

# EEP 596: AI and Health Care || Lecture 1

Dr. Karthik Mohan

Univ. of Washington, Seattle

Mar 27, 2022

# Instruction Team



Karthik



Ayush, TA



Mathew, Co-ader

# Class Timings Logistics

- **Days:** Monday and Wednesday, 4 - 6 pm PST

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- **Monday:** In-person - Expected + in-class discussions and exercise

↳ 3 lectures take from home



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- **Wednesday:** Online, on zoom, and recorded
- **This week:** Have a conflict on Wednesday 4 pm. Alternative timing: Wednesday 2-4 pm pst (Zoom recorded)

# Class Timings Logistics

- **Course Updates on Discord:** Do join in - No more email updates after this week

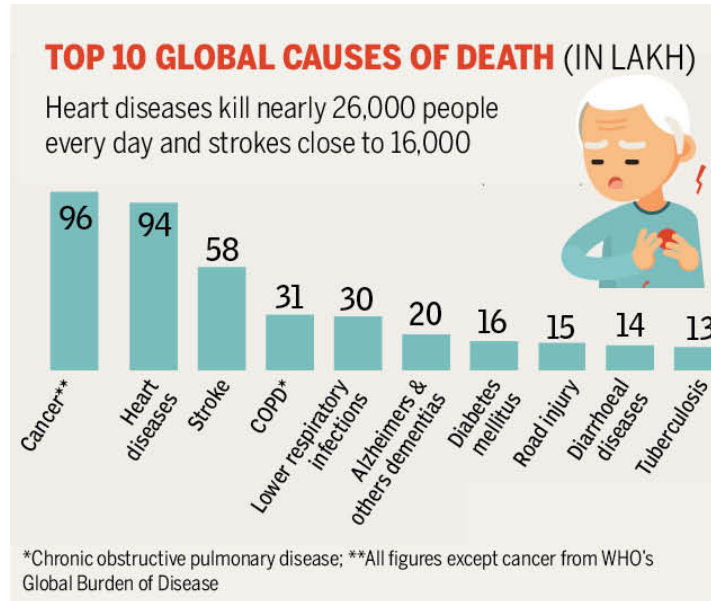
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- **Webpage:** Almost ready & something exciting coming up!
- **Pre-course Survey:** Last I checked, we had 8 responses. Please fill out now, if you haven't done already!

# Motivation: Top Diseases

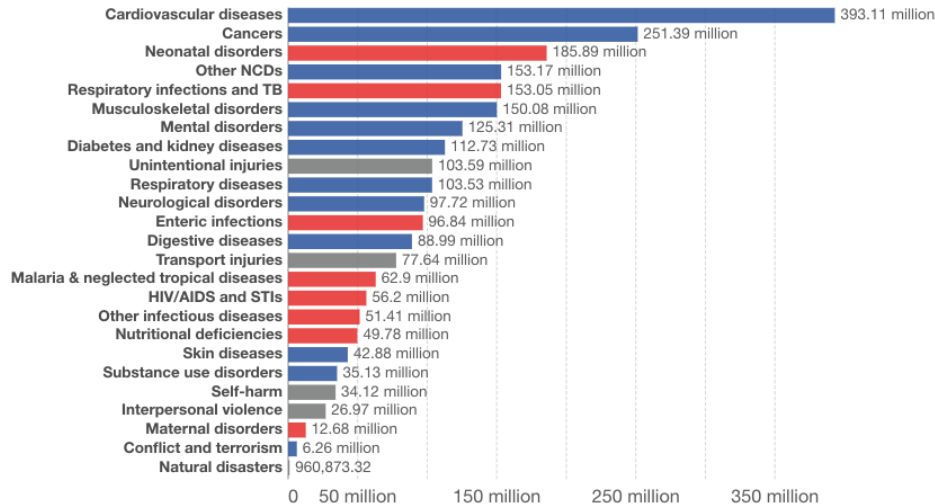


# Motivation: Top Diseases

## Burden of disease by cause, World, 2019

Our World  
in Data

Total disease burden, measured in Disability-Adjusted Life Years (DALYs) by sub-category of disease or injury. DALYs measure the total burden of disease – both from years of life lost due to premature death and years lived with a disability. One DALY equals one lost year of healthy life.



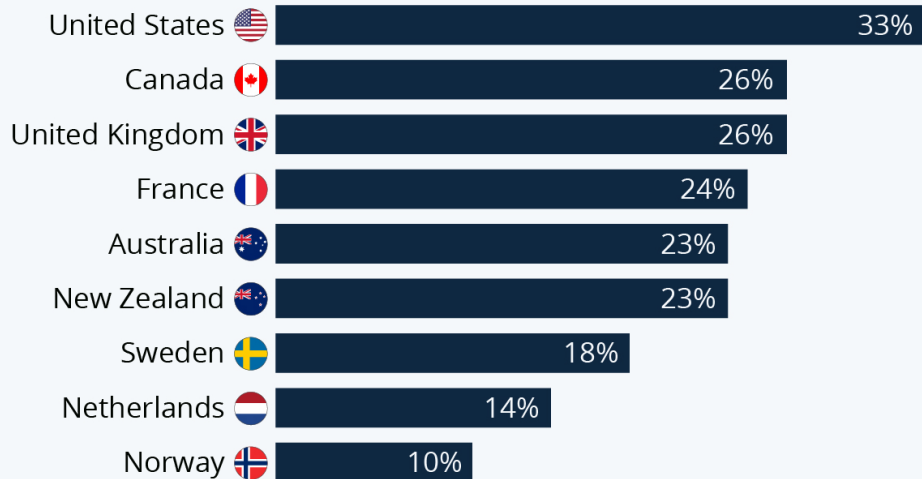
Source: IHME, Global Burden of Disease

OurWorldInData.org/burden-of-disease • CC BY

# Mental Health Spotlight

## Covid-19's Widespread Impact On Mental Health

Share of adults who experienced stress, anxiety or sadness that was difficult to cope with alone during the pandemic



