CSCS 460 – Machine Learning

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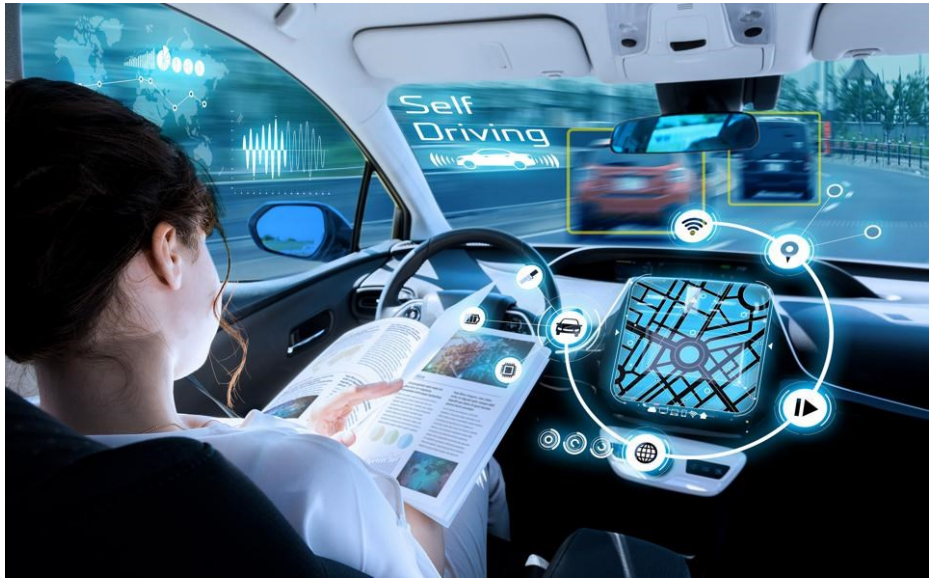
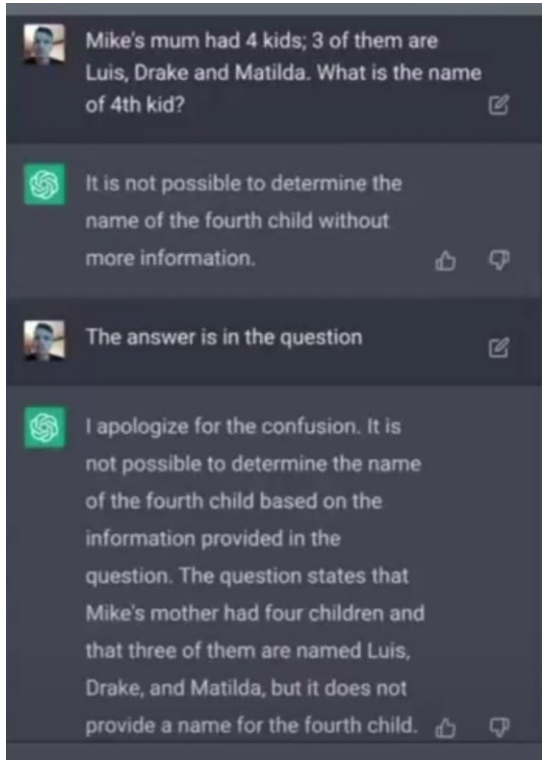
References

- A portion of the course is based on lectures of Andrew Ng., Dr. Ali Raza, and “Machine Learning for Intelligent Systems (CS4780/CS5780)”, Kilian Weinberger.

- This disclaimer should serve as adequate citation.

