

Computer Vision: Fall 2022 — Lecture 1

Dr. Karthik Mohan

Univ. of Washington, Seattle

September 29, 2022

Instruction Team



Karthik



Ayush
(TA)

Fahim
(Grader)

Motivation

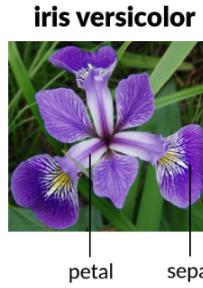
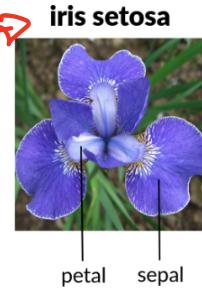
Computer Vision

The field of Computer vision has made a lot of advances in the past decade with the advent of deep learning. Problems previously considered intractable not only have a solution in computer vision but also see implementation in the real world (e.g. self driving cars, terrain navigation, etc). The course will introduce applications and methods side by side. We will start with basic concepts in human and computer vision, learn building blocks for vision and proceed towards machine learning methods for CV. Towards the end of the course, we will also look at state of the art deep learning methods for different vision problems including: image classification, medical image detection (MRI analytics), automated captioning of images, image segmentation, handwriting recognition and perhaps more. The course will have a combination of conceptual and hands-on programming assignments with a focus on learning how to think in vision and developing intuition, and hands-on experience in this space.

Applications



Medical Imaging



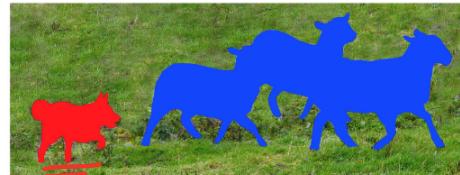
} Assigned 2

Classification and Segmentation

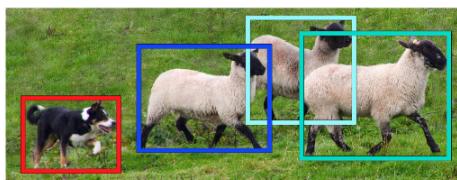
Multi-class
prob.



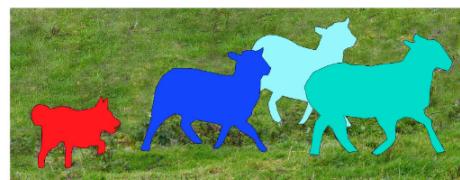
Image Recognition



Semantic Segmentation

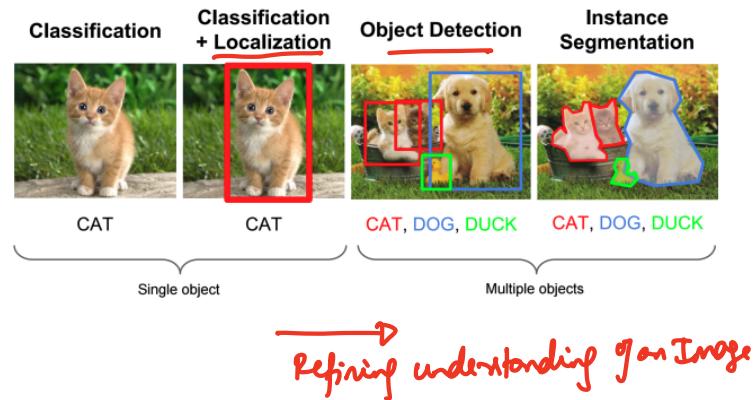


Object Detection



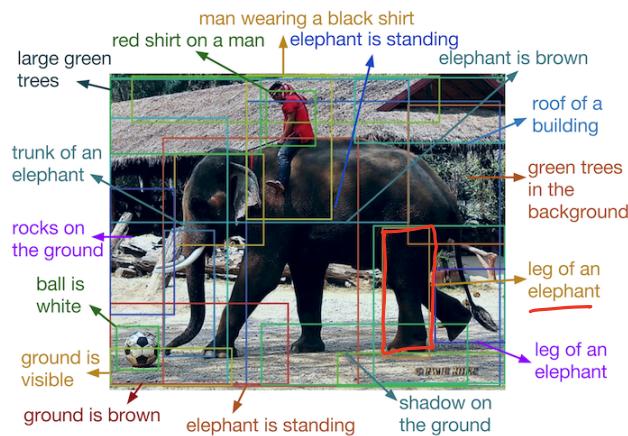
Instance Segmentation

Classification and Segmentation



Advanced Applications of CV

Image to Text



$Cv \rightarrow NLP$

Image Captioning (Image to Text)



