Wed., Jan. 9 | 2 | Search (Uninformed Search) | AIMA 3.1-3.4 | | Search & planning |
| Fri., Jan. 11 | 3 | Search (A* and Heuristics) | AIMA 3.5, 3.6 | P1 released (Search) | |
| Mon., Jan. 14 | 4 | Search (Adversarial Search) | AIMA 5 | | |
| Wed., Jan. 16 | 5 | Constraints Satisfication Problems | AIMA 6.1 - 6.5 | | |
| Fri., Jan. 18 | 6 | Intro & Recap of Probability | | | |
| Mon., Jan. 21 | **Holiday** | | | | |
| Wed., Jan. 23 | 7 | Markov Decision Making I | AIMA 17 1-3, RLAI 3-4 | Project proposal due | Decision Making |
| Fri., Jan. 25 | 8 | Markov Decision Making II | | P1 due | |
| Mon., Jan. 28 | 9 | Reinforcement Learning I | AIMA 21, RLAI 6.1-6.5 | | |
| Wed., Jan. 30 | 10 | Reinforcement Learning II | | P2 released (MDP+RL) | |
| Fri., Feb. 1 | 11 | Game Theory | | | |
| Mon., Feb. 4 | 12 | *Summary of the first two modules* | | | |
| Wed., Feb. 6 | **Midterm I** | | | | |
| Fri., Feb. 8 | 13 | Hidden Markov Models | AIMA 13.1-13.5 | | Machine Learning |
| Mon., Feb. 11 | 14 | Bayesian Network | AIMA 14.1-2 | P2 due | |
| Wed., Feb. 13 | 15 | Regression | AIMA 18.1-2,6 | P3 released (HMM+Bayesian Network) | |
| Fri., Feb. 15 | 16 | Classification I | AIMA 20.1-2 | Project progress report due | |
| Mon., Feb. 18 | **Holiday** | | | | |
| Wed., Feb. 20 | 17 | Classification II | | P4 released (Classification) | Machine Learning |
| Fri., Feb. 22 | 18 | Unsupervised Learning | AIMA 18.8 | P3 due | |
| Mon., Feb. 25 | 19 | Neural Networks | | | |
| Wed., Feb. 27 | 20 | Deep Learning I | | | |
| Fri., Mar. 1 | **Midterm II (ML)** | | | | |
| Mon., Mar. 4 | 21 | Deep Learning II | | | Recent Topics |
| Wed., Mar. 6 | 22 | Generative Adversarial Networks | | | |
| Fri., Mar. 8 | 23 | Adversarial ML (guest lecture) | | P4 due | |
| Mon., Mar. 11 | 24 | Fair ML | | | |
| Wed., Mar. 13 | 25 | Interprable ML (guest lecture) | | | |
| **Thur., Mar. 14** | **Project Presentation** | | | | |
| Fri., Mar. 15 | **No Class (due to joint project presentation)** | | | | |
| TBD | | **Project Report Due** | | | |