XCS221: Artificial Intelligence

Principles and Techniques

Syllabus and Course Information

Welcome

Welcome to XCS221: Artificial Intelligence – Principles and Techniques! This professional course is based on graduate-level material from Stanford's on-campus course, CS221, adapted for a professional certificate format.

What is this course about?

What do web search, speech recognition, face recognition, machine translation, autonomous driving, and automatic scheduling have in common? These are all complex real-world problems, and the goal of artificial intelligence (AI) is to tackle these with rigorous mathematical tools. In this course, you will learn the foundational principles that drive these applications and practice implementing some of these systems. Specific topics include machine learning, search, game playing, Markov decision processes, constraint satisfaction, graphical models, and logic. The main goal of the course is to equip you with the tools to tackle new AI problems you might encounter in life.

In this course you will:

- Learn from Stanford classroom lecture videos that have been edited and segmented by topic for easier navigation, reference, and review.
- Complete problem sets enhanced with additional supports and scaffolding.
- Receive support from Stanford-affiliated Course Facilitators.
- Connect with a cohort of peers from diverse locations and professional backgrounds.

Course Launch

All lecture videos will be available on the first day of the course **(November 1st) at 12:00pm Pacific Time**. Course problem sets will be released as indicated in the calendar below, without exception. Maintaining this schedule enables Course Facilitators to be most effective in providing support and answering questions on subject matter throughout the course.

****NOTE:** This normally 10-week course will be delivered over 12-week period, with a two-week Stanford Winter Closure from **Monday, December 20, 2021 – Friday, December 31, 2021.** During this break learners will have access to course materials and assignments, however staff support will be unavailable.

Getting Started

This course will use different tools to distribute content, manage problem sets, and deliver support. They are:

- **SCPD Learning Management System** – accessed via the mystanfordconnection site which you used to apply to and enroll in this course.
- **GitHub** – to distribute code and data for the problem sets.
- **Slack** – for additional course support and class discussions.

Joining Slack

In addition to direct small group support from Course Facilitators (more details and guidelines in Course Facilitators, Support, and Guidelines section below), the cohort will have a Slack workspace to ask additional questions and discuss course topics**.** An email invitation to the Slack workspace will be sent to your email address on file with SCPD on **October 29th.**

If you have previously joined an SCPD/Stanford Slack Workspace for a previous course in the AI Professional Program, Slack does not send a notification when our staff 're-invites' you to this workspace. Instead, you are automatically re-activated, and on **October 29th** should proceed directly to http://xcs221-scpd.slack.com/ → I have a guest account → Log in using your credentials.

Joining GitHub

You will receive an email invitation to a GitHub team called "XCS221-Fall-2021" at your address on file with SCPD. If you would like to receive a GitHub invitation at a different address, just let us know!

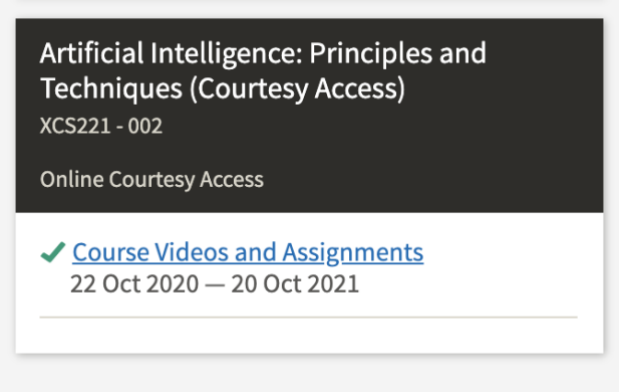
You will need to accept the invitation and be logged into your GitHub account in order to view course assignments and code.

The team's repository will be blank in the beginning – code files will be added gradually as each problem set is released (see schedule on page 5).

Getting Started (November 1st)

Accessing Your Course

1. On **November 1st after 12pm Pacific Time**, log in to the mystanfordconnection account that you used when applying for the XCS221 course.
2. XCS221: Artificial Intelligence – Principles and Techniques will be visible as a live course. Click the link titled "Course Videos and Problem Sets" to enter our learning management system.