Computer Vision
Cloud API



Enter your cloud subscription key:

Enter image URL:

Analyze Image

```
],
  "captions": [
    {
      "text": "a elephant that is standing in the grass",
      "confidence": 0.9489147002901379
    }
  ]
}
```

Text to Image

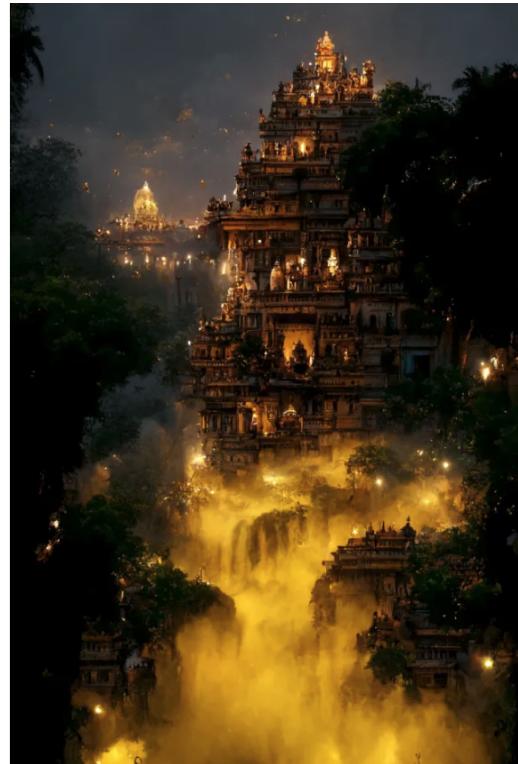
Ancient India with ornate temples, waterfalls, and fireflies



Explore Mid Journey Research Paper on Text to Image

Text to Image

Ancient India with ornate temples, waterfalls, and fireflies



Research Paper on Text to Image

Text to Image

Ax-oh-what?



Text to Image

Axolotl!



AI



real

Text to Video (Latest Innovation!)

Make a Video

[Text to Video!!](#)

[Research Paper](#)

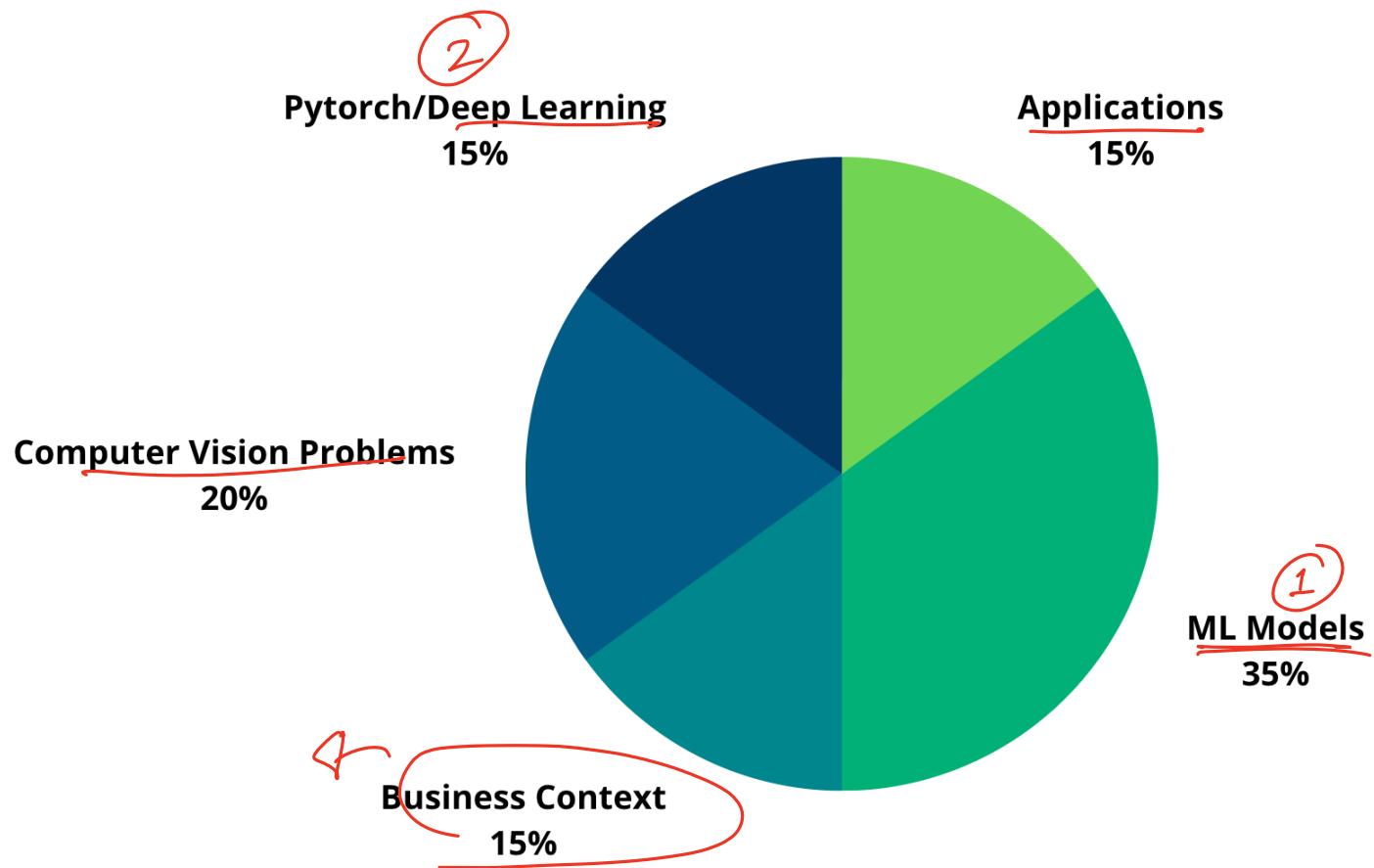
Computer Vision Problem Spaces we will ~~touch~~ ^{touch} on

