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~~ agents."

  – Nilsson 1998

Like math, physics or theology

- AI is not a thing/object. [Note: Trends shifting though!]
- 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)?

- Subfield of *artificial intelligence* (AI)

  "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

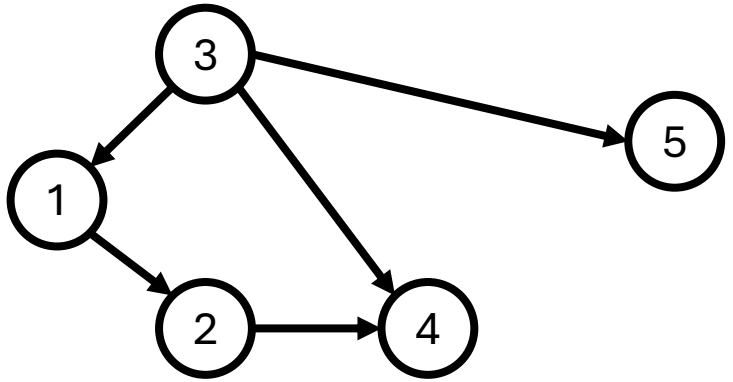
```
while (value < 100)
        value = value + 10
```

- **Question**: Can you produce even more efficient code?
- **Answer**:

```
if (value < 100)
        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 ⊂ programming languages ⊂ systems.

Example: Program B



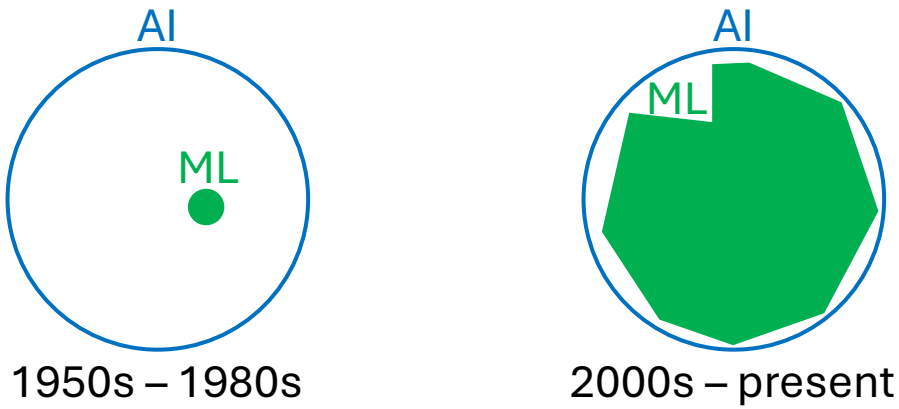
$V = \{1,2,3,4,5\}$
$E = \{(1,2), (2,4), (3,1), (3,4), (3,5)\}$
$s = 1$
$g = 5$

- **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.

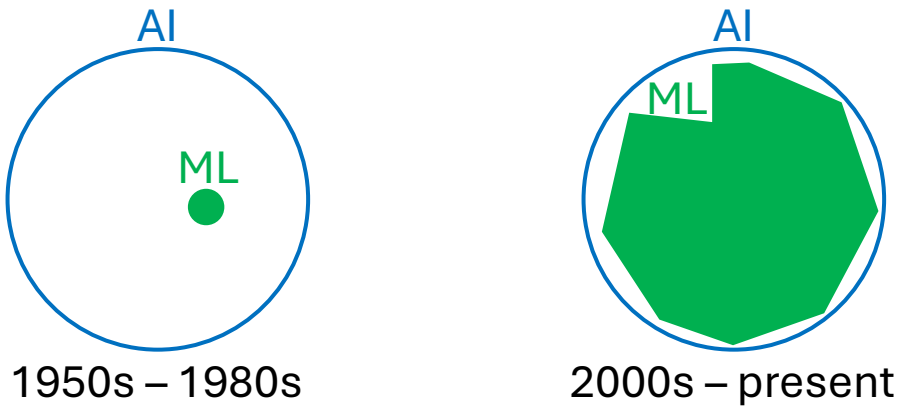
- Don't get stuck on the name "artificial intelligence" including "intelligence".