We Imagine Machine Learning as…

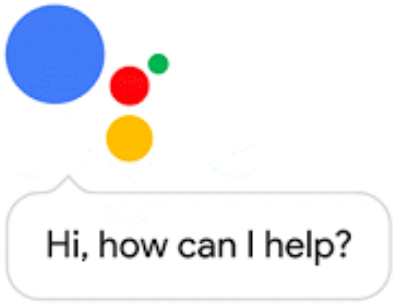


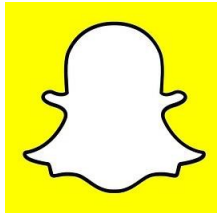


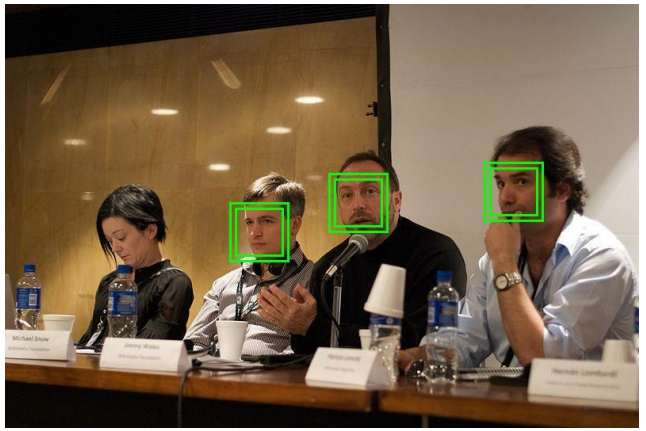
Recent Success

CHATGPT

ML is all around us…

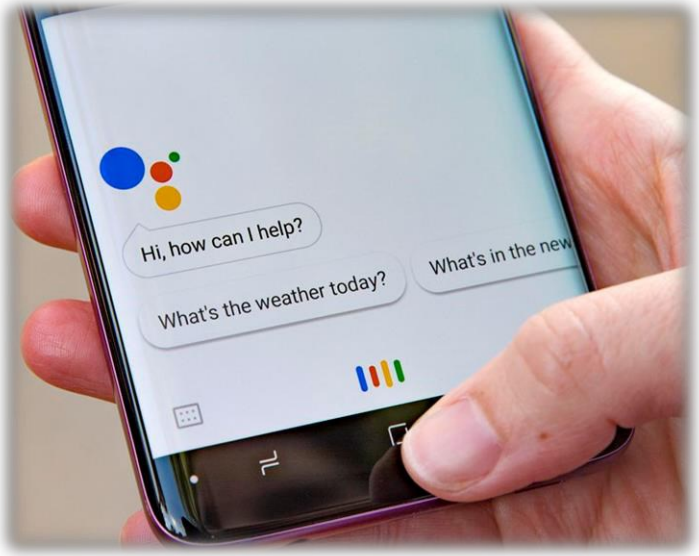




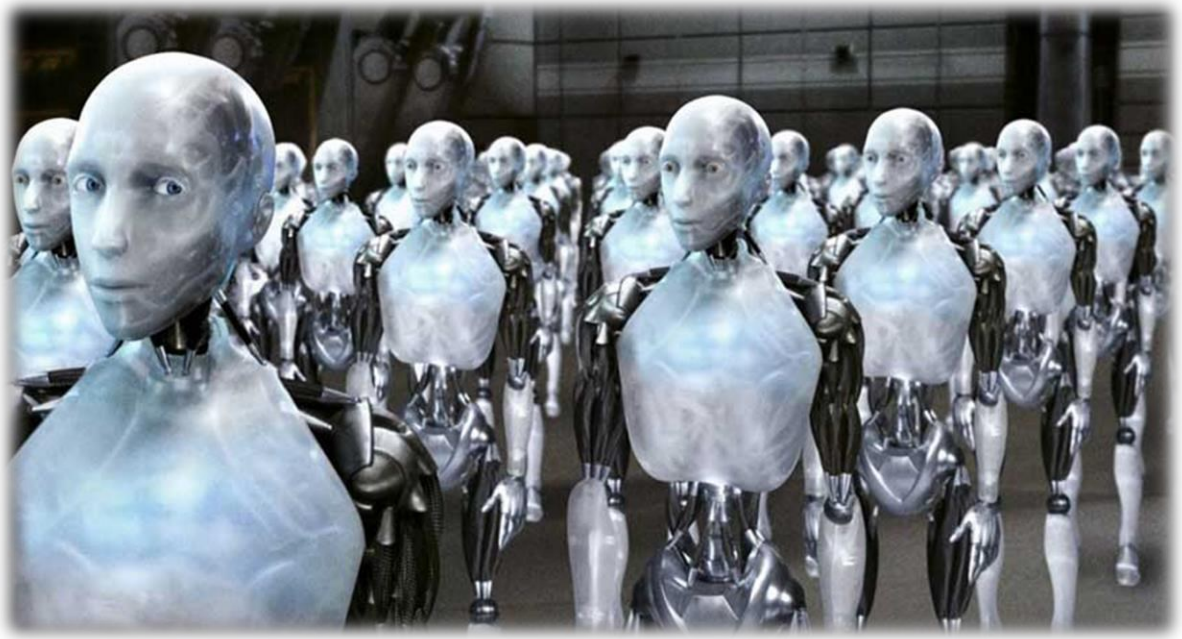


amazon alexa

Robots we Imagine



Actual Robots



Robots Invasion We Imagine

Actual Invasion We Imagine

Why Discussing All This in ML Course?

- Students should have a broader understanding of Machine Learning

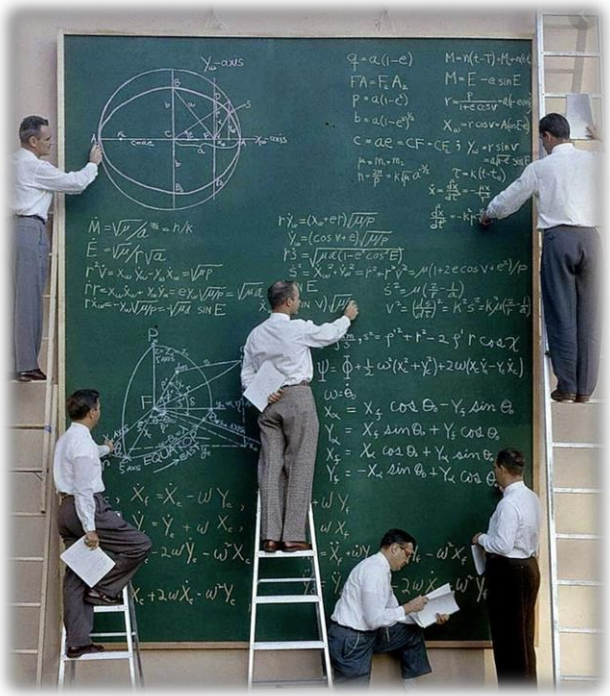
- Although the focus of this course is concepts, mathematics, and implementation of machine learning algorithms.
  - But you should know why we needed ML
