



About This Class

Welcome to AI! I'm glad you're here!
I'd like to start by making you three
promises.

I promise to treat you like a human being

I understand our current circumstances are bizarre, and that few people would choose this. I understand you're working at home, or in an even more complex arrangement, and life might happen that you have to deal with even when you're in class.

- I will always make my expectations clear
- I will be easy to communicate with
- I will always be flexible with requests for extensions, even if you don't tell me a reason
- I will always let you eat, drink, use the restroom, etc
- I won't ever require you to have your camera on in class (though I'd love it if you did, and I might require you to record a video on your own time between classes)



✕ I promise you will learn enough AI skills to literally get a job

To be fair, this isn't as incredible a promise as it sounds; AI is a relatively young field and expertise just doesn't go very deep yet. But I always check with actual professionals when I build the course plan, and I receive feedback that this course is enough experience to be employable! Of course, you still have to be able to program well, but in terms of AI knowledge, we walk right to the cutting edge.

- This course will be updated to the current state of the art every year
- This course will include the foundational projects in AI that college courses of study use
- This course will use professional tools and have professional expectations for satisfactory code

I promise you will become a powerful problem solver

On the one hand, this course is about learning the content knowledge of the field of Artificial Intelligence. But that might not be the most important thing in the course. I've also designed this course to give you experience with genuine problem solving - designing solutions to complex problems from scratch. This is a superpower that you can transfer to any context you'll encounter - programming or otherwise!

- The labs will not start with shell code - you will be in charge of planning as well as executing each lab
- The labs will be authentic, open-ended challenges that come from famous, well-documented AI investigations
- The labs will be long - some assignments in this course last three or four weeks (!!)
- I will always be excited to help you think through an assignment, or plan your code, or debug; we will build these skills together

This is what you will learn.

Artificial Intelligence is a large field that leads in many directions. Universities are beginning to offer entire majors in AI. Obviously, this course won't cover everything! We've prioritized two things: one, the material that is foundational to any AI extension in any direction, and two, cutting edge use of neural networks and prediction algorithms. We've chosen assignments along the way that are both canonical examples of the techniques we'll learn and opportunities to dive deep into problems and learn problem solving skills in general.





First Semester

First semester focuses primarily on **computers making decisions**. All of the problems we analyze can be modeled as a single, large decision tree - one choice, leading to another branching set of choices, each of those leading to another branching set, and so on. These are the problems that began the field of AI, and the algorithms that appear in numerous subfields and modern offshoots; this is the knowledge anyone working in AI needs to have.

- Unit 1: Uninformed Search & Informed Search
 - Learn how to efficiently comb through decision trees for solution states.
 - Assignments include efficiently solving [the 15 puzzle](#), generating word ladders, and exploring the breadth-first-search, depth-first-search, iterative deepening search, and A* search algorithms.
- Unit 2: Constraint Satisfaction Problems
 - Learn how to solve problems wherein a large number of variables constrain each other, like in a Sudoku puzzle or map coloring problem.
 - Assignments include rapidly solving hundreds of Sudoku puzzles, efficiently solving the N-Queens problem on larger and larger grids, and exploring forward looking and constraint propagation algorithms that wildly increase efficiency in these problems.
- Unit 3: Adversarial Games
 - Learn the basics of AI in turn-based adversarial games, with a chance to pit your AI against other students' work.
 - Assignments include optimizing Tic-Tac-Toe, developing a unique strategy for Othello (and seeing how you fare against other students!), and seeing how minimax, negamax, and alpha/beta pruning algorithms enable your code to look further into the future.
- Additional Topic: Regular Expressions
 - Regular expressions are a powerful tool used in many programming contexts to do intelligent text search. As the semester progresses, we will examine the power of this tool and use it in increasingly complex tasks.
 - Assignments consist of devilishly tricky problem sets that lead to a level of expertise equal to any programmer using them regularly.





Second Semester

Second semester focuses primarily on **computers making judgments**, ie computers looking at individual items and deciding which categories they fall into. This may seem rudimentary, but this is the modern neural network coding that has led to advancements in predictive problem solving, linguistic analysis, and medical diagnosis. This work leads students to be able to make genuinely novel senior research projects, should they choose to continue to the Systems Laboratory.