  - Is "computer science" only about computers?
- Rule of thumb: Be inclusive!
  - Avoid arguments saying, "this doesn't belong in AI because it's not about intelligent behavior."

ML is a subfield of AI



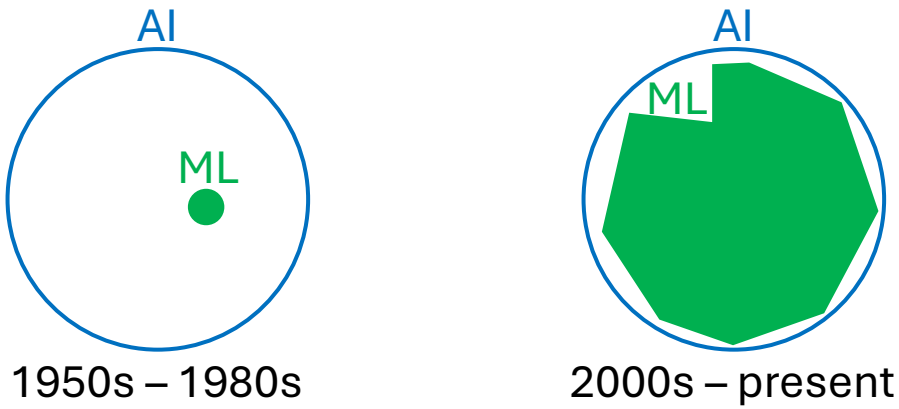
- ML is a subfield of AI "*concerned with the question of how to construct computer programs that automatically improve with experience.*" [Tom Mitchell, 1997]