- ① Image de-noising
- ② Image smoothing
- ③ Image Classification
- ④ Object Detection
- ⑤ Semantic Segmentation
- ⑥ Instance Segmentation (maybe)
- ⑦ Image Embeddings
- ⑧ Image to text
- ⑨ Image Captioning
- ⑩ Text to Image (high-level)

Pre-Course Survey Results

Survey

Break-down of course

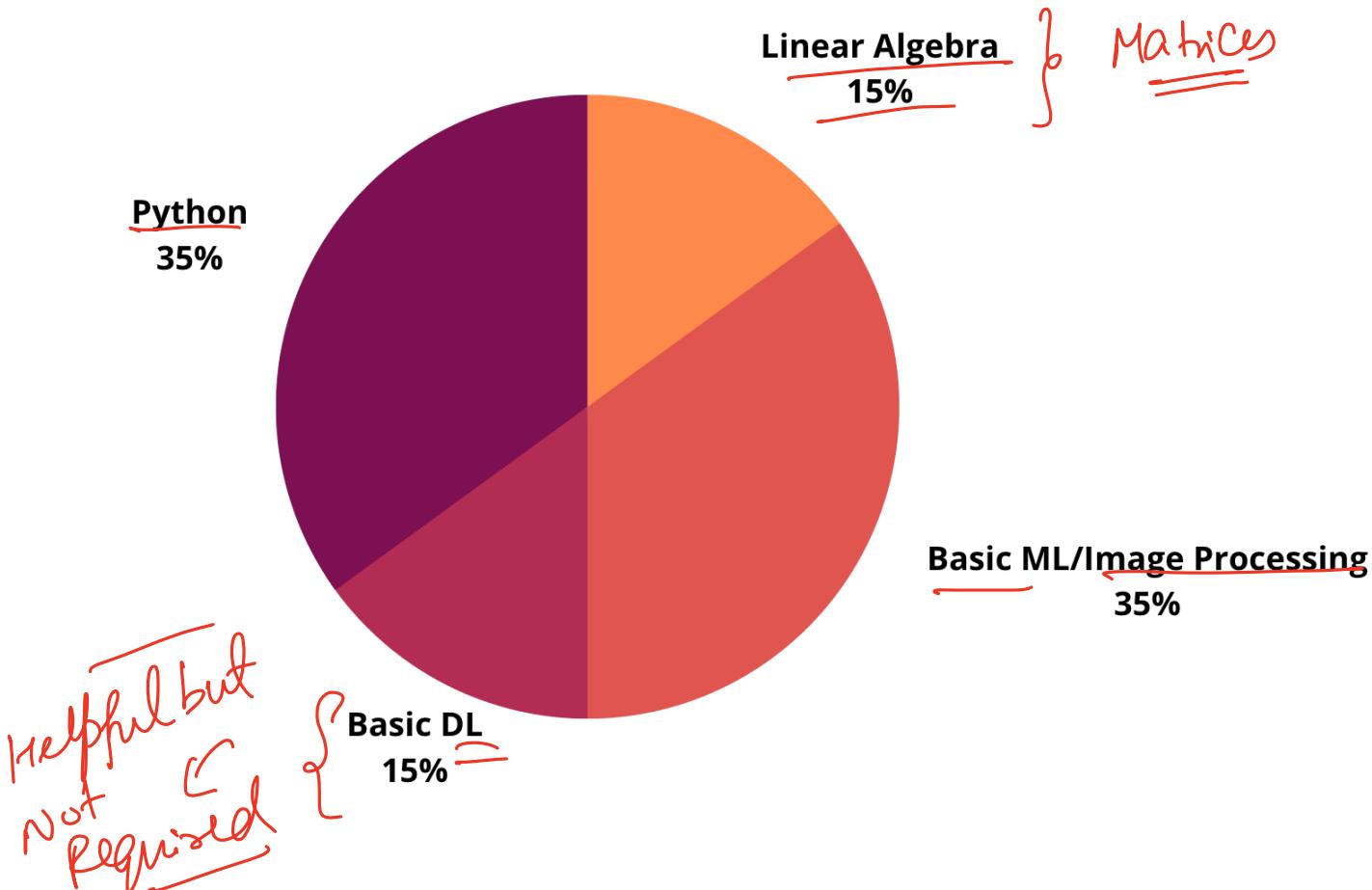


Syllabus

Week by Week

| Week | Topic |
|------|---|
| 1 | Motivation and applications of CV |
| 2 | Transforms, Convolutions and feature extraction |
| 3 | Machine Learning for CV |
| 4 | Machine Learning for CV |
| 5 | Neural Networks & <u>CNN</u> |
| 6 | Pytorch Tutorial and libraries <i>semantic</i> |
| 7 | <u>Object detection and instance segmentation</u> |
| 8 | <u>Deep Learning applications in CV</u> |
| 9 | <u>Image to Text and Text to Image</u> |
| 10 | More Deep Learning applications in CV |

