CS 5100 Syllabus

Course Description

All course materials, including assignments, grades and announcements are published on the coursework website for CS 5100 (go https://northeastern.instructure.com/courses/174479).

CS 5100 introduces the fundamental problems, theories, and algorithms of the artificial intelligence field. Topics include heuristic search and game trees, knowledge representation using predicate calculus, automated deduction and its applications, problem solving and planning, and introduction to machine learning. Required course work includes the creation of working programs that solve problems, reason logically, and/or improve their own performance using techniques presented in the course. Requires proficiency in Python.

Learning Goals

- Define search problems and understand the difference between different search models.
- Explore more complex search problems (Constraint Satisfaction Problems, Adverserial games) and their differences.
- Analyze Markov Decision Processes (MDPs) and the applications in which they occur.
- Develop Reinforcement Learning Models.
- Build different supervised learning models and analyze what challenges can be encountered with different models (underfitting, overfitting).
- Understand what deep learning is and how Neural Networks can be used for model learning.
- Understand how some Large Language Models (LLMs) can be developed with a focus on Transformers.

Course Schedule

There are two sections for this class. The lectures are scheduled for

- Monday and Thursday 9:00 AM - 10:40 AM PST for section 9.
- Monday and Thursday 11:00 AM - 12:40 PM PST for section 8.

The Instructional Team

The instructional team is here to help you learn. We are available during office hours and will also answer questions posted in Piazza (see below for more information). For personal matters, you can send a direct email to any of the members of the instructional team

Instructor

Dr. Nadim Saad, n.saad@northeastern.edu
Nadim is an Assistant Teaching Professor in Computer Science and Data Science in Khoury College of Northeastern University. He received both his MS and Ph.D. in Computational and Mathematical

Engineering from Stanford University. In his free time, Nadim enjoys running, swimming, climbing and skiing. I am very excited to see some familiar faces in both classes and meet new students!

Languages: English, French, Arabic and some Spanish (happy to learn more from you).

Teaching Assistants

Xinyao Chen, chen.xinyao@northeastern.edu
Hi, I'm Xinyao Chen, a student in the Computer Science Align program. I have a strong passion for AI and software development, particularly in solving real-world problems. Outside of academics, I enjoy baking homemade bread, reading philosophy, and hiking. I'm excited to support you in this course - feel free to reach out with any questions. Let's have a great semester!

Languages: English, Mandarin

Yidan (Danielle) Cong, cong.yi@northeastern.edu
I'm Danielle Cong, part of the CS-Align program. I'm passionate about artificial intelligence and machine learning and interested in software development. When I'm not immersed in tech, you'll find me crocheting intricate patterns, hiking scenic trails, or discovering hidden gems in historic towns. I'm always eager to learn and share knowledge!

Languages: English, Mandarin

Qiaochu Liu, liu.qiaoc@northeastern.edu
Hi, this is Qiaochu and you could call me Qiao for short. I'm currently attending the CS Align program here, and I'm thrilled to share the journey of exploring those fantastic theories and models related to AI and ML and offer my help anytime. During my leisure time, I enjoy TRPGs, various board games, traveling, and camping. I wish we could create a fruitful semester together!

Languages: English, Mandarin

Xuedong (Steven) Pan, pan.xue@northeastern.edu
My name is Xuedong Pan, and I also go by Steven. I am in my final semester of the Master of Science in Computer Science program at Northeastern University's Silicon Valley Campus. During my undergraduate studies, I focused on back-end web development and gained hands-on experience through relevant internships. As I progressed through my graduate program, I had the opportunity to work on several machine learning projects, which sparked my interest in AI and inspired me to dive deeper into this exciting field. Outside of academics, I enjoy traveling and have visited several countries, including Canada, Japan, and Australia. I'm excited to support you in CS5100 this semester!