n=8,259 (February to June 2020)  
Source: The Commonwealth Fund

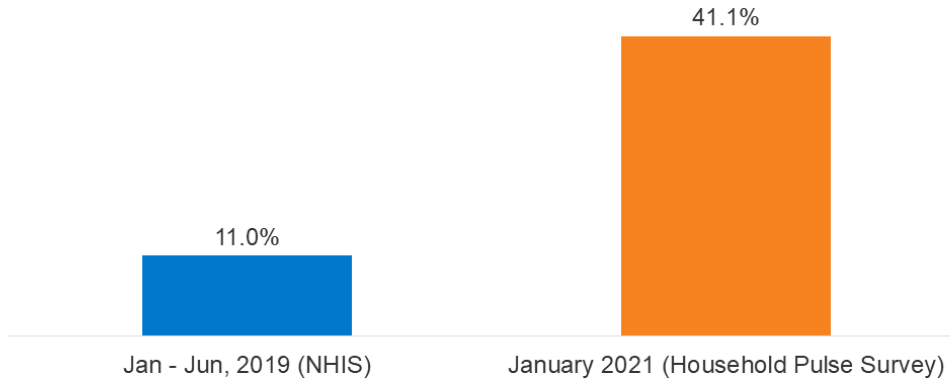




# Mental Health Spotlight

Figure 1

Average Share of Adults Reporting Symptoms of Anxiety Disorder and/or Depressive Disorder, January-June 2019 vs. January 2021

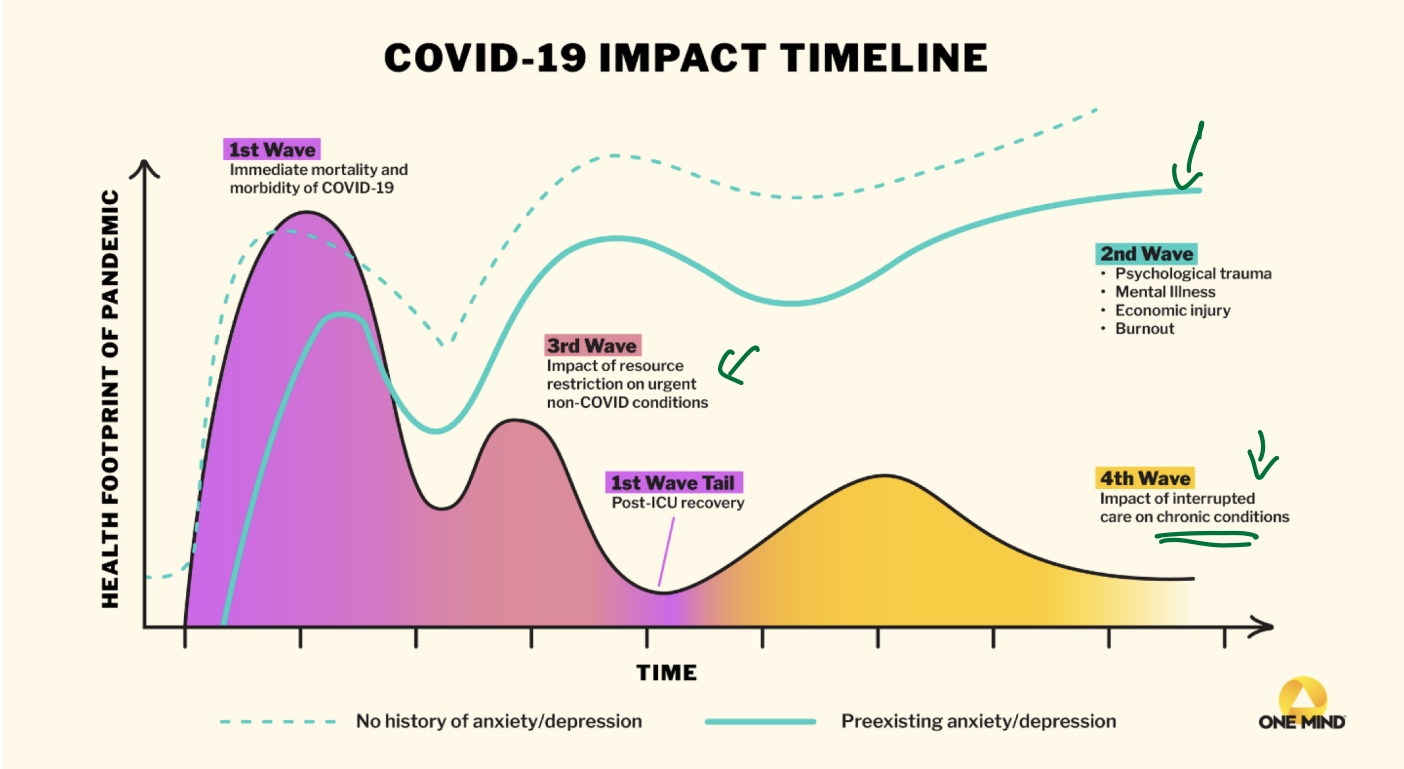


NOTES: Percentages are based on responses to the GAD-2 and PHQ-2 scales. Pulse findings (shown here for January 6 – 18, 2021) have been stable overall since data collection began in April 2020.

SOURCE: NHIS Early Release Program and U.S. Census Bureau Household Pulse Survey. For more detail on methods, see: <https://www.cdc.gov/nchs/data/nhis/earlyrelease/ERmentalhealth-508.pdf>