- Unit 4: Crossword Puzzle Generator
 - We begin second semester with an assignment that focuses on the problem solving skills objectives of the course; this teaches no new AI content, but tasks students to conceptualize a difficult, complex problem with several nested challenges, and plan and execute successfully.
- Unit 5: Genetic Algorithms
 - Learn how to spontaneously generate strategies without specifically coding them using an algorithm based on genetic diversity in a wild population.
 - Assignments include solving substitution ciphers, producing effective Tetris-playing bots, and exploring modern offshoots of the genetic algorithm.
- Unit 6: Unsupervised Learning & Supervised Learning
 - In this brief unit, we introduce unsupervised learning - computers finding categories in data without definition by a user - as well as supervised learning - computers using previously established categories and determining where new data points should be classified. The former is exemplified with the k-means algorithm; the latter, by constructing decision trees.
 - Assignments include intelligently posterizing images by finding the unique set of possible colors closest to the original image's many shades and reading patterns out of large data sets, eg determining when mushrooms are poisonous.
- Unit 7: Perceptrons, Neural Networks, & Back Propagation
 - This is the main event: we mathematically derive and code from scratch self-training neural networks that can recognize handwritten numbers.
 - Assignments include exploring what a single "neuron" can do by recreating logic gates, then multiple neurons by recreating algebraic relationships, then immense networks of hundreds of neurons to recognize handwritten numbers.
- Unit 8: Modern Tools
 - This unit brings us right up to the present day, introducing two modern libraries - Natural Language Toolkit and fast.ai. (Unless something better is released before May!) We will explore their capabilities, and the course will end with many avenues of further study available!



× This is how you will be graded.

I've worked hard to develop a grading system that is simple, easy to follow, and encourages you to genuinely master the material as well as find your own connections and challenges to meet. In particular, I do not give partial credit. If you have only partially finished an assignment, I want you to go back, keep working, and finish it!

There are two types of assignments in this class - required work and Outstanding Work. Below are the details for how all of this works.

Required Work

80% of your grade (8 assignments in first quarter; 12 assignments in each other quarter) will be comprised of required work. These are assignments each student is expected to complete.

- Most of this work will be labs!
 - Each lab can only receive three possible scores:
 - 5/10: a submission that is missing or that doesn't work
 - 9/10: a submission that meets all submission criteria, but was late
 - 10/10: a submission that meets all submission criteria
 - If you have a 5/10, you're allowed to resubmit (as many times as you need) until you get a 10/10. There's no penalty, as long as your submissions are before the due date.
 - If you need to keep working on a lab until after the due date has passed, you get a score of 9/10 on it once it works. This, again, has nothing to do with the number of submissions you've sent! This is only based on when your final working submission is sent.
 - **However**, in practice, **very few students get late points deducted**. The reason is that I am very flexible with granting extensions! As long as you ask by 4pm on the day an assignment is due, I will almost always grant a one week extension. And if you need more time, keep asking! This material is **hard** and taking a long time to master a topic is not unusual.
- Occasionally, you'll receive a small quiz on something that I can't accurately assess from code alone; in these cases, much like the labs, you'll be required to get a perfect score but you'll have as many tries as you need to do so.
- **This class has no tests of any kind - no unit tests, no midterm, no final.**





Outstanding Work

20% of your grade (2 assignments in first quarter; 3 assignments in each other quarter) will be comprised of Outstanding Work. You will receive many options to choose from - you only need to choose the required number to complete. This allows you to pursue unique challenges, specific areas of interest, or connections between AI and other subjects that intrigue you. **The choice is yours** - Outstanding Work is how you set yourself apart from your peers.

- This work could include extensions to required labs, all new labs, excursions to other programming languages aside from Python, book reports, historical reports, videos, and any other ideas you or I have as the year goes on.
- If you don't like the options, you can always propose a new one. At least seven of the Outstanding Work options I gave last year came from student suggestions!
- Outstanding Work is graded just like required work - either a 5, a 9, or a 10. That's it.
- There will be no class time specifically given to work on Outstanding Work submissions. This is your chance to set yourself apart; it's on you to find the time to do the work, either by working ahead or working outside of class.
- One Outstanding Work submission will be due about every three weeks.

