



COMPSCI 389

Introduction to Machine Learning

Introduction to Machine Learning

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What is machine learning (ML)?

- Subfield of *artificial intelligence* (AI)

“AI is a field concerned with intelligent behavior in ~~artifacts~~.”

– Nilsson 1998

Like math, physics or theology

- AI is not a thing/object.
- The thing/object using AI methods is called an agent.
 - Agent: Something that acts, from Latin *agere*, which means “to do.”
 - E.g., a robot, software program, or collection of matchboxes (with rules)

What is machine learning (ML)?

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*“AI is a **field** concerned with intelligent behavior in **agents**.”*

~ Nilsson 1998

- What is intelligent behavior?
 - No agreed upon definition.
 - ~~How then do we know when we have created an AI?~~
 - How then do we know whether a topic belongs in the AI field?
 - Consensus.
 - Not always obvious or intuitive.
 - Not always agreed upon.

Bad question:
AI is not a thing/object

Questions

- Is soccer a sport?
- Is chess a sport?
- Is rebooting computers a sport?

- Notice that we determine whether something is a sport or not by consensus.
- How can we use the word “sport” if it’s not well defined?
 - If we think there’s ambiguity, we clarify our statements.
- The term “AI” is like “sport” in this way.

Example: Program A

- **Input:** Easy to read source code

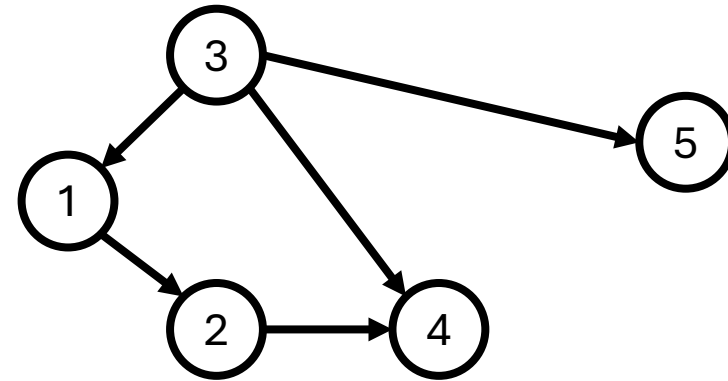
```
while (value < 100)
    item = 10
    value = value + item
```

- **Output:** Fast to run source code

```
while (value < 100)
    value = value + 10
```

- **Question:** Can you produce even more efficient code?
- **Answer:** `value = 100 + (value mod 10)`
- **Question:** Does Program A exhibit intelligent behavior?
- **Answer:** No right/wrong answer. I would say “yes.”
- **Question:** Does the study of programs like this fall within AI?
- **Answer:** The general consensus is “no.”
 - This is part of compilers \subset programming languages \subset systems.

Example: Program B



$$V = \{1,2,3,4,5\}$$

$$E = \{(1,2), (2,4), (3,1), (3,4), (3,5)\}$$

$$s = 1$$

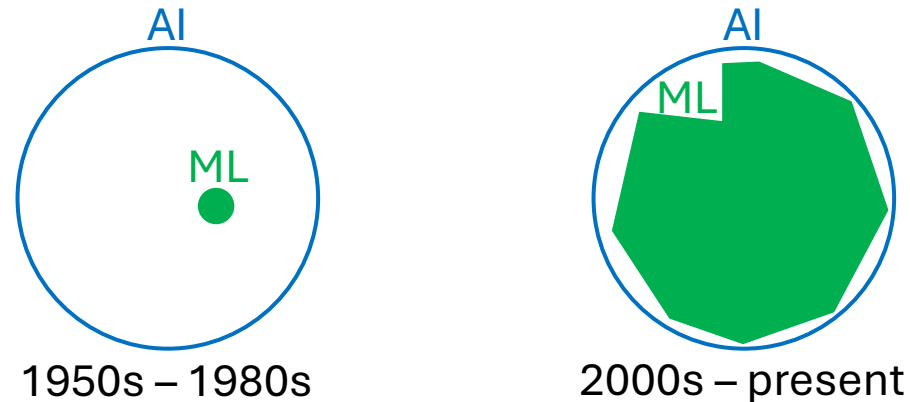
$$g = 5$$

- **Inputs:**
 - A directed graph (V, E)
 - A vertex $s \in V$ (start)
 - A vertex $g \in V$ (goal)
- **Output:** Does there exist a path from s to g ? (Yes/No)
- **Question:** Does Program B exhibit intelligent behavior?
- **Answer:** No right/wrong answer. I would say “no”.
- **Question:** Does the study of programs like this fall within AI?
- **Answer:** Yes! This is a “search” algorithm.