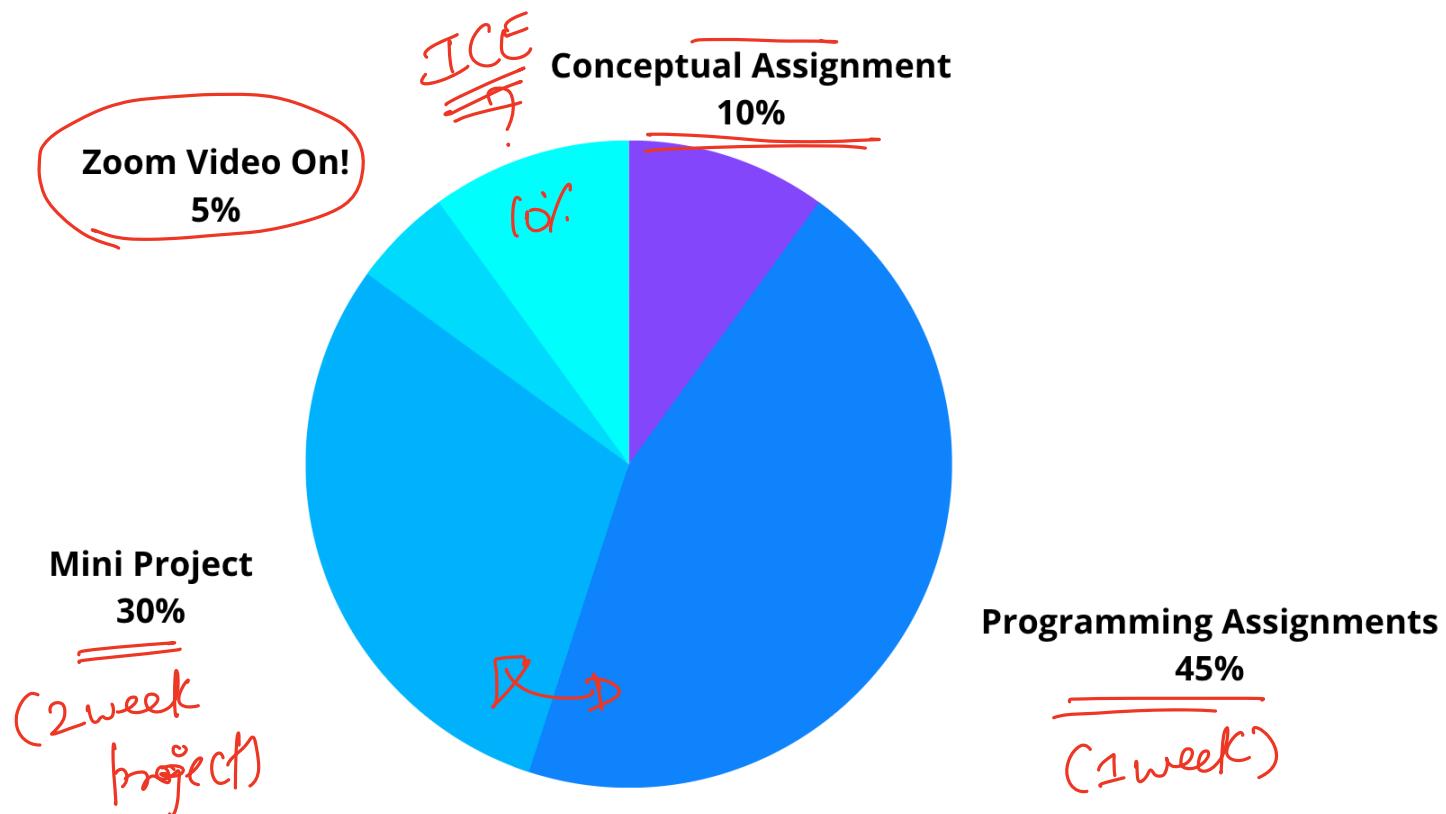
Pre-requisites



(Heads Up) Advanced Intro to ML - Taught in Winter 2023

| Week | Lecture Material | Assignment |
|------|--------------------|--|
| 1 | Linear Regression | Housing Price Prediction |
| 2 | Classification | Spam classification (Kaggle) |
| 3 | Classification | Flower/Leaf classification |
| 4 | Clustering | MNIST digits clustering |
| 5 | Anomaly Detection | Crypto Prediction (Kaggle + P) |
| 6 | Data Visualization | Crypto Prediction (Kaggle + P) |
| 7 | Deep Learning | Visualizing 1000 images |
| 8 | Deep Learning (DL) | ECG Arrhythmia Detection |
| 9 | DL in NLP | TwitterSentiment Analysis (Kaggle + P) |
| 10 | DLs in Vision | TwitterSentiment Analysis (Kaggle + P) |