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



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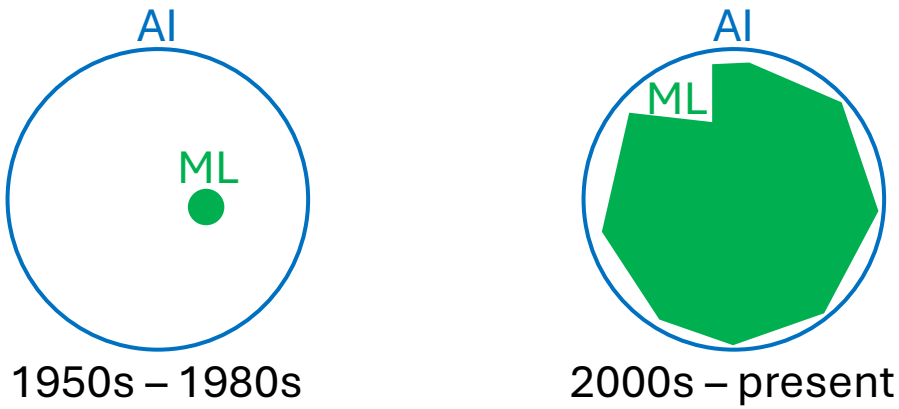
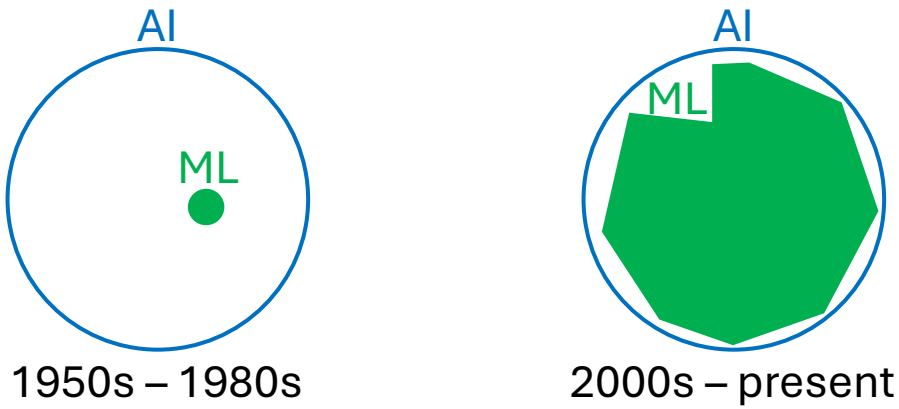
- Improve = learn
- Experience = data

ML is a subfield of AI



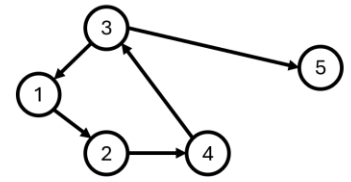
- ML is a subfield of AI "*concerned with the question of how to construct ~~computer~~ programs that automatically improve with experience.*" [Tom Mitchell, 1997]