*AI is a **field** concerned with “intelligent behavior” in **agents**.*

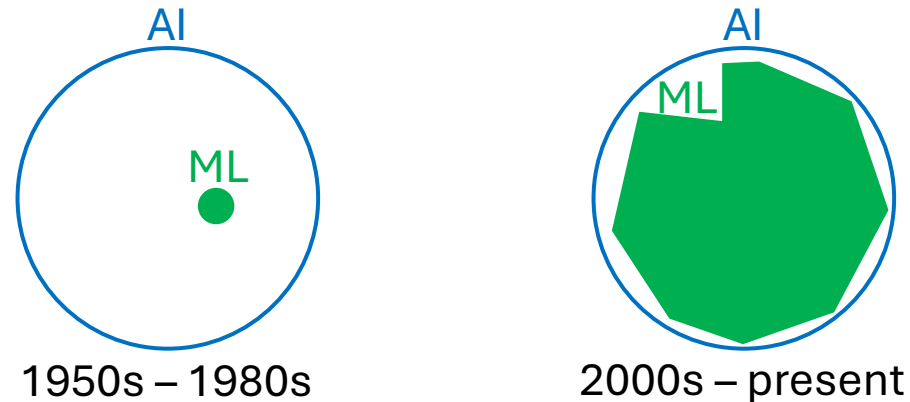
- Don't get stuck on the name “artificial intelligence” including “intelligence”.
 - Is “computer science” only about computers?
- Rule of thumb: Be inclusive!
 - Avoid arguments saying, “this doesn't belong in AI because it's not about intelligent behavior.”

ML is a subfield of AI



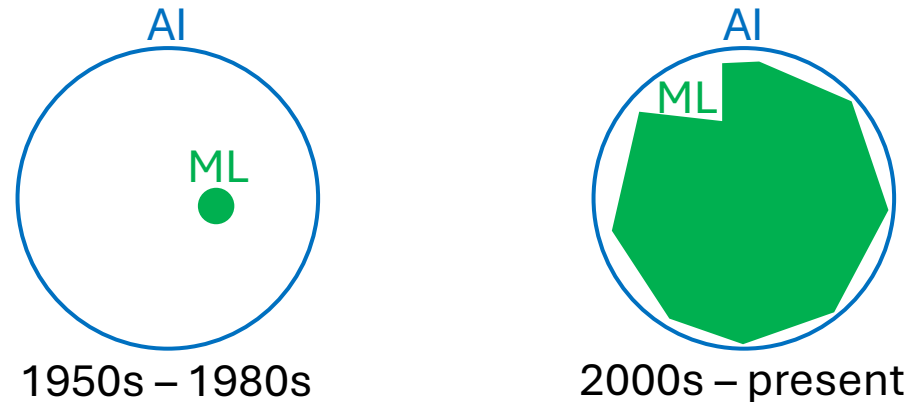
- ML is a subfield of AI “*concerned with the question of how to construct computer programs that automatically improve with experience.*” [Tom Mitchell, 1997]