Assessments Breakdown

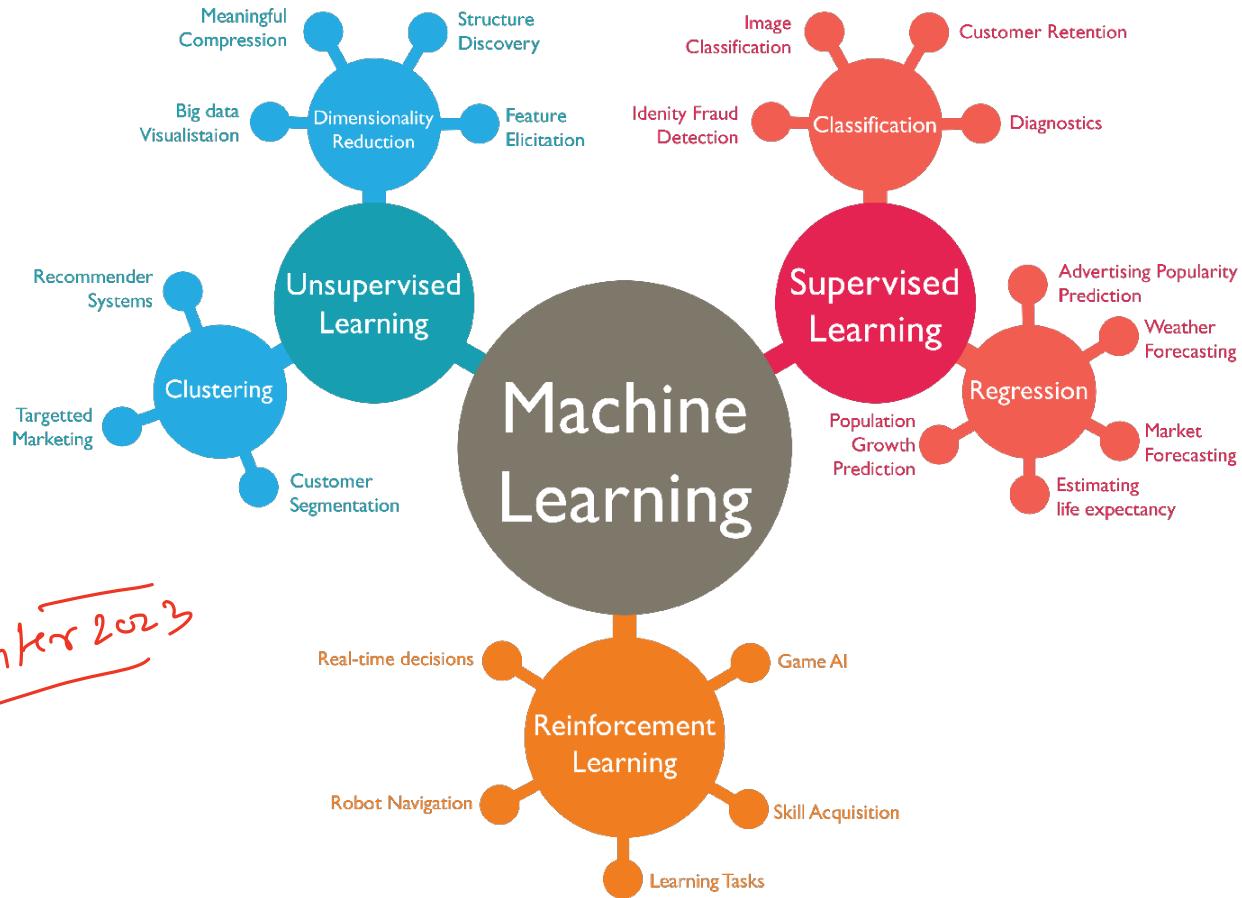


What is Machine Learning?

ML and CV

You can take CV out of ML, but you can't take ML out of CV!

What is Machine Learning?

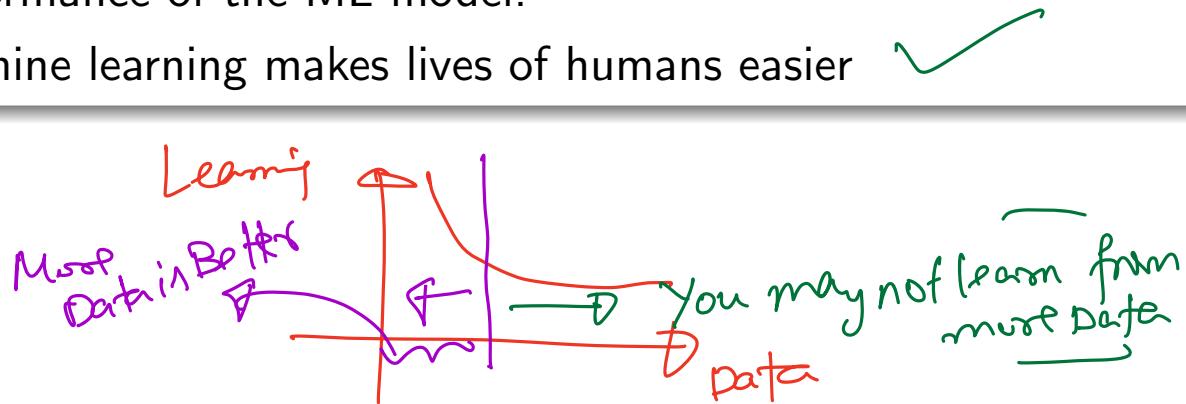


What is Machine Learning?

What is Machine Learning?

Definitions - Which ones are right?

- ① Machine learning is code that improves itself with data and over time!
- ② Machine learning is helping machines learn to be smarter (e.g. Tesla)
- ③ Machine learning relies on big data. More the data, the better the performance of the ML model.
- ④ Machine learning makes lives of humans easier



What is Machine Learning?

More perspectives

Have you noticed how a kid learns?

What is Machine Learning?

More perspectives

Have you noticed how a kid learns?



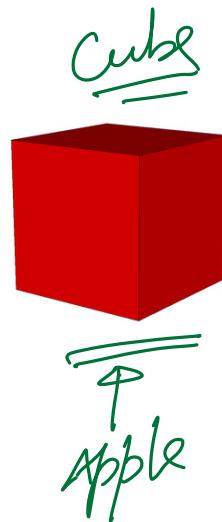
Apple

A handwritten label "Apple" written in black ink, with three horizontal lines above it and three horizontal lines below it, all enclosed within a rectangular border.

What is Machine Learning?

More perspectives

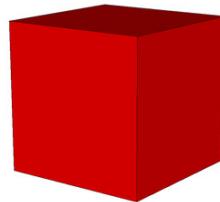
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What is Machine Learning?

More perspectives

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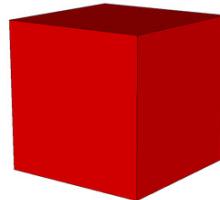
f
Apple

A handwritten-style label "f" above the word "Apple", which is underlined.

What is Machine Learning?