Languages: English, Mandarin

Assessment

Your final grade will be based on assignments, project and one quiz:

- Assignments count for 50%. There are 5 assignments. Only the four highest scores are counted. The assignments are essential aids: they help you understand material deeper and help prepare you for the project and quiz. Assignments are always due before 11:59 pm PDT. They will be returned to you a week after the due date. See the course calendar for all deadlines. Note that because we only count the four highest assignment scores, missing up one homework assignment due to unforeseen circumstances will not affect your final grade. Whenever an assignment is graded, you will have three days to go over the provided comments and resubmit your work, in case you lost some credit. In the updated parts, you will need to answer three questions: What was not correct previously? Why wasn't it correct? What is your new solution? You can gain back the lost points.

- The project counts for 30%. The project will allow you to apply everything you learned in this class to a real-world problem. There will be four main components for the project:
  - Project proposal (6%)
  - Progress report (8%)
  - Final report (10%)
  - In class oral presentation (6%)
- The quiz counts for 20%. The quiz will be given during the Thursday lecture in week 13.

Assignments will be administered through Gradescope, which has been linked to Canvas (and you should be automatically enrolled). If you have any issues with Gradescope, please report on the Piazza course page or send me an email and I'll be more than happy to help you. I will post guidelines to let you know how to submit assignments on Gradescope.

Office Hours

The office hour schedule (in Pacific time) is as follows (Pacific):

Tuesday	Xinyao: 9:30 AM - 11:00 AM
Wednesday	Nadim: 10:00 AM - 12:00 PM
Wednesday	Steven: 4:00 PM - 5:30 PM
Thursday	Qiao: 3:00 PM - 4:30 PM
Friday	Danielle: 2:00 PM - 3:30 PM

Support Outside of Office hours

We will provide additional support on Piazza. The teaching team will monitor the board and respond to posted questions in a timely fashion every weekday. You can and are encouraged to answer questions too. Post, answer, discuss: the more you do, the faster the help you will receive.

Computers and Software

In this course, we will make use of Python for both the computational components of the assignments and the project.

Textbook and Notes

There are no required textbooks for this class, and you should be able to learn everything from the class lectures and assignments. However, if you would like to pursue more advanced topics or get another perspective on the same material, here are some great resources:

- Russell and Norvig. Artificial Intelligence: A Modern Approach. A comprehensive reference for all the AI topics that we will cover.
- Koller and Friedman. Probabilistic Graphical Models. Covers factor graphs and Bayesian networks.
- Sutton and Barto. Reinforcement Learning: An Introduction. Covers Markov decision processes and reinforcement learning (free online).
- Hastie, Tibshirani, and Friedman. The Elements of Statistical Learning. Covers machine learning from a rigorous statistical perspective (free online).
- Tsang. Foundations of Constraint Satisfaction. Covers constraint satisfaction problems (free online).

Note that some of these books use different notation and terminology from this course, so it may may take some effort to make the appropriate connections. The book by Russel and Norvig is the one mentioned in the schedule below for recommended readings.

Diversity and Classroom Dynamics

- This is an inclusive classroom. Everybody has a name and a pronoun. I am committed to referring to you with the correct pronoun. Please feel free to correct me if I make a mistake.
- As your instructor, I care deeply about your well-being. Please speak with me if you are having any academic or personal difficulties. It's very important that we stay connected.

Access and Accommodations

The Disability Resource Center (DRC) is dedicated to partnering with the diverse population of students, staff, and faculty who we serve at Northeastern and in the surrounding community. We strive to provide exemplary service, education, and resources in the work that we do.

If you experience disability, please register with the DRC. Professional staff will evaluate your needs, support appropriate and reasonable accommodations, and prepare an Academic Accommodation Letter for faculty. To get started, or to re-initiate services, please visit https://drc.sites.northeastern.edu/.

Collaboration

You may collaborate with your fellow classmates on the assignments, but each person must submit their own assignment and code. All code which you submit must be your own. In addition to the academic integrity policy below, the following rules apply when collaborating with classmates:

- If you have had a substantive discussion of any homework or programming solution with a classmate, then be sure to cite them in your report. If you are unsure of what constitutes "substantive", then email me. You will not be penalized for working together!
- You must not copy answers or code from another student either by hand or electronically. Another way to think about it is that you should be talking English with one another, not Python.
- You may consult online resources as part of your course work, but you may not copy code from online sources. If you get an idea of how to solve a problem from an online source, include a short citation at the top of your .py file.