ML is a subfield of AI



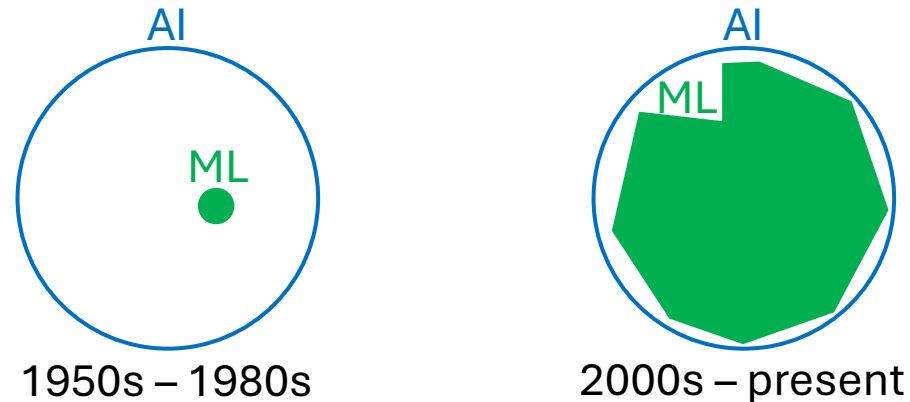
- ML is a subfield of AI “*concerned with the question of how to construct computer programs that automatically **improve** with experience.*” [Tom Mitchell, 1997]
- **Improve = learn**

ML is a subfield of AI



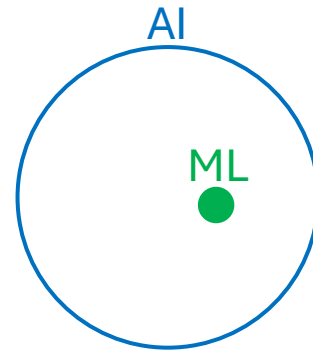
- ML is a subfield of AI “*concerned with the question of how to construct computer programs that automatically **improve** with **experience**.*” [Tom Mitchell, 1997]
- Improve = learn
- Experience = data

ML is a subfield of AI

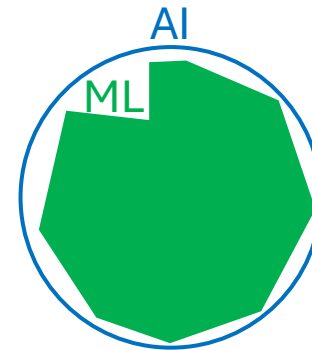


- ML is a subfield of AI “*concerned with the question of how to construct ~~computer~~ programs that automatically **improve** with **experience**.*” [Tom Mitchell, 1997]
- Improve = learn
- Experience = data
- Computer = unnecessary

ML is a subfield of AI



1950s – 1980s



2000s – present

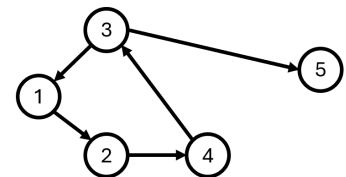
- ML is a subfield of AI concerned with the question of how to construct programs that learn from data.
- **Question:** Does Program B fall within ML?
- **Answer:** No. It doesn't learn from data.