More perspectives

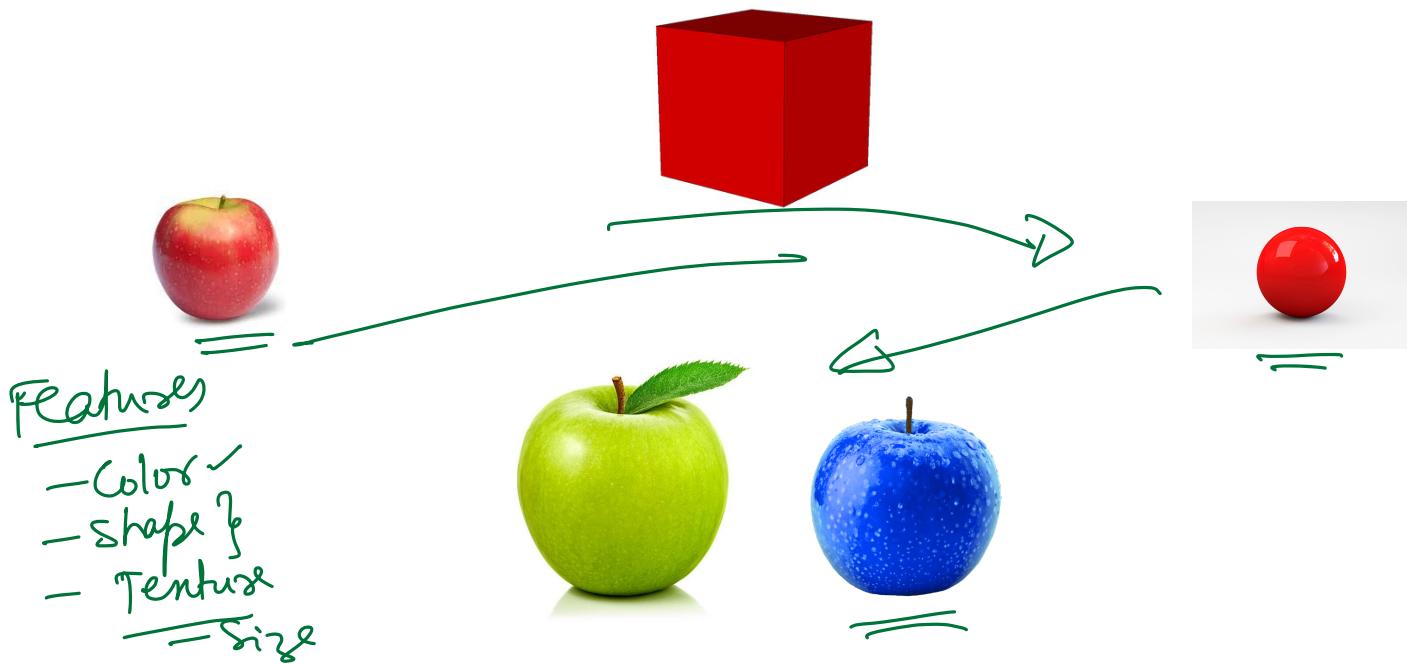
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What is Machine Learning?

More perspectives

Have you noticed how a kid learns?



What is Machine Learning?

- Machine Learning is understanding patterns in data!



What is Machine Learning?

- Machine Learning is understanding patterns in data!
- It's knowing what combinations of features or factors in the data contribute to a decision? (e.g. shape and color for recognizing an apple)

Learning

↳ Feature Engineering

↳ Feature Stores

What is Machine Learning?

- Machine Learning is understanding patterns in data!
- It's knowing what combinations of features or factors in the data contribute to a decision? (e.g. shape and color for recognizing an apple)
- Machine Learning helps you appreciate human learning! Our brains are so complex and smart - Even a simple act of driving requires tons of intelligence (some electric cars still make mistakes)!

Philosophy

When do you stop learning?

Human vs Machine

- For humans, learning doesn't stop - Isn't it?

When do you stop learning?

Human vs Machine

- For humans, learning doesn't stop - Isn't it?
- What about machines. Would you say "learning" could stop at some point in the machine learning process ? And if so, how do you check ?

When do you stop learning?

