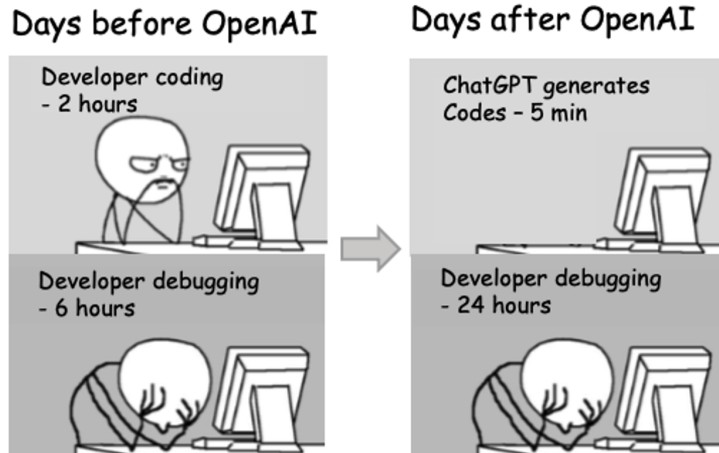


## CSCI 3202

### Lecture 36

November 19, 2025



### Announcements

- Homework 8 is available today
  - Fitting a decision tree model
  - There are code fragments that help you with the work
  - Due Wednesday, December 3, 2025
  - Final homework for semester
  - Remember that you can drop **one** homework
- Interview grading available starting today
  - Link for signup available on Canvas
  - 15 minute interviews
  - Interviews are done on Zoom
  - Share your IDE
  - Run your project and answer questions
  - **We will do interview grading after fall break as well**
- You may resubmit Worked Out Problems (Q13-Q20) only from the midterm for regrading. The points you receive will replace your original score on the midterm. If you do not submit anything, there will be no change in your score. You have until Friday November 21 to submit. No late submissions will be accepted
  - Before calculating your final grade, I will add 5 points to your midterm exam

score due to the length of the exam

- These points will only count towards your midterm score. They will not count as extra credit toward your course grade

### **Final Exam**

- Will be remote ("Take Home") on Canvas
- Time limited to 3 hours once you open the exam
- On paper and in Canvas
- Similar in format to Midterm
- Take a photo of your results and turn in photo(s)
- Comprehensive, but focused mainly on last half of semester
- Will be due at the listed time of our Final, Thursday at 4:00 pm
- No late exams will be accepted

### **Fitting a Decision Tree**

- Fit a decision tree to Titanic Survivors Data
- Uses Entropy instead of Ginni
  - Entropy describes the amount of randomness or uncertainty in a sample
  - The larger the entropy, the more random or uncertain it is
  - Entropy is similar to Ginni, but entropy has very nice mathematical properties
  - <https://www.geeksforgeeks.org/machine-learning/entropy-in-information-theory/>
- Example: <https://erickhangati.com/decision-tree-explained-through-titanic-dataset/>

### **Large Language Models**

- How does ChatGPT Really Work\_ The New York Times.pdf
- I asked ChatGPT to explain how it works for undergraduate students in an Introduction to Computational Thinking course.

Sure! Here's an explanation aimed at undergraduate students in an **Introduction to Computational Thinking** course—no advanced math or machine learning background required.

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## How ChatGPT Works (Conceptually)

ChatGPT is a type of **artificial intelligence** called a **large language model (LLM)**. Its job is to generate text that is useful, coherent, and relevant based on the input it receives. Let's break that down using ideas you're already learning: **abstraction, patterns, algorithms, and data**.

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### 1. ChatGPT Learns Patterns From Lots of Text

Imagine you're learning a new language. You read tons of books, articles, messages, code snippets, and conversations. Over time, you get good at predicting what words or phrases usually come next.

ChatGPT does the same thing—but at a huge scale:

- It is trained on a large collection of publicly available text, licensed text, and data created by human trainers.
- During training, it repeatedly tries to **predict the next word** in a sentence.
- If it's wrong, it adjusts its internal settings (called *parameters*) to improve.

After doing this billions of times, it becomes extremely good at recognizing patterns and producing fluent language.

Think of it as:

***Pattern recognition + probability, learned from lots of examples.***

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## 2. Inside the Model: A Giant Pattern-Matching Machine

ChatGPT is built on a neural network architecture called a **Transformer**. You don't need its math, but conceptually:

- It can **look at all parts** of your input text at once.
- It figures out **which parts depend on each other**.
- It uses that to generate the next piece of text.

You can think of it like a supercharged autocomplete system that can analyze context with incredible detail.

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## 3. Generating a Response Is Like Guided Autocomplete

Once trained, ChatGPT responds to your prompt by:

1. Reading your input.
2. Figuring out what you're asking.
3. Predicting what text (word by word, or token by token) would make the most sense next.
4. Continuing until it forms a complete answer.

It doesn't look up facts the way a search engine does, and it doesn't "know" things like a human. Instead, it uses patterns it learned during training to generate plausible and helpful responses.

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## 4. Human Feedback Helps Improve the Model

After the initial training, humans help improve ChatGPT using a method called **Reinforcement Learning from Human Feedback (RLHF)**.

Trainers:

- Look at pairs of possible answers.
- Choose which one is better.
- Guide the model to produce more helpful, safe, and accurate responses.

This helps the model behave more like a helpful assistant instead of just a raw text generator.

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## 5. What ChatGPT *Isn't*

Understanding limitations is part of computational thinking too.

ChatGPT:

- Does **not** think or understand the world like humans.
- Does **not** have beliefs, consciousness, or intentions.
- Does **not** have real-time access to the internet (unless explicitly given).
- Can sometimes produce incorrect or made-up information (“hallucinations”).

It simply generates text that fits the patterns of human language based on its training.

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## 6. Why ChatGPT Feels So “Smart”

Because language contains a ton of structure and patterns, learning to predict text well accidentally gives the model:

- Basic reasoning ability
- Conversational skills

- Some problem-solving capacity
- The ability to write code, summarize text, or explain ideas

These abilities emerge because the model has absorbed and generalized from huge amounts of text data.

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## Summary for Intro Computation Students

- **Data:** It trains on huge amounts of text.
- **Pattern Recognition:** It learns statistical patterns in language.
- **Algorithm:** Uses a Transformer to predict the next word/token.
- **Abstraction:** It represents meaning using thousands of learned internal features.
- **Feedback Loops:** Humans guide it to be more helpful and safe.
- **Limitation Awareness:** It doesn't "understand" like humans—it generates text probabilistically.

### Deeper Dive on ChatGPT architecture

- <https://www.zdnet.com/article/how-chatgpt-actually-works-and-why-its-been-so-game-changing/>

### Upcoming

- Transformer architecture
  - <https://www.datacamp.com/tutorial/how-transformers-work>
  - <https://www.geeksforgeeks.org/deep-learning/architecture-and-working-of-transformers-in-deep-learning/>
  - Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., ... & Polosukhin, I. (2017). Attention is all you need. Advances in neural information processing systems, 30.
- Quiz on Neural Networks
- Fall Break!