Course Schedule

Week	Suggested Videos	Assignments	
Weeks 1 & 2 (Nov 1 – 14)	Machine Learning State-based Models: Search Problems	A1 Released A2 Released A7 (EXTRA CREDIT) Released	Monday, November 1 Monday, November 1 Monday, November 1
		A1 Due A3 Released	Friday, November 12 Friday, November 12
Weeks 3 & 4 (Nov 15 – 28)	State-based Models: Markov Decision Processes	A2 Due	Sunday, November 21
		A4 Released	Friday, November 19
Weeks 5 & 6 (Nov 29 – Dec 12)	State-based Models: Adversarial Games Variable-based Models: Constraint Satisfaction Problems	A3 Due	Sunday, December 5
		A5 Released A6 Released	Friday, December 3 Friday, December 10
Week 7 (Dec 13 –19)	Variable-based Models: Bayesian Networks		
(Dec 20 – Jan 2)	**Stanford Winter Closure** Course materials and assignments available but Course Facilitators will be offline.		
Week 8 (Jan 3 – 9)	Variable-based Models: Bayesian Networks	A4 Due	Sunday, January 9
Weeks 9 & 10 (Jan 10 – 23)	Logic Deep Learning	A5 Due A6 Due A7 (EXTRA CREDIT) Due	Sunday, January 16 Sunday, January 23 Sunday, January 23

Assignments

Assignments will be released via the SCPD course platform on the dates noted above in the course calendar. Below is a brief summary of what each problem set will entail:

Assignment 1: Sentiment Analysis

In this assignment, you will build a binary linear classifier that reads movie reviews and guesses whether they are "positive" or "negative."

Assignment 2: Text Reconstruction

In this assignment, you will consider two tasks: word segmentation and vowel insertion. Word segmentation often comes up when processing many non-English languages, in which words might not be flanked by spaces on either end, such as written Chinese or long compound German words. Vowel insertion is relevant for languages like Arabic or Hebrew, where modern script eschews notations for vowel sounds and the human reader infers them from context. More generally, this is an instance of a reconstruction problem with a lossy encoding and some context.

Assignment 3: Peeking Blackjack

Markov decision processes (MDPs) can be used to formalize uncertain situations. In this assignment, you will implement algorithms to find the optimal policy in these situations. You will then formalize a modified version of Blackjack as an MDP, and apply your algorithm to find the optimal policy.

Assignment 4: Multi-agent Pac-Man

In this assignment, you will design agents for the classic version of Pac-Man, including ghosts. Along the way, you will implement both minimax and expectimax search.

Assignment 5: Scheduling

In this assignment, you will write a program that does automatic course scheduling for you based on your preferences and constraints. The program will cast the course scheduling problem (CSP) as a constraint satisfaction problem (CSP) and then use backtracking search to solve that CSP to give you your optimal course schedule.

Assignment 6: Car Tracking

Building an autonomous driving system is an incredibly complex endeavor. In this assignment, you will focus on the sensing system, which allows you to track other cars based on noisy sensor readings.

Assignment 7: Logic (Extra Credit)

In this assignment, you will gain hands-on experience with logic. You'll see how logic can be used to represent the meaning of natural language sentences, and how it can be used to solve puzzles and prove theorems. Most of this assignment will be translating English into logical formulas, but in Problem 4, we will delve into the mechanics of logical inference.

Honor Code

Students will be asked to review and maintain the standards set forth by the Stanford Honor Code when completing quizzes and assignments in this course. You can review the section labeled Violations of the Honor Code for representative examples relevant to this course.

Students are strongly encouraged to form study groups, discuss, and work on homework problems in groups and help each other; However, each student must write down the solutions independently and cannot refer to written notes from the joint session. **In other words, you must understand the solution well enough in order to reconstruct it independently**. Further, because we occasionally reuse problem set questions from previous years, you are expected not to copy, refer to, or look at the solutions when preparing your answers. It is an honor code violation to intentionally refer to previous year's solutions.

After completing this course, you are welcome to share your experience and credential with others; However, it is considered a violation of the honor code to share assignment solutions including on public platforms such as GitHub. Faculty in the computer science department have strongly encouraged us to refrain from posting solutions for assignments, thus we ask that you **DO NOT** share the exact code.