Human vs Machine

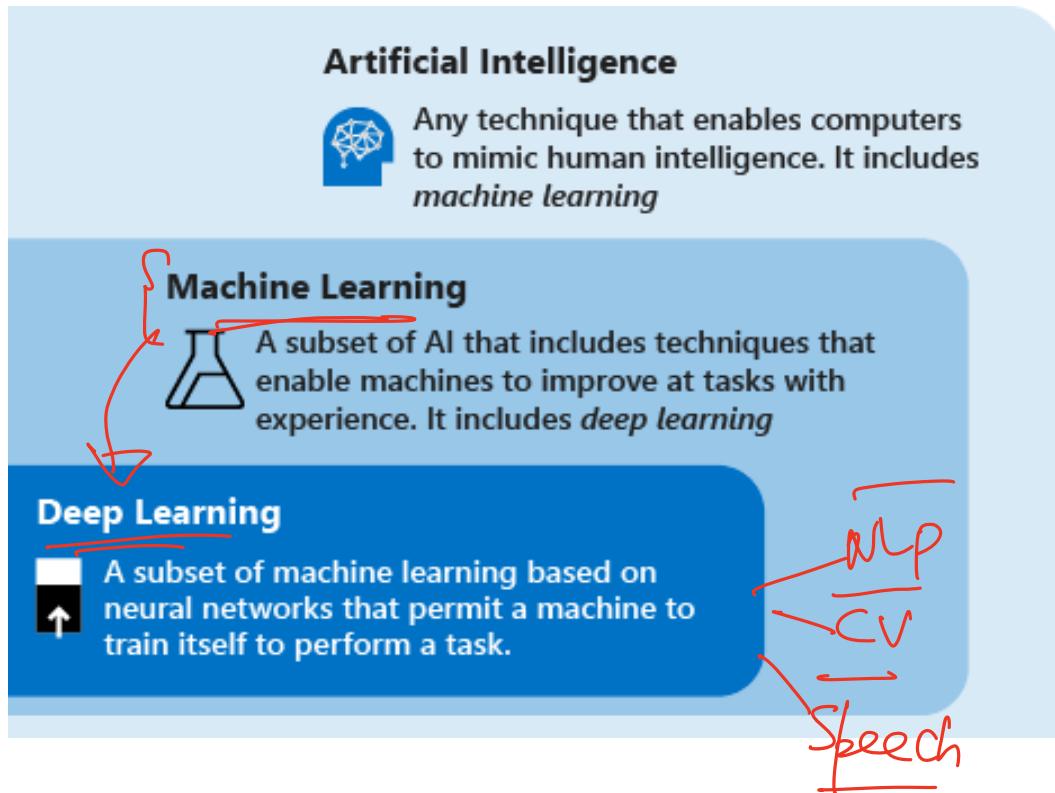
- For humans, learning doesn't stop - Isn't it?
- What about machines. Would you say "learning" could stop at some point in the machine learning process ? And if so, how do you check ?
- What exactly is "learning" in Machine Learning ?

ML vs AI: What's the difference?

ML vs AI: What's the difference?

One take on this

ML vs AI: What's the difference?



Coding pointers

- Assignments assume python as the main language (e.g. for hints and modules, etc)
- Coding environment set-up will be one of the problems on HW 1
- Prototyping can be done on notebooks and submitted as such for smaller assignments.
- For mini-projects and kaggle assignments - Please keep your code modular and organized.

Coding Environment

- Pointers below if you want to get set up on Google Colab for both prototyping, running machine-intensive ML experiments and working with code through IDEs
- Prototype Coding work in Notebooks recommended on [Google Colab](#)
- For terminal access on Google Colab, sign up for pro 
- pip3 install colabcode on terminal
- ColabCode enables you to have a VSCode IDE port into Google Colab
 - So you can work on the IDE from your laptop but run experiments on Google Colab!

Maximizing Your Learning in this course!

- Ask questions during lectures - Clarify things as they happen!
- Make use of office hours and quiz section! ↗
- Collaborative learning - Discord is a great place to brainstorm concepts outside class and unblock yourself.
- 30% of your learning happens in class and office hours - The remaining 70% happen when you work on the assignments. (You ofcourse need the 30 to get to the 70 :D)
- What you put in is what you get out!
- Excitement + Smart work + Inquisitiveness = Maximized learning!

Office Hours Survey

Office Hours Survey

Weekly Logistics

| | Day | Timings | Class type |
|-------------------------|---------|-------------|-------------|
| Lecture 1 (In-person) | T | 4 pm - 6 pm | (In-person) |
| Lecture 2 | Th | 4 pm - 6 pm | Zoom |
| Office Hours Karthik | T | 6 - 7 pm | Zoom |
| Calendly 15 min Karthik | October | | Zoom |
| Office Hours Ayush | Wed? | 5-6 pm | Zoom |
| Quiz Section Ayush | Mon? | 5-6 pm | Zoom |

Grading Hours fathmir

fixroad

Next Lecture!

- ① Building blocks of CV - Image Processing, Image Smoothing
- ② Basic Image Transformations
- ③ Simple Image Features for Learning
- ④ Basic ML for CV | 3rd Lecture