Example: Program B

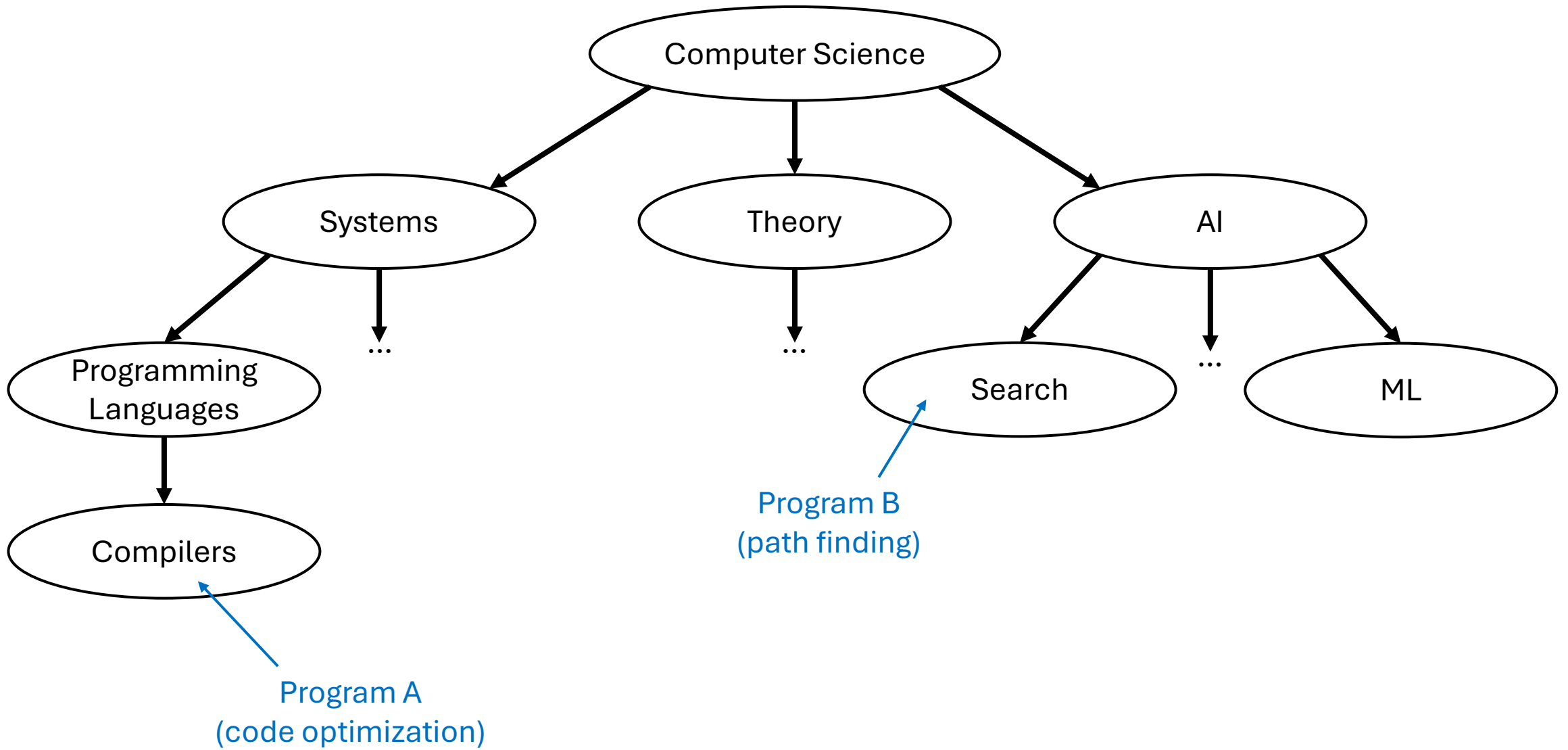
- **Inputs:**

- A directed graph (V, E)
- A vertex $s \in V$ (start)
- A vertex $g \in V$ (goal)

- **Output:** Does there exist a path from s to g ? (Yes/No)



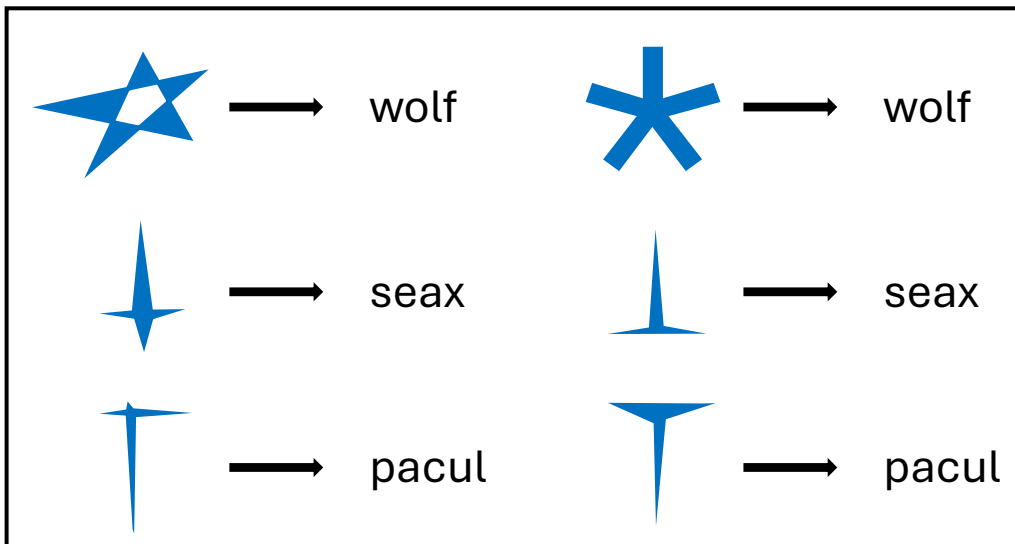
$V = \{1, 2, 3, 4, 5\}$
 $E = \{(1, 2), (2, 4), (4, 3), (3, 1), (3, 5)\}$





Example: Program C


- **Input:**
 - Data: Images of handwritten letters with labels.
 - Query: An image of a letter.
- **Output:** Prediction of the label for the query.