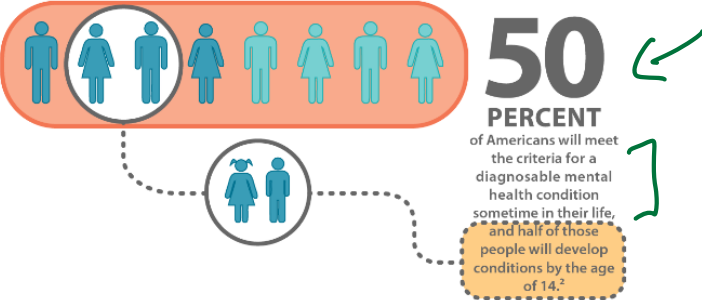


# Mental Health Spotlight



# Mental Health Spotlight - Missed Diagnosis

## Mental Health Matters For Everyone



# Mis-Diagnosis of Disease

PREVALENCE

## 12 million

adults are misdiagnosed every year

10-20% are patients with serious conditions

44% of some types of cancer are misdiagnosed

51% of breast imaging second opinions result in a big change of interpretation



# Mis-Diagnosis of Disease

**Misdiagnoses: the stats**

More than **three in ten** cases of sepsis suffer a **delay in diagnosis**

One in three heart attack cases are **misdiagnosed**

Rates of **epilepsy misdiagnosis** are between **20-31%**

One in ten Chronic Obstructive Pulmonary Disease (COPD) patients have no definitive diagnosis, but are still **prescribed inhaled drugs**

Areas of the body most commonly associated with a delay in cancer diagnosis are **gynaecological, skin, urological and breast**

**37%** of women and **15%** of men saw their **GP five times or more** before being referred for bowel cancer tests in 2015

On the most recent statistics, **half of all cancers in England weren't diagnosed until they were at an advanced stage**

One in five people waited over a year to be diagnosed with bowel cancer after first seeing their GP

**Four out of ten** people with cancer in the UK are misdiagnosed at least once before their disease is correctly diagnosed

**Four in five** multiple sclerosis sufferers in the UK are misdiagnosed

**SOURCES:**

<https://www.epipyrresearch.org.uk>  
<http://www.epipyr.org.uk/2015/05/03/what-is-sepsis-its-symptoms/>  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4049965/>  
<https://www.thuab.com/news-and-journals-in-press-heart-attack-cases-misdiagnosed/>  
<https://www.epipyrresearch.org.uk/newsroom/2017/epipyr-research-technology-improves-early-diagnosis-of-sepsis/>  
<https://www.brit-thoracic.org.uk/pressroom/2017/research-shows-a-lack-of-diagnosis-of-chronic-lung-disease-in-primary-care/>  
<http://www.cancer.gov/about-nci/nci/research/epipyr-research-technology-improves-early-diagnosis-cases-sepsis-1611>  
<https://www.independent.co.uk/news/health/cancer-diagnosis-misdiag-misdiag-misdiag-report-the-866656.html>  
<https://www.epipyrresearch.org.uk/about-epipyr/diagnosis-of-epipyr/>

0800 0 224 224 [www.thompsons.law](http://www.thompsons.law)

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# Mis-Diagnosis of Disease

## The Most Misdiagnosed Diseases in the U.S.

Misdiagnosis or wrong diagnosis is one of the most common diagnostic errors. The following are the most common:

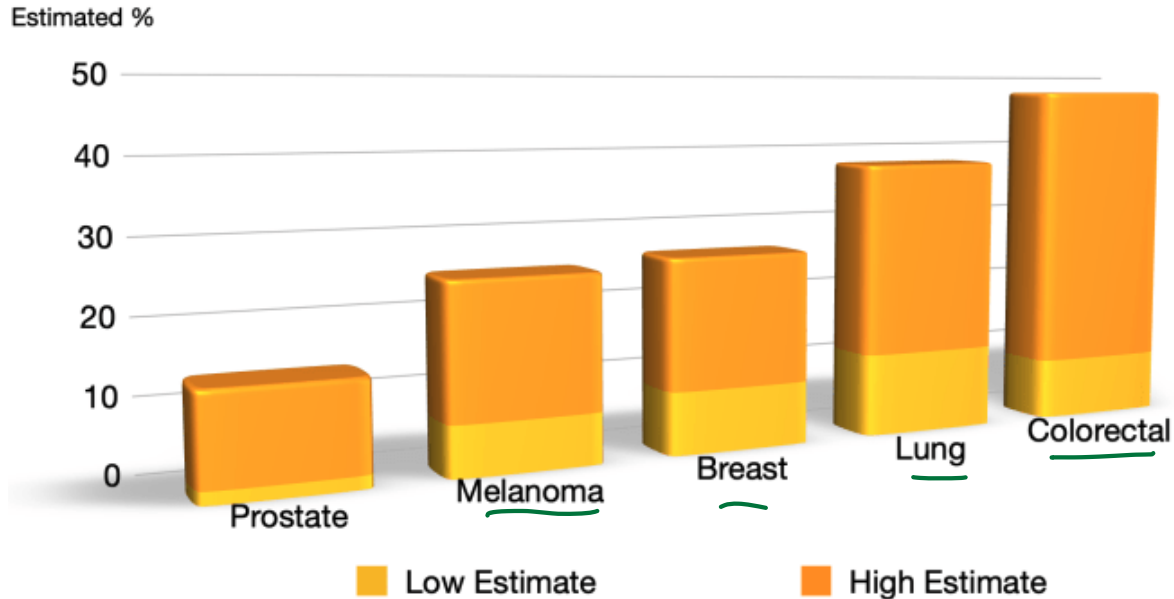
- |                |                 |
|----------------|-----------------|
| X Lung Cancer  | X Breast Cancer |
| X Heart Attack | X Stroke        |
| X Sepsis       | X Meningitis    |
| X Encephalitis | X Lyme Disease  |
| X Tuberculosis | X Pneumonia     |

For more information, go to [McIntyreLaw.com](https://www.McIntyreLaw.com).



# Mis-Diagnosis of Disease

## Top 5 Cancers Misdiagnosed



Adapted from Newman-Toker, DE, Wang, Z, et al, *Rate of diagnostic errors and serious misdiagnosis-related harms for major vascular events, infections and cancers: toward a national incidence estimate using the "Big Three,"* Diagnosis 2021; 8(1): 67-84 (DeGruyter)

# This Course & Course Logistics



# Health Care and AI (Spring Quarter Course)

## High Level

Motivation and Applications, Personalized health tracking. Patient diagnosis and monitoring. Machine Learning Problems: Anomaly Detection, Classification, Time-series analysis. Natural Language Processing for Medical Health Records. Interpretability in Machine Learning.

