

Shall We Play a Game? Competing with AI

Student Instructor: Zach Yahn zry2yz@virginia.edu

Faculty Advisor: Prof. Haifeng Xu hx4ad@virginia.edu

Course Description

Why do we bother playing games? Better yet, why do we bother pouring hundreds of millions of dollars into algorithms that will play games for us? Games have been an essential benchmark of artificial intelligence since its inception, and many of the most famous examples of AI are in the realm of game playing. This course is a conceptual, high-level introduction to the ideas, algorithms, and people behind game playing AI. We will talk about the systems that have dominated popular games like Go and Chess, and also the experiences of the human experts who went toe-to-toe with them.

There are no prerequisites, and the course is accessible regardless of your experience (or total lack thereof) with computer science. Whether you're so competitive that you can't stand losing to the robots all the time or you're just curious about the hype, this course has something for everyone.

Lecture Schedule

Week	Class Day	Topic and Assignment
1	1/25	<u>Course Intro</u> Before Class: Complete the course intro survey if you haven't already.
2	2/1	<u>Intro to Games</u> Why bother teaching computers to play games? What are the different types of games and why do they matter? Before Class: Read any one section of this Stanford article that interests you. Be prepared to talk about it in class. https://plato.stanford.edu/entries/game-theory/ Quiz Link:
3	2/8	<u>Intro to AI</u> What does intelligence mean? How far has AI gotten today? Before Class: Brief writeup: find an example of "intelligent" (whatever that means to you) AI. How do you know it's intelligent? Quiz Link:
4	2/15	<u>Basic Games</u> How do computers play simple games like slide puzzles? Before Class: Brief writeup: What's the simplest game you can think of? Can you think of a process that guarantees you win every time?

		Quiz Link:
5	2/22	<p><u>Two-Player Games</u> What happens when we want to beat an opponent? What if that opponent doesn't play optimally?</p> <p>Before Class: Play a game of chess with a computer. If you don't know where to start, check out Chess.com</p> <p>Quiz Link:</p>
6	3/1	<p><u>Two-Player Games II</u> How much can we optimize a single system to be an expert at one game like Chess? Is this the right approach, or do we need something more?</p> <p>Before Class: Read IEEE's article on Deep Blue: https://spectrum.ieee.org/how-ibms-deep-blue-beat-world-champion-chess-player-garry-kasparov</p> <p>Quiz Link:</p>
7	3/8	<p><u>Reinforcement Learning</u> What is reinforcement learning? How can it help us play games with elements of chance?</p> <p>Before Class: No assignment for this class!</p> <p>Quiz Link:</p>
8	3/15	<p><u>Deep RL</u> How do famous programs like AlphaGo and AlphaStar work? What's the current state of the art in mastering a single game? How good can we get?</p> <p>Before Class: Watch the AlphaGo documentary on YouTube (approx 1.5 hours long). You can turn on English captions for the parts in Korean. https://www.youtube.com/watch?v=WXuK6gekU1Y</p> <p>Quiz Link:</p>
9	3/22	<p><u>Deep RL II</u> How do you beat a world champion? What does this mean for us as human players if the best of us still lose?</p> <p>Before Class: Read this Verge article about Lee Sedol: https://www.theverge.com/2019/11/27/20985260/ai-go-alphago-lee-se-dol-retired-deepmind-defeat</p>

		Quiz Link:
10	3/29	<p><u>Creativity and Mastery</u> What does it mean to master or solve a game? Can AI “invent” new moves, and does this show creativity and/or intelligence?</p> <p>Before Class: Read Wired’s article about creative moves in Go: https://www.wired.com/2016/03/two-moves-alphago-lee-sedol-redefined-future/</p> <p>Quiz Link:</p>
11	4/5	<p><u>Other Game-Playing Methods</u> What are some other popular algorithms? How do systems like Watson work? What does it mean to “know” something?</p> <p>Before Class: Read this NYT article about IBM’s Watson: https://www.nytimes.com/2011/02/17/science/17jeopardy-watson.html</p> <p>Quiz Link:</p>
12	4/12	<p><u>Team Games</u> Can AIs work together? Is this more effective than human teamwork?</p> <p>Before Class: Read this OpenAI article about OpenAI Five: https://openai.com/blog/openai-five-defeats-dota-2-world-champions/</p> <p>Quiz Link:</p>
13	4/19	<p><u>Human-AI Teamwork</u> What happens when humans and AI team up? Is there still a place for humans in games that have been “solved?”</p> <p>Before Class: Watch Garry Kasparov’s TED talk: https://www.youtube.com/watch?v=NP8xt8o4_5Q</p> <p>Quiz Link:</p>
14	4/26	<p><u>Generalized Learning</u> How can we make AI that can play multiple games? Can we eventually make systems that can play anything?</p> <p>Before Class: Read DeepMind’s article about AlphaZero: https://deepmind.com/blog/article/alphazero-shedding-new-light-grand-games-chess-shogi-and-go</p>

		Quiz Link:
15	5/3	<u>Course Wrap-up</u> Where do we go from here? Assignment: Complete the course recap survey if you haven't already.

“Grading” Policy

Each class will have a brief quiz that should be completed before the start of the next lecture. These are meant to be easy assignments that recap the material from class and ask you to think about what we discussed. Sometimes the questions will be multiple choice, and sometimes they will be short answer. No part of this course is meant to be stressful, and the quizzes will reflect that philosophy.

Passing grade: Complete 8 or more quizzes (out of 13) with a grade of 60% or higher.

Course Requirements/Expectations

This course is meant to be a fun and exciting introduction to AI and game playing. While students should complete the designated assignment after each lecture, the most important “homework” is thinking deeply about the lecture questions before each class. Significant parts of many lectures will be dedicated to class discussion, so I expect students to participate!