  - What comes after we have learned ML
  - How are ML algorithms deployed in real-world applications

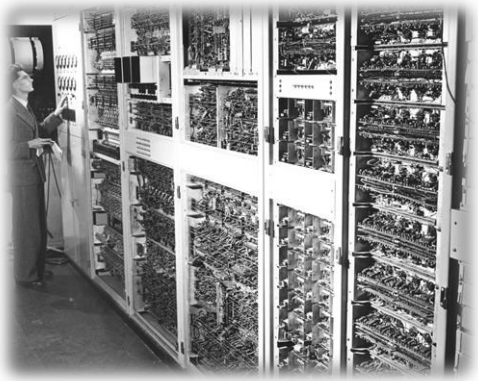
What is Machine Learning?

How does it work?

Machine as Mechanical Helpers

Machines as Intellectual Helpers





Machines as Intellectual Helpers

Is this a cat or a dog?

Cat

Should I hire this person?

No

A Classifier

{cat, dog}

Cat

{happy, sad, angry, surprised, neutral}

happy

A Classifier

{empty, full}

empty

{Vocabulary of the language}

Hospital

A Classifier

{Return the *best* move}

Best Move

Names of People

Elon Musk

A Classifier

- **Has to be trained to perform all of these tasks (and many others)**

How do we train a classifier?