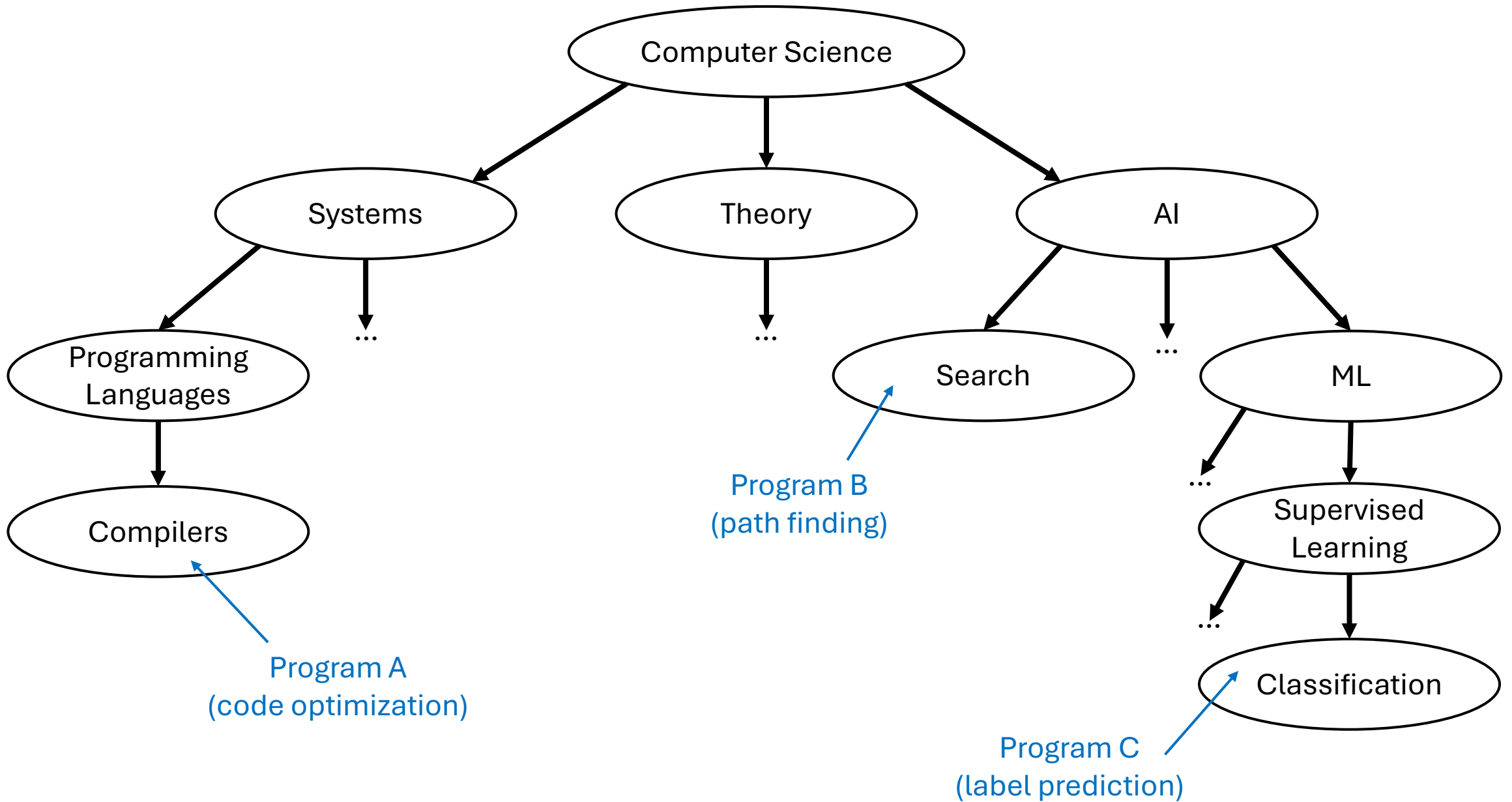
Data



Query 1: 

Query 2: 

Query 3: 



Summary

- **Artificial Intelligence (AI):** Field concerned with agents that exhibit intelligent behavior.
- **Machine Learning (ML):** Subfield of AI concerned with agents that learn from data.
- These distinctions are vague, but they provide some structure for thinking about different types of programs and algorithms we might want to create.