Academic Integrity Policy

The Academic Integrity Policy articulates Northeastern's expectations of students and faculty in establishing and maintaining the highest standards in academic work.
See https://osccr.sites.northeastern.edu/academic-integrity-policy/ for more information on the Academic Integrity Policy.

Course Schedule

Week 1	Monday 01/06/2024 Lecture 1: Introduction Book sections: Chapters 1,2	Thursday 01/09/2024 Lecture 2: Search Problems HW1 released Book sections: Chapter 3
Week 2	Monday 01/13/2024 Lecture 3: Search Problems Book sections: Chapter 3	Thursday 01/16/2024 Lecture 4: Search Problems Book sections: Chapter 3
Week 3	Monday 01/20/2024 No class: Martin Luther King, Jr.Day	Thursday 01/23/2024 Lecture 5: Adversarial Games Project Proposal released Book sections: Chapter 5
Week 4	Monday 01/27/2024 Lecture 6: Adversarial Games HW1 due, HW2 released Book sections: Chapter 5	Thursday 01/30/2024 Lecture 7: Constraint Satisfaction Problems (CSPs) Book sections: Chapter 6
Week 5	Monday 02/03/2024 Lecture 8: CSPs Project Proposal due Book sections: Chapter 6	Thursday 02/06/2024 Lecture 9: Uncertainty Quantification Book sections: Chapter 13 and lecture notes on Canvas
Week 6	Monday 02/10/2024 Lecture 10: Bayesian Networks Book sections: Chapter 14	Thursday 02/13/2024 Lecture 11: Markov Decision Processes HW2 due, HW3 released Book sections: Chapter 16,17
Week 7	Monday 02/17/2024 No class: Presidents Day	Thursday 02/20/2024 Lecture 12: Markov Decision Processes Project Progress Report released Book sections: Chapter 16,17
Week 8	Monday 02/24/2024 Lecture 13: Learning Book sections: Chapter 18 and lecture notes on Canvas	Thursday 02/27/2023 Lecture 14: Reinforcement Learning HW3 due Book sections: Chapter 18 and lecture notes on Canvas
Week 9	Monday 03/03/2024 No class: Spring break	Thursday 03/06/2024 No class: Spring break

Week 10	Monday 03/10/2024 Lecture 15: Intro to Linear Algebra HW4 released Lecture notes on Canvas	Thursday 03/13/2024 Lecture 16: Intro to Linear Algebra Project Progress Report due Lecture notes on Canvas
Week 11	Monday 03/17/2024 Lecture 16: Supervised Learning Book sections: Chapter 18 and lecture notes on Canvas	Thursday 03/20/2023 Lecture 17: Supervised Learning Book sections: Chapter 18 and lecture notes on Canvas
Week 12	Monday 03/24/2024 Lecture 18: Deep Learning Project Final Report released Book sections: Chapter 18 and lecture notes on Canvas	Thursday 03/27/2023 Lecture 19: Deep Learning HW4 due Book sections: Chapter 18 and lecture notes on Canvas
Week 13	Monday 03/31/2024 No class: Cesar Chavez Day	Thursday 04/03/2024 Quiz
Week 14	Monday 04/07/2024 Lecture 22: Natural Language Processing (NLP) HW5 released Book sections: Chapter 22,23	Thursday 04/10/2024 Lecture 23: NLP and Language Models Book sections: Chapter 22,23
Week 15	Monday 04/14/2024 Lecture 24: Language Models Book sections: Chapter 22,23	Thursday 04/17/2024 Lecture 25: Conclusions HW5 due Book sections: Chapter 26,27
Week 16	Monday 04/21/2024 Project Presentation	Thursday 04/24/2024 Project Presentation Project Final Report Due