This is what I expect from you.

Asynchronous Expectations

Every assignment will be made available on a Monday and will be due on a later Monday. Information necessary to do any assignment will be posted in videos that accompany the assignment. **Learning new content** will happen almost entirely asynchronously!

Outside of synchronous class, I will expect you to:

- Watch each assignment's new videos as they are posted
- Turn in work on time or ask for an extension before 4pm on the Monday the assignment is due
- Communicate effectively with me and with classmates through our chat service on TJ's servers (this means communicating professionally and in a timely manner, being helpful and supportive to peers, and maintaining the chat as a classroom space)





Synchronous Expectations

In class, we will focus on **interaction** and **time to work and ask questions** - I won't be talking to the whole class much, but you *will* be meeting with groups of peers to build your knowledge, getting questions answered by myself and your peers, and exploring controversial topics.

Inside class, I will expect you to:

- Collaborate and discuss with your peers when you are in small groups (which we will do to start every class and potentially other times as well)
- Stay focused on AI during discussions, chats, and independent work
- Clearly communicate to me when you are stepping away from class and why (ie, if you need to use the restroom) so that if you are unresponsive I know why

Please note that **attendance will be taken**, and ghosting out of class after a few minutes will count as an absence!

Most importantly: HONOR YOUR DISSATISFACTION!



Finally, I would like to make one thing as clear as I possibly can: ***my only purpose in this classroom is to make you mc awesome.*** We've chosen a curriculum that is incredibly challenging and relevant and designed to push everyone; after that curriculum has been set, I am no longer interested in curving scores or balancing grades or any of that. My only goal is for you to succeed as highly as you possibly can. I am on your side, and I will help you as much as I can to achieve.

I can't do that if you don't tell me when something is wrong. If you feel like an assignment is unfair, or impossible, or boring; if you feel like a classmate isn't helping you when they should; if you feel like the schedule isn't working and you need more structure, or less structure... whatever the case may be, I can't resolve your problem if I don't know what it is. I am here for you, I want you to succeed, and I know that's a different journey for each student. I **love** it when I make an assignment that I think is awesome and a student tells me they hate it! My intuition can't speak for every student; you make me a better teacher when you let me know my ideas aren't working for you. By TJ standards, I basically prefer it when my students are slightly rude to me. I'd rather you be blunt than polite; I'd rather you ask for an extension instead of pull an all-nighter; I'd rather you ask to do different work than force yourself through something you hate.

In general, my students report that they like this class quite a lot! In my survey results last year:

- 37.3% of students said this was the single best class they took at TJ
- 59.3% said it was *one of* the best classes they took at TJ
- 3.4% said it was better than the average TJ class
- 0 students said it was average or below average

And I'm quite proud of that! But: those were the students that made it through AI1 and AI2. Not every student completes both courses. Every year, a few students drop because of failing grades. Inevitably, when that happens, it is because ***they spent weeks and weeks behind schedule and feeling like a failure... and never said a word to me.*** And at some point it was too late to turn it around. I have *never* had a student who communicated with me regularly, asked questions a lot, and asked for extensions when they needed them who ended up dropping the class. One student wasn't able to complete a single assignment for *five weeks* at the beginning of the year... then later got "A"s for both semesters! It can be done.

The only way to fail this course is to struggle *silently*. Every one of you is capable of succeeding, but...

You have to **tell me when it feels too hard.**

You have to **tell me when you get stumped or get frustrated.**

You have to **tell me when you watch a lecture video and don't understand it.**

Your dissatisfaction matters to me. Social dissatisfaction, academic dissatisfaction, workload dissatisfaction - *it matters to me.* Please, honor your dissatisfaction as well. Know that I expect you to speak up, to ask for help, and to tell me when something isn't right. Don't suffer silently! Honor your dissatisfaction and **let me hear it.**

I look forward to a great year!