I would like to create a program that takes as input video captured from a camera on a car, and outputs a prediction of whether there are any pedestrians near the car, and if so, where they are.

I have gathered thousands of hours of video recording, and hired people to manually label where pedestrians are at all times.

Question: Is the program I create an ML program?

Question: What if I have thousands of hours of video, but no labels describing where pedestrians are?

I want to create a program that takes as input the rules of a board game, like chess. When presented with a state of the game, it should then be able to produce as output a prediction of what the best move would be.

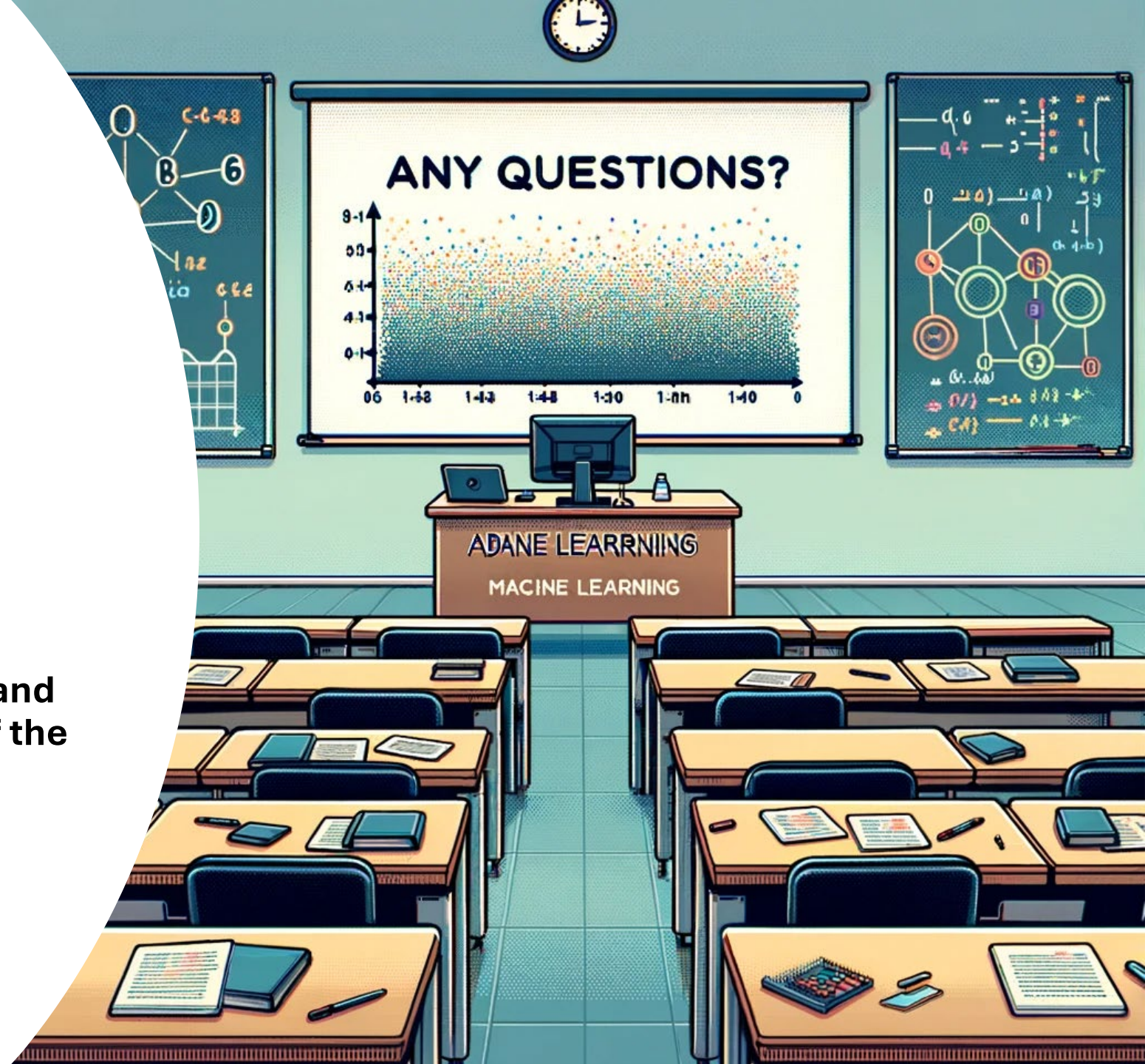
Question: Is this program an ML program?