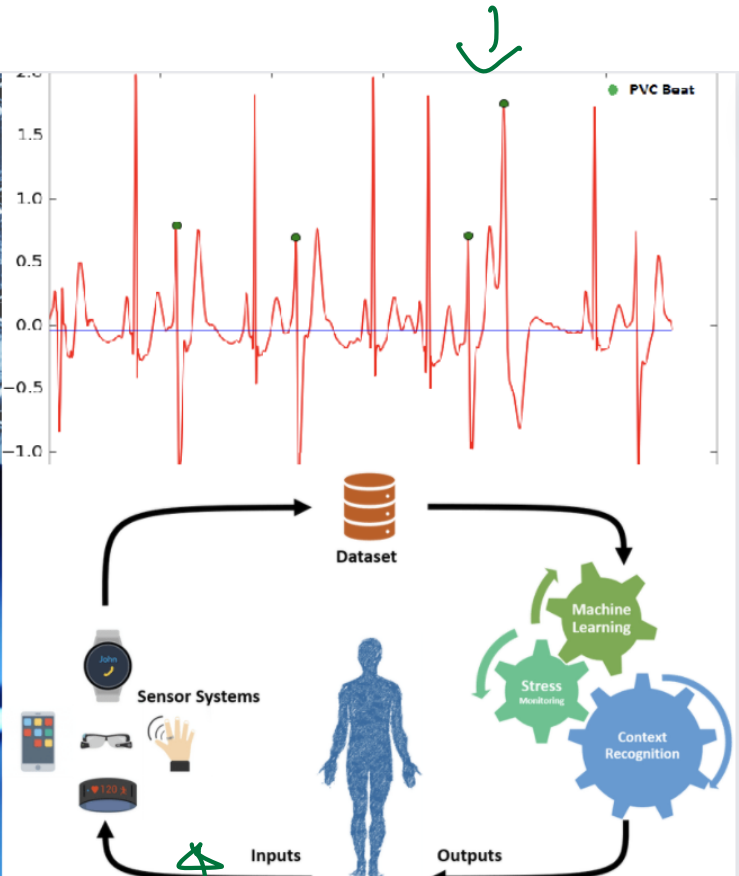
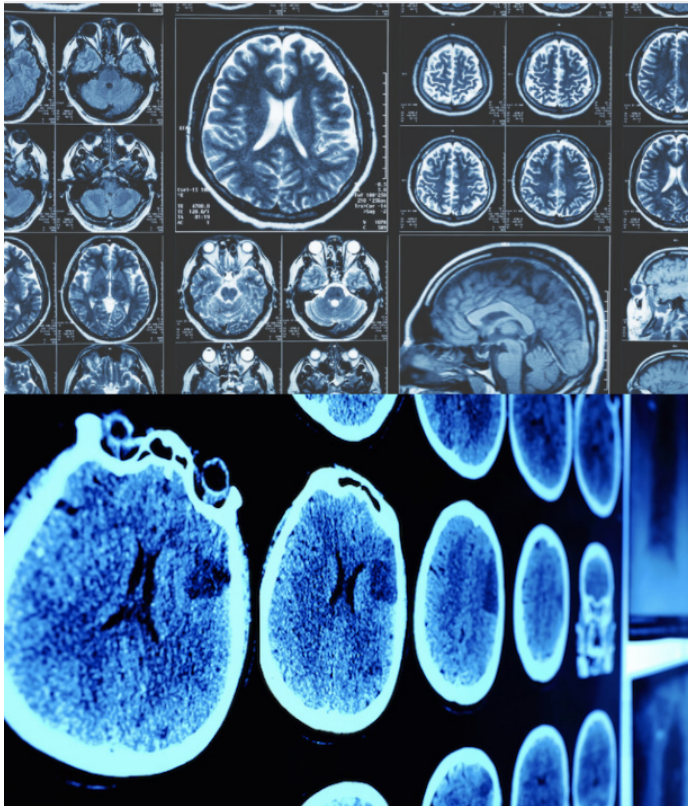
*Handwritten notes:* sleep tracking, heart rate, CT/MRI, EHR, LIME, Grad Cam

## Applications

Arrhythmia detection, Cancer detection, MRI classification, Automated Scribing of health records, Stress Monitoring Systems, patient risk assessments and more!

Assessments: Weekly conceptual and programming assignment and final project

# MRI, Heart, Stress and Cancer Detection (clockwise)



*Mini Project*

# Week by Week Breakdown

## Week 1

Health care problems. Personalized health tracking. Patient diagnosis and monitoring. Automating health records. Other problems? How can AI help? Case studies and examples. Getting started with foundations of AI for health care.

## Week 2,3 & 4

**Health focus:** Disease diagnosis and patient monitoring: Case studies

**Data focus:** Data from wearables and other sensors - Reliability and Signal/Noise

**Data focus:** Data sources, data cleaning, pre-processing and post-processing techniques in ML

**Model focus:** Modeling AI for Disease diagnosis Machine learning models  
- Foundations and libraries Unsupervised, Supervised ML and contexts  
Specific applications Conceptual assignments and programming portions for case study

# Week by Week Breakdown

## Week 5 and 6

**Health focus:** Automating health records - Case study

**ML focus:** Natural Language Processing - Foundations and applications to health care Classic example of handwriting recognition and document generation Conceptual assignments and programming portions for structured learning from NLP data sets Project: Discussion of final project

## Week 7

**Health focus:** Interpretability in Health care and Machine Learning - Case study

**ML focus:** Why is interpretability of models important and how to measure it? ML focus: Deep dive into models in ML from standpoint of interpretability Conceptual + programming portion for Interpretability case study in health care

# Week by Week

## Week 8

**Health focus:** Assessing patient risks for treatments **ML focus:** Models for risk assessment Conceptual + programming portion for Interpretability case study in health care

## Week 9 & 10?

Open topics discussion Project presentations Final project due

# High-level Areas for this course

## Intensive deep-dive into AI for Health applications

- Preventative health analytics (E.g. detecting arrhythmia) esp. from apps and IoT data
- Medical imaging analysis for disease detection (e.g. MRI scans)
- Medical record automation (NLP application)
- Gene expression analytics for cancer detection (e.g. [research paper](#))
- Stress management applications (e.g. apps like calm)
- Patient risk assessment