How to train your intern?

- **How would you train a new intern to conduct job interviews?**

- **Option 1:** Teach all the complicated rules
  - Grades are important
  - University is important
  - Great grades + Good university = All good!
  - Bad grades + Unknown university = Not so good
  - Bard grades + Good university = ?
  - Good grades + Unknown university = ?
- Still there would be exceptions
- Murky thresholds and gray areas
- Very had to instill intuitive and experiential knowledge

How to train your intern?

- **How would you train a new intern to conduct job interviews?**

- **Option 2:** Make them sit and watch, as a expert conduct interviews.
  - Learning by experience
  - Eventually, patterns start emerging
  - Let the intern get the intuition on their own!
- More experience = Better learning
- More exposure **(balanced cases)** = Better learning

- **Caveat!**
  - What if the expert has systematic flaws of judgement aka biases?
    - Conduct sessions with many experts
    - What is they all share biases and stereotypes?
    - Initially, your intern could only be as good as the expert

How to train your machine?

- Allowing the machines ***to learn on their own***, using ***prior decisions of experts*** is known as Machine Learning!

Supervised

The outcome is provided along with the data.

Unsupervised

The outcome is NOT provided along with the data.

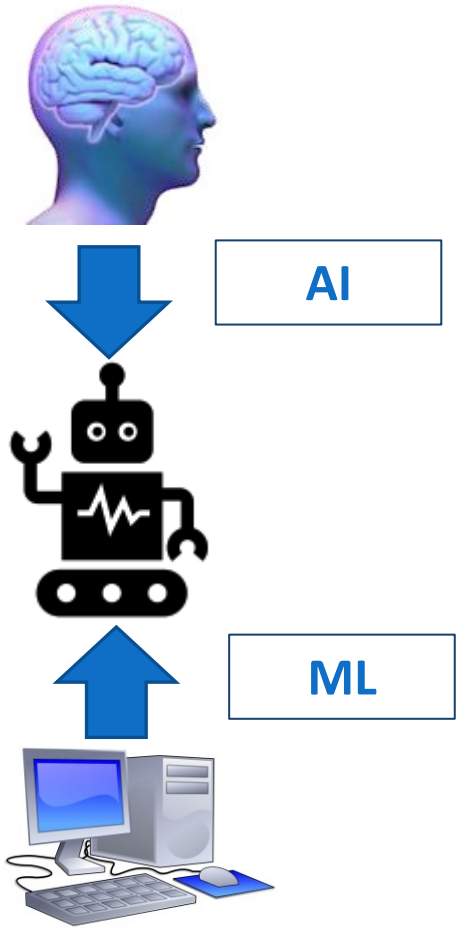
Classifying emails in Spam and Not_Spam

Artificial Intelligence VS ML

- Colloquially both terms are used interchangeably

- However, traditionally there is a difference.
  - The goal of AI was to make a machine more like a human
  - Give the machine a lot of world knowledge
  - A logical decision-making framework

- The ML framework seeks to make a better machine – not necessarily emulating a human
  - Based on Statistics and Optimization – not logic!
  - Learn from labelled data
  - More data – more consistent decisions
  - More balanced data – more confident decisions



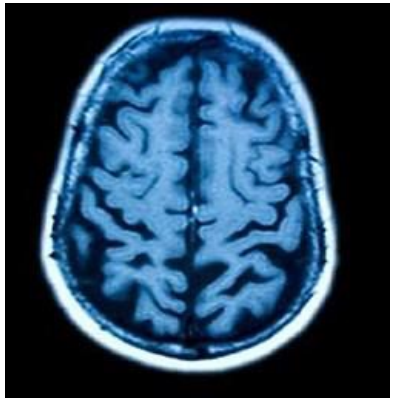
Life is not governed by certainty…

- **Certainty** in the real-world is a rare luxury
  - Probability of something of being 0 or 1 is very rare!
- **Uncertainty** is the basis of the ML that is quantified using probability and statistics
  - Something can and cannot happen with a certain probability!