Grading

Coding Questions are graded automatically upon upload and will show your score. You can continue to re-submit up until the due date. To view an example of what this process looks like, you can view this video - https://youtu.be/8T8RFwI_dZ0

Written Questions will be manually graded by Course Facilitators no later than one week after a problem set's 'on-time' due date. Problem sets turned in late may be graded slightly later. To view an example of what the written submission process looks like, you can view this video - https://youtu.be/eEn826KNUqw .

Late Problem Sets and One-time Penalty Waiver

Late problem sets are assessed a penalty of **one point per day late, up to a maximum of five days late at which point the submission link will close**.

We understand that personal or professional events may cause you to miss a deadline on a problem set. Each student is able to use a **one-time penalty waiver on a problem set, which will not be assessed a scoring penalty**. The waiver cannot be split into smaller parts (e.g. you cannot use two days on Assignment 3 and three days on Assignment 4.). In order to use your waiver, contact your Course Facilitator or SCPD staff.

Passing the Course and Earning the Certificate

In order to earn the Certificate of Achievement associated with this course, you must complete problem sets with a total cumulative score of 70% or higher. Once you have successfully completed the course and the post-class survey, a digital Record of Completion will be emailed to you and the Certificate of Achievement will be mailed in a Stanford holder in approximately four weeks. If you are interested in calculating your progress along the way, it may be helpful to know:

- There are a total of 300 base points in the course (meaning 210 to achieve 70%)
- 28 extra points are available that can go towards your score

Deliverable	Regular Points	Extra Credit Points
A1	25	-
A2	55	-
A3	55	-
A4	55	8
A5	55	-
A6	55	-
A7 (Extra Credit)	-	20
Total Available	**300**	**28**
Minimum Passing Total	**210 (70% of Regular Total)**	

Videos and Slides

As noted, this course utilizes content originally delivered in the CS221 graduate course. A few things you will notice about this adaptation process:

- At times you will hear instructors make reference to the final project or poster session. As noted above these have been removed from the current version of XCS221 and you need not worry about the reference.
- Instructors may make reference to “Week 1”, “Week 2”, “Week n” of the course – these references can be ignored.
- In a few specific cases you may see names and/or faces blurred. In general, this is usually due to guidelines regarding student privacy.

Course Facilitators, Support, and Guidelines

You have a wide range of support available to you throughout the course. You will be assigned and receive contact information for an individual Course Facilitator (CF) who will act as your primary point of contact. Below is a summary of the available resources and course support:

Office Hours

Your CF will be in touch with availability and scheduling logistics for video conference office hours. Office hours may be conducted using the Zoom conference service or via Slack video (more information below on the course Slack workspace). Your CF will provide further information on how they will schedule and run office hour sessions.

Email

Your CF will also be available to answer questions via email – a Stanford contact address will be provided when you are first connected to your CF.

Note on Code Questions and Debugging

While the course team is here to help and support your experience, it is ultimately your responsibility to write, test, and de-bug your own code. CFs may view and provide guidance on your work, however they will not send you exact answers on what to insert into your problem sets. Additionally, before reaching out to a CF or Slack for help, it’s expected that you have taken the reasonable steps of reading and performing an analysis yourself. This policy is meant to ensure that you leave the course having mastered the material and enable CFs to focus attention on questions where their guidance is most impactful.

Slack Workspace – Usage and Guidelines

In addition to the individual and small group support provided by CFs, Slack will be a place where questions may be posed to the entire community (this is the fastest way to get an answer!).