DNA Sequencing

# Pre-course survey results

## Pre-course Survey Results

# Lecture Format

- Case studies





# Lecture Format

- Case studies
- In-class group activity



# Lecture Format

- Case studies
- In-class group activity
- Guest Lectures



2nd half of Wednesday lecture

# Weekly Logistics

	Day	Timings	Class type
<b>Lecture 1 (In-person)</b> ✓	M	<u>4 pm - 6 pm</u>	(In-person)
<b>Lecture 2</b> ✓	W	<u>4 pm - 6 pm</u>	Zoom
<b>Office Hours Karthik</b>	T	<u>5 - 6 pm ?</u>	Zoom
<b>Office Hours Ayush</b>	TBD	TBD	Zoom
<b>Quiz Section Ayush</b>	TBD	TBD	Zoom
<b>Grading hours Mathew</b>	TBD	TBD	Zoom

2-4 PM  
Just this week

more hours on weekends

# Assessments

- Programming Assignments: 40%
  - Conceptual Assignments: 20%
  - Mini Projects: 30%
  - Project Presentation: 5%
  - In-class Exercise and Participation: 5%
- 
- The image contains several handwritten green annotations. A bracket groups the first two items (Programming and Conceptual Assignments). Another bracket groups the last three items (Mini Projects, Project Presentation, and In-class Exercise and Participation). A large bracket on the right side encompasses the last three items and is labeled '2 week investment'. There are also several arrows pointing to the percentage values.

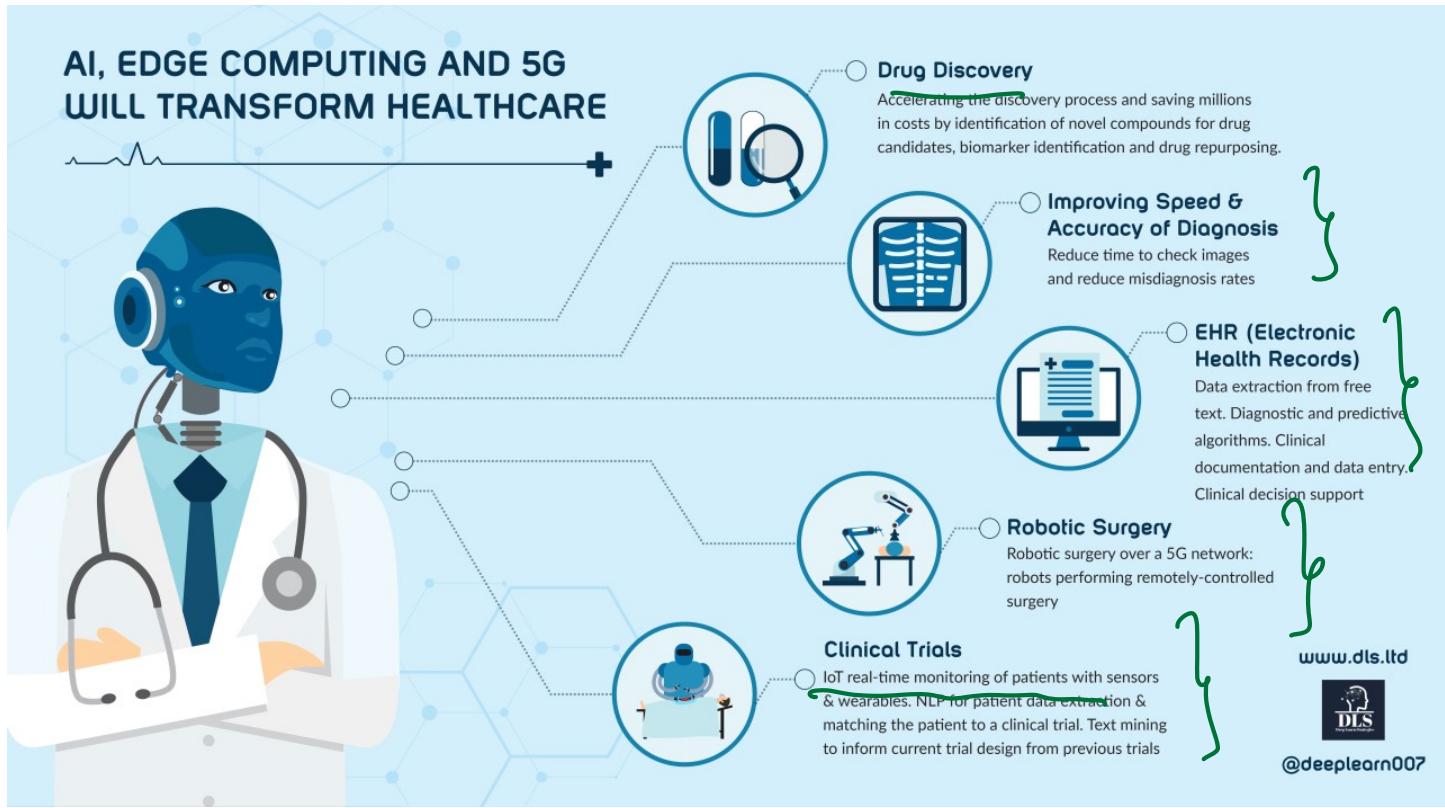
# Coding pointers

- 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. Guidelines will be provided for submissions.

# 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!

# AI and Health Care



# AI and Health Care

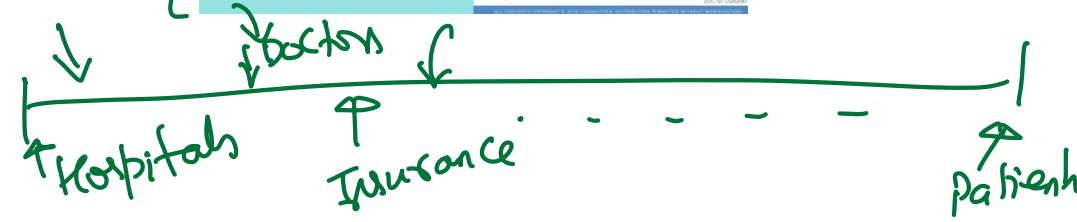
**9 WAYS IN WHICH AI IS TRANSFORMING HEALTHCARE**

Given the huge potential of AI, it is transforming healthcare industry, performing human tasks but more efficiently, more quickly, and at a lower cost. Here are 9 valuable ways AI is transforming the industry.