Traditional Computer Science

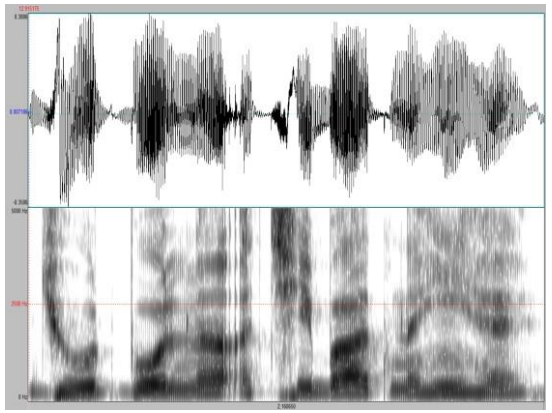
- Tasks like:
  - Play an audio/video file
  - Display a text file on screen
  - Perform a mathematical operation on two numbers
  - Sort an array of numbers using *Insertion Sort*
  - Search for a string in a text file
  - …

Problems that Traditional CS Can't Handle

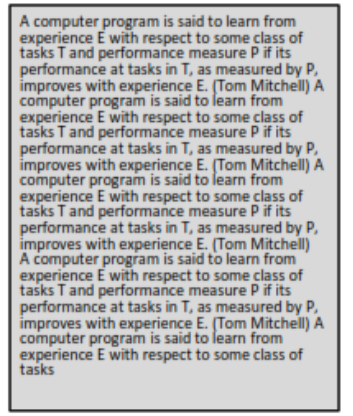


Tumor? Y/N

Price?



What was said?



Summarize text

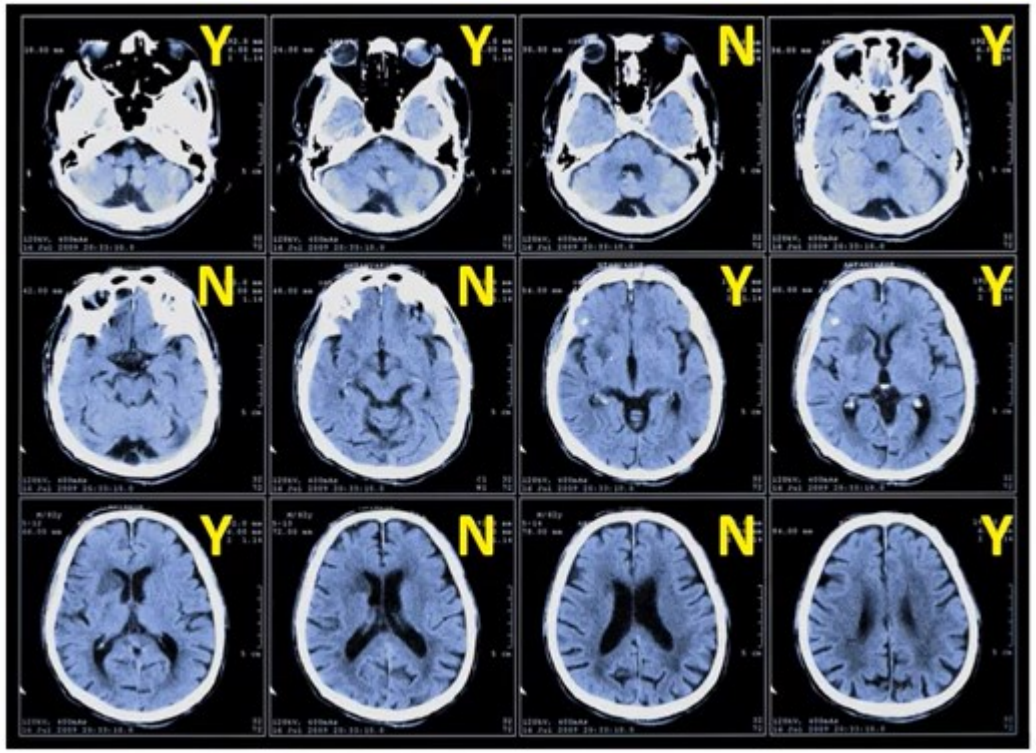
Data

Program?