- Improve = learn
- Experience = data
- Computer = unnecessary

ML is a subfield of AI



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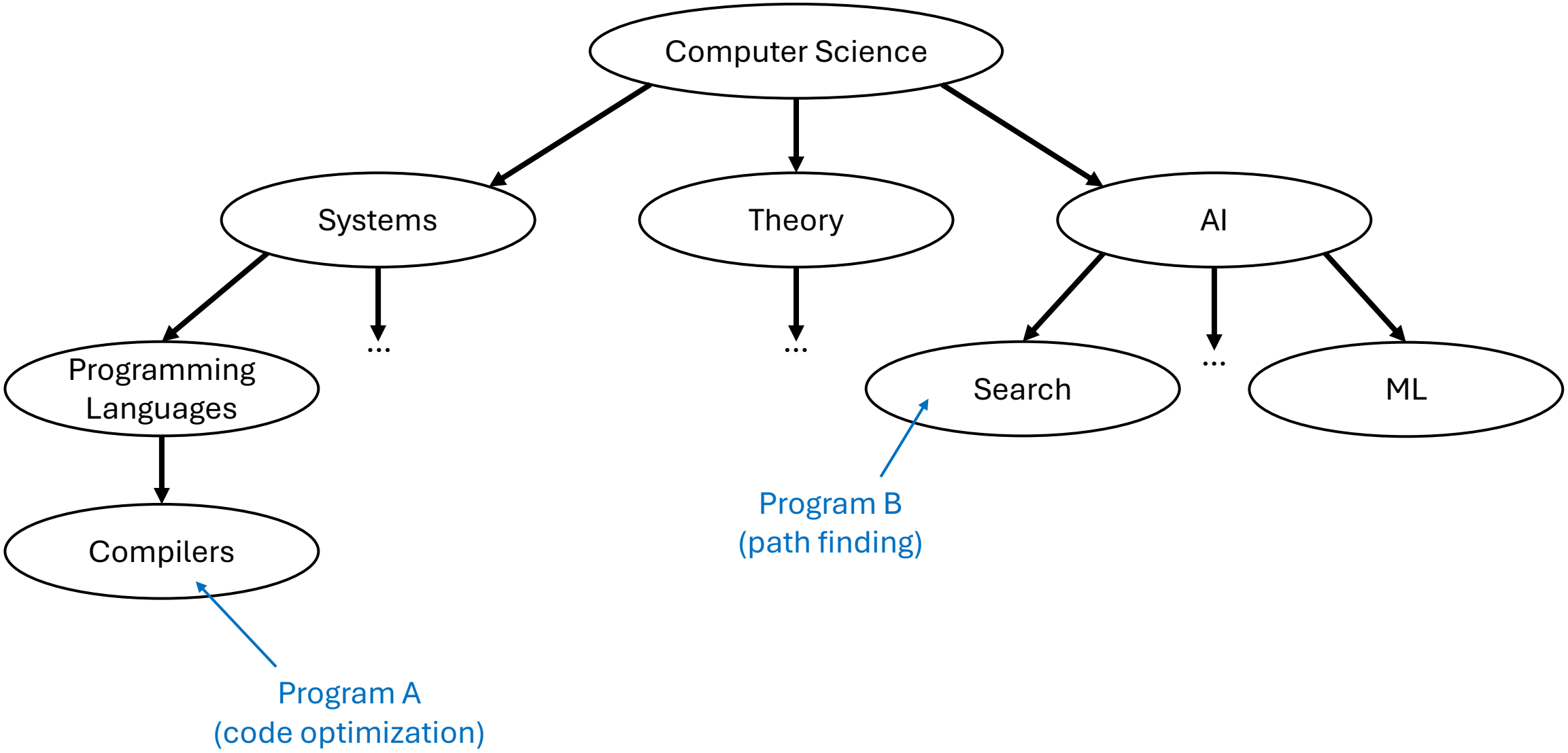
$V = \{1,2,3,4,5\}$

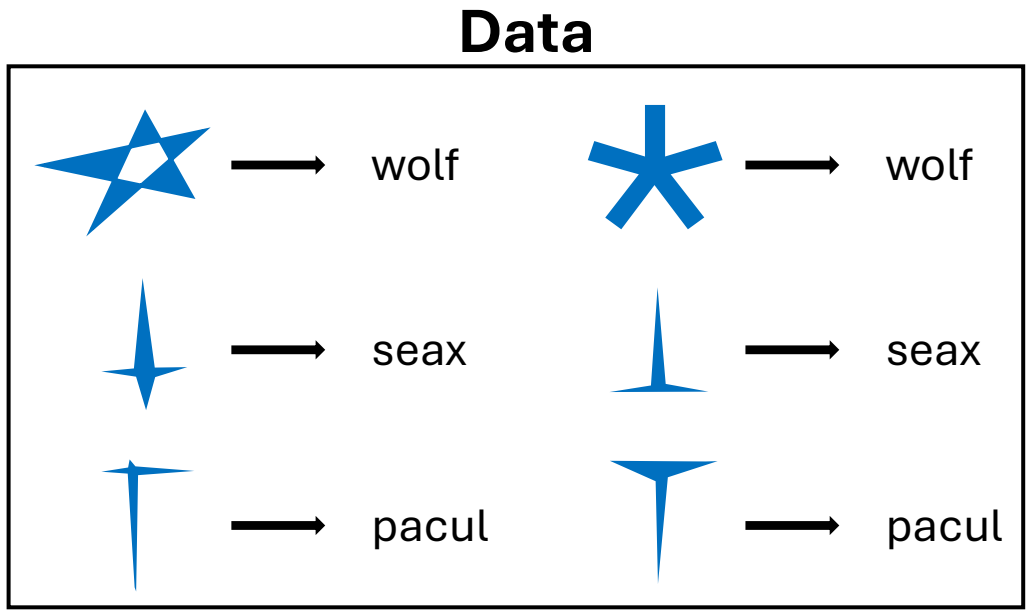
$E = \{(1,2), (2,4), (4,3), (3,1), (3,5)\}$

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


Computer Science
Systems
Theory
AI
...
...
...