- 1 ROBOT-ASSISTED SURGERY**  
Surgical robots work alongside human surgeons to aid in surgical procedures.
- 2 VIRTUAL NURSING ASSISTANTS**  
Keep patients and care providers in communication 24/7.
- 3 ADMINISTRATIVE WORKFLOW ASSISTANCE**  
Prioritize urgent matters and saving time on routine tasks like writing chart notes, prescribing medications, and ordering tests.
- 4 FRAUD DETECTION**  
Identify healthcare fraud by identifying suspect charges or false claims before payments are made.
- 5 ERROR REDUCTION**  
Prevent human mistakes such as dosing appropriate dosage and minimizing wrong diagnosis.
- 6 CONNECTED MACHINES**  
Manage all connected devices used to track and manage health e.g. mobile, wearables, or online.
- 7 CLINICAL TRIAL ASSISTANCE**  
Facilitate clinical trial by identifying potential participants.
- 8 AI ASSISTED DIAGNOSIS**  
AI can review medical images and diagnosis things such as spot rashes and cancerous moles as well as review CT scans and x-rays.
- 9 PATIENT ENGAGEMENT**  
Unlock data-driven insights to improve healthcare outcomes.

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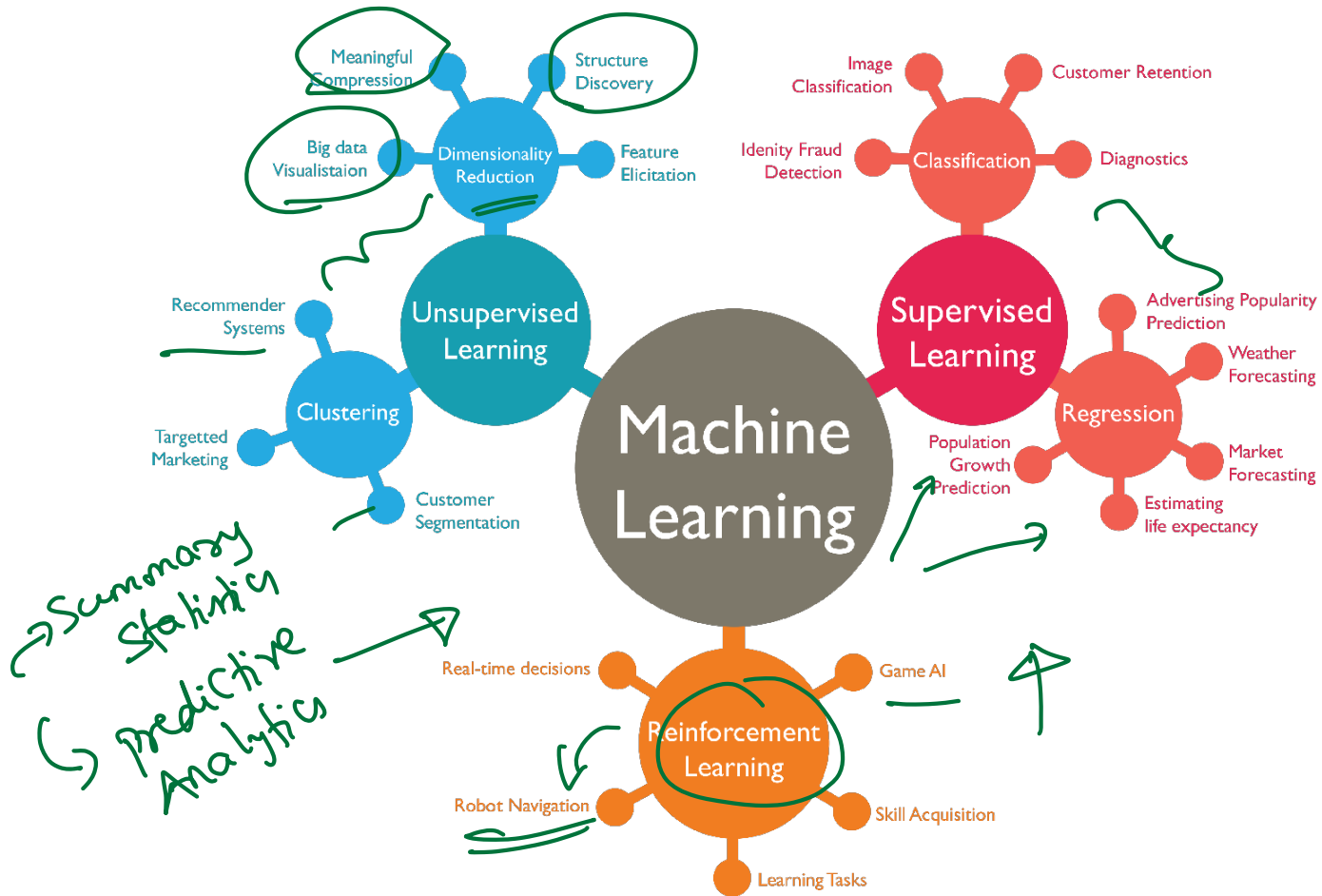
Misdiagnosis





# What is AI/Machine Learning?

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# 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?