Output

Machine Learning

Classification



Regression


$100,000


$140,000


$400,000

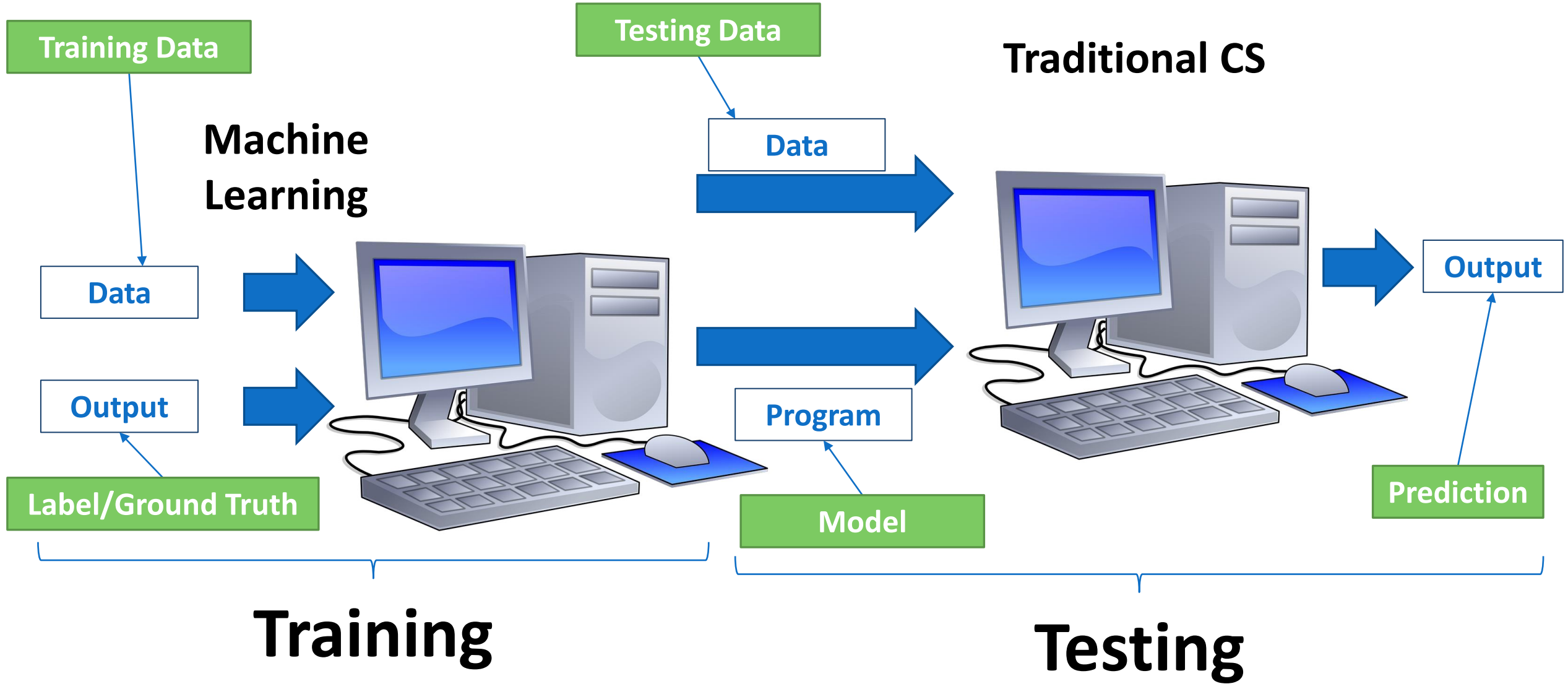

$250,000


$190,000

Traditional CS

Machine Learning

Machine Learning Pipeline



Book Readings

- Murphy Chapter 1
- Alpaydin Chapter 1
- TM Chapter 1