Programming Languages
Search
ML
Compilers
Program B
(path finding)
Program A
(code optimization)

Example: Program C

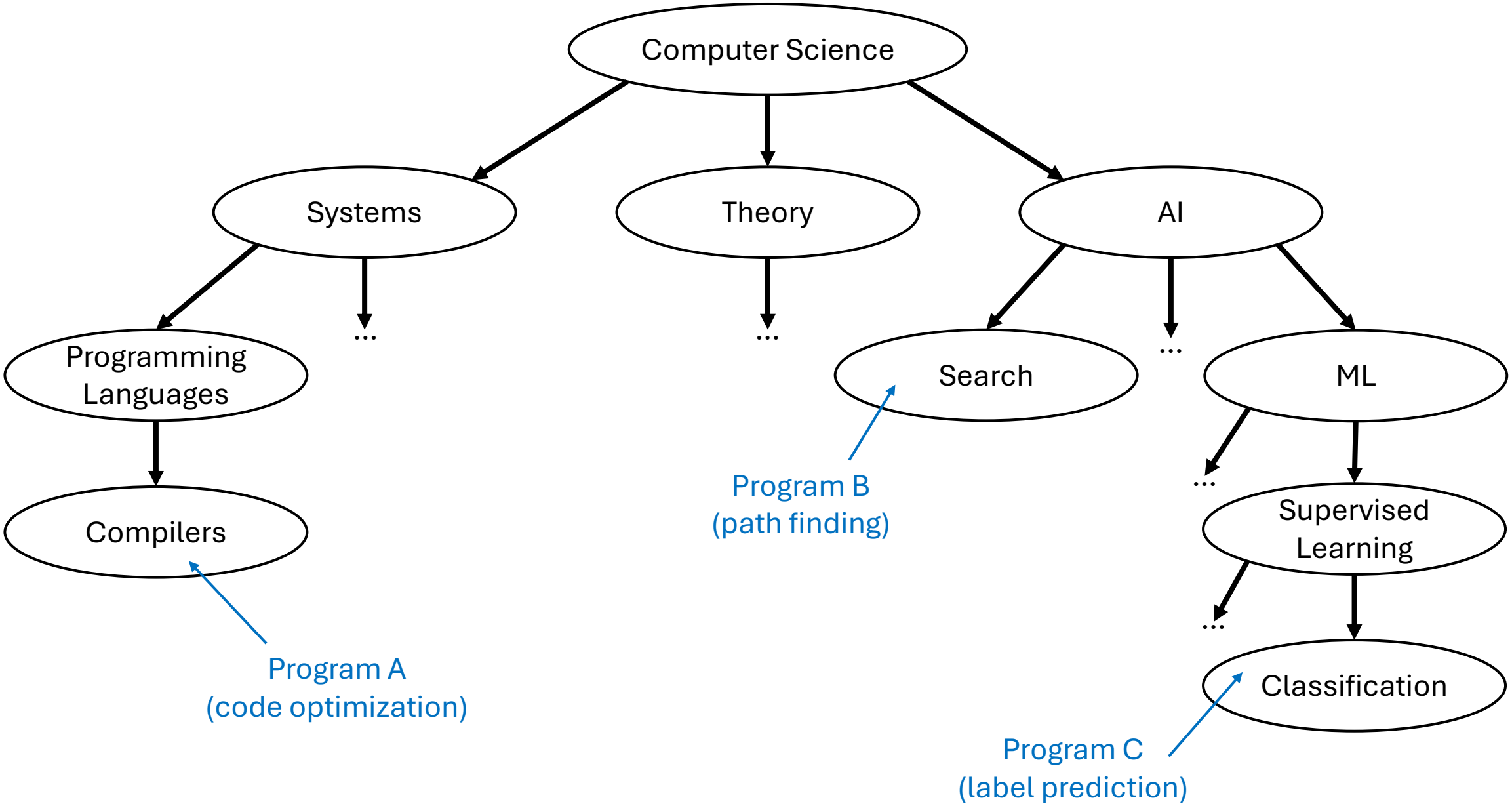
- **Input**:
  - Data: Images of handwritten letters with labels.
  - Query: An image of a letter.
- **Output**: Prediction of the label for the query.



Query 1: 

Query 2: 

Query 3: 


Computer Science
Systems
Theory
AI
...
...
...
Programming Languages
Search
ML
...
...
...
Compilers
Supervised Learning
...
Classification
Program A
(code optimization)
Program B
(path finding)
Program C
(label prediction)

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?

End