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More perspectives

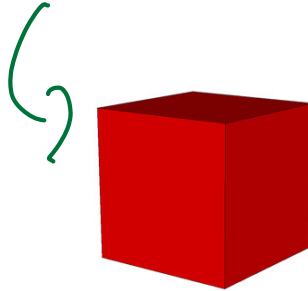
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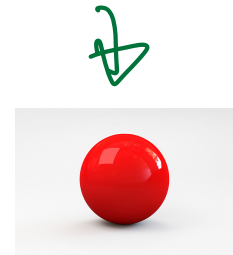
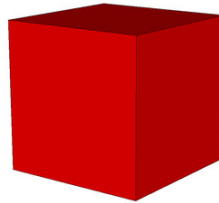
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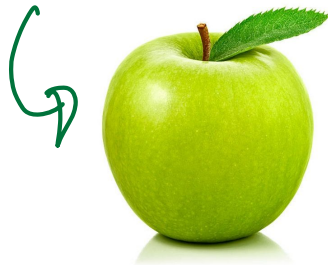
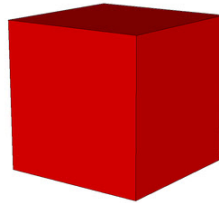




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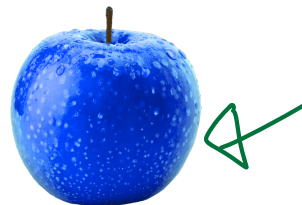
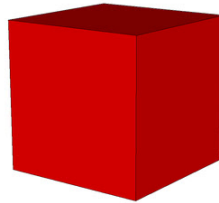
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# What is Machine Learning?

- Machine Learning is understanding patterns in data!

↳ more useful data  
(Active Learning)

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- 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)

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- 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)!

# When do you stop learning?

## Human vs Machine

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

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## 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?

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One take on this

# ML vs AI: What's the difference?

## Artificial Intelligence



Any technique that enables computers to mimic human intelligence. It includes *machine learning*

## Machine Learning



A subset of AI that includes techniques that enable machines to improve at tasks with experience. It includes *deep learning*

## Deep Learning

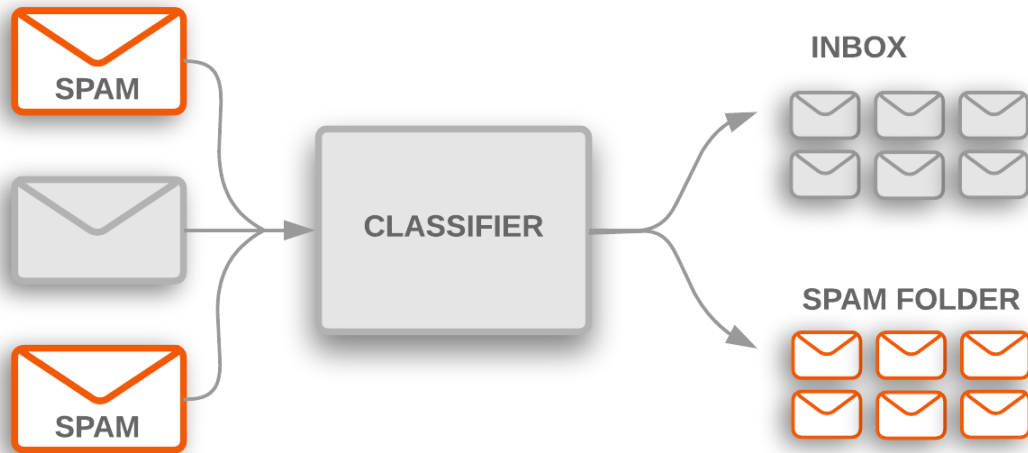


A subset of machine learning based on neural networks that permit a machine to train itself to perform a task.

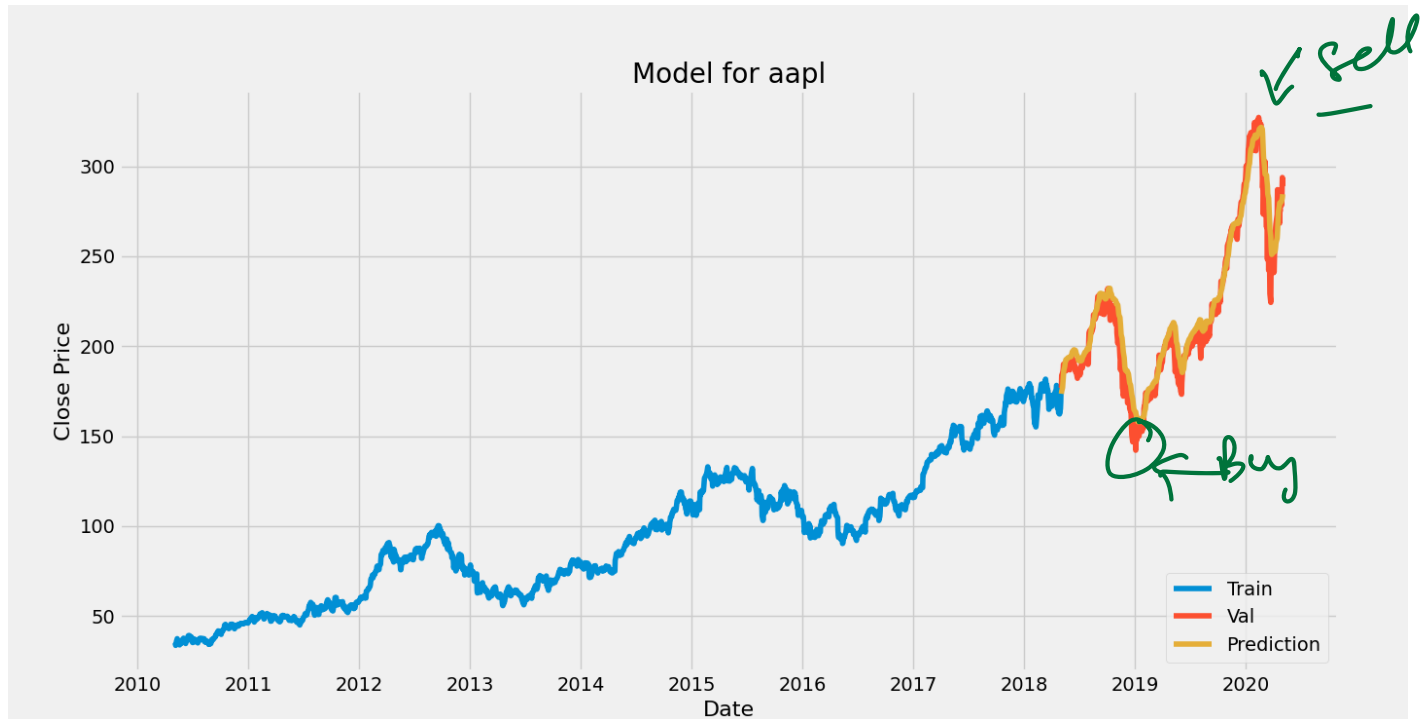
# ML application: Housing price prediction