I have access to millions of games played by strong players, and I want to use this data to create a program that plays like humans by predicting the move that a player would have made.

Question: Is this program an ML program?

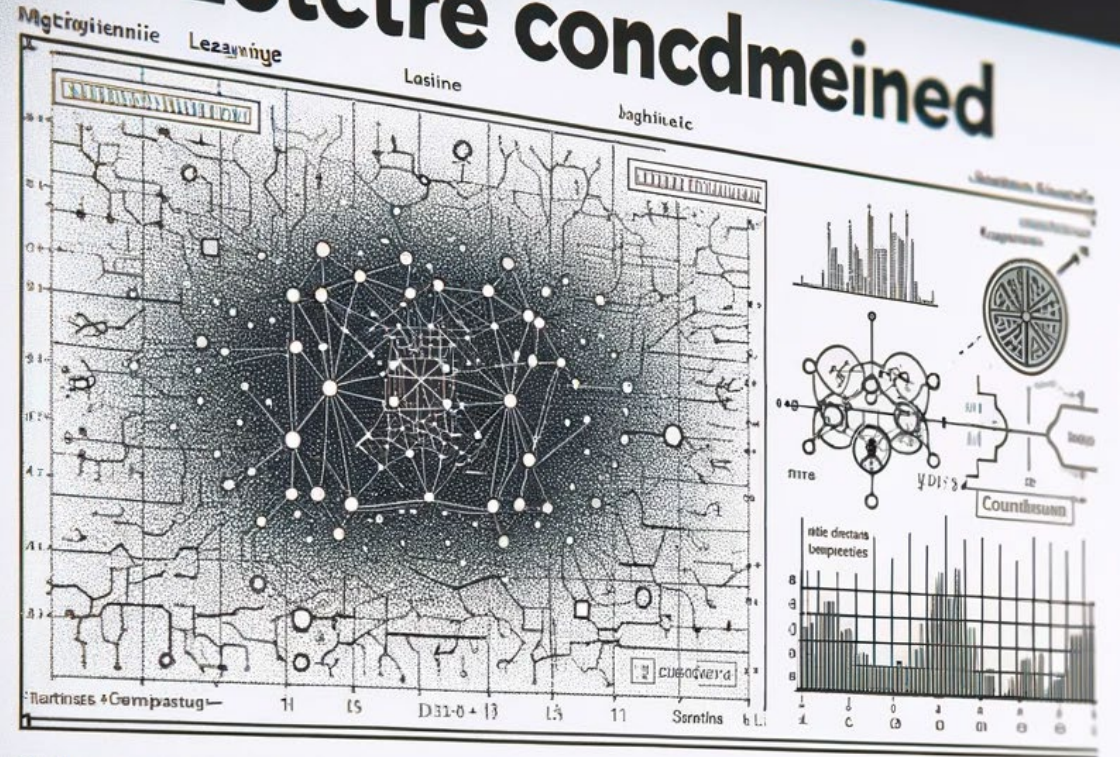
Intermission

- Class will resume in 5 minutes.
- Feel free to:
 - Stand up and stretch.
 - Leave the room.
 - Talk to those around you.
 - **Write a question on a notecard and add it to the stack at the front of the room.**



End

Letctre concdmeined



Thank you.