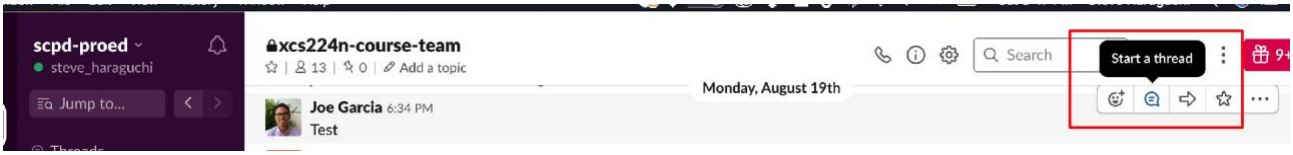
General Principles

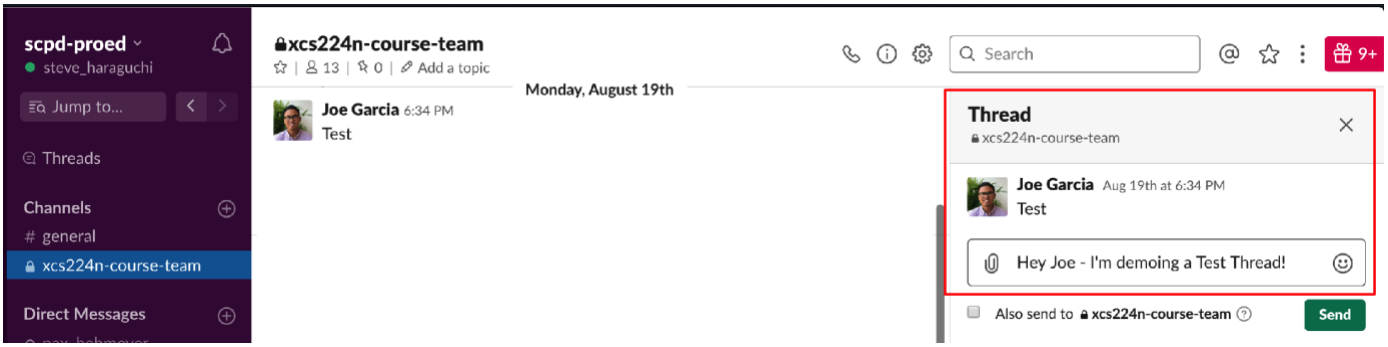
While it is an integral course support, joining the Slack workspace is optional and It is not a requirement to pass the course. All participants in the Slack community are expected to communicate respectfully with each other in line with Stanford's University Code of Conduct. The workspace is actively moderated by SCPD staff and should you experience any issues with conversation, please reach out to the course team immediately with any concerns.

Threading Conversations

In order to keep the Slack workspace readable, searchable, and useful to all, please follow the following guidelines:

Reply in Threads to Keep Conversation Organized – When you are replying to a post or joining a conversation, respond by starting or joining a threaded conversation, rather than responding in the full flow of the standard timeline. See below for an example of how to respond in a threaded conversation to Joe's test message:





Use Multi-line Messages – Even if messages are threaded, you will soon see that Slack becomes unmanageable unless people use **single, multi-line messages instead of multiple, single-line messages**. Especially for mobile Slack users, it gets out of control!

Rather than the following:
"Hey all I have a question" [RETURN] ← Creates new message
"I am a little confused about the quiz" [RETURN] ← Creates new message
"I'm getting F for Question 40, but it seems like T is better" [RETURN] ← Creates new message
---
Instead, try this!
"Hey all I have a question" [SHIFT+RETURN] ← Creates new line in SAME message
"I am a little confused about the quiz" [SHIFT+RETURN] ← Creates new line in SAME message
"I'm getting F for Question 40, but it seems like T is better" [SHIFT+RETURN] ← Creates new line in SAME message
[RETURN] ← Posts message

Workspace Archive

At the end of the course, the Slack workspace is cleared and conversation is removed before the start of the next course cohort.

Drop/Transfer Policy

You may drop this course for a full refund up until **November 1st, 2021** – the day the course starts. Once the course has begun, if you request to drop the course by Friday at 5:00pm PST on the third week of the cohort (**November 19th , 2021**) you will be reimbursed 100% of your tuition minus a drop fee of $100. Beyond the third week of the course, tuition refunds are not granted. Up until **November 19th, 2021** you may also request to transfer your enrollment to a future cohort of XCS221 or another course in the AI Professional Program, also for a transfer fee of $100. To request a drop or transfer, send an email to xcs221-staff@stanford.edu

Questions and Contacts

For course-specific questions or concerns (content, assignments, CF support), please contact your designated Course Facilitator.

For other course related questions, email xcs221-staff@stanford.edu