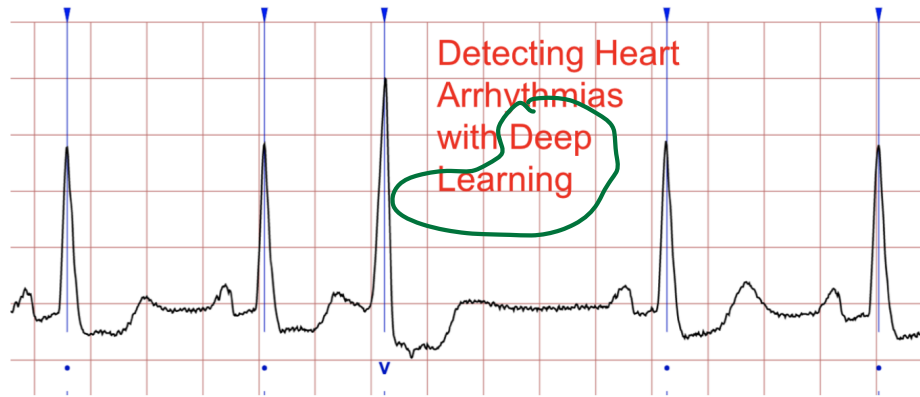
# ML application: Spam detection



# ML application: Stock Price Prediction



# ML application: Arrhythmia detection



# In Practice though!!

ML Modeling

No one is going to hand you a binary classification problem!!



# Textbook(s)

## Classic ML

→ Periton Discovered

- Too many to name! But one good one I recommend is by Christopher Bishop.
- Note that we will not be following a textbook as such! Supplemental reading materials/references may be posted depending on the lecture/topic.

## Deep Learning

Deep Learning by Yoshua Bengio et al ↙

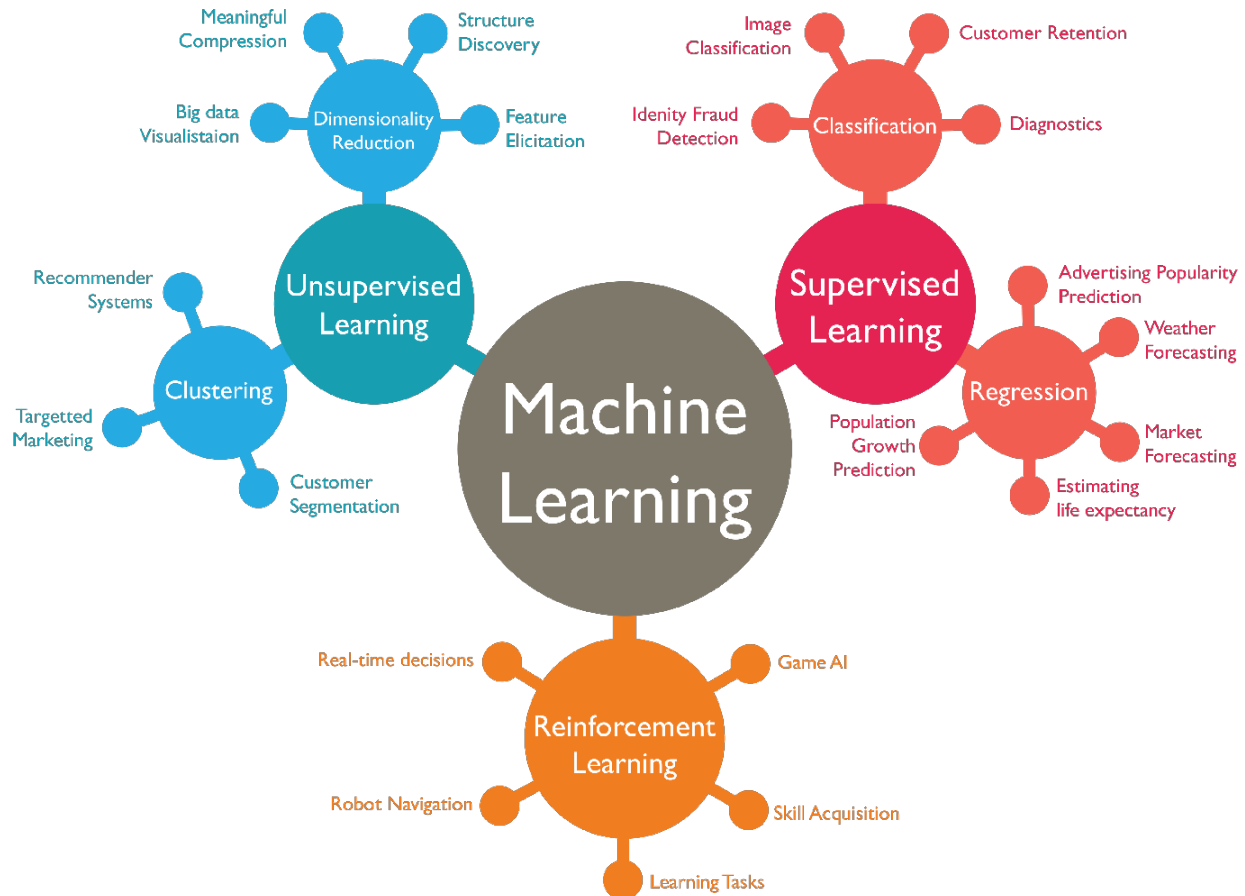
## Health Care

- We will regularly be referencing papers for intersection of AI and health care
- References will also be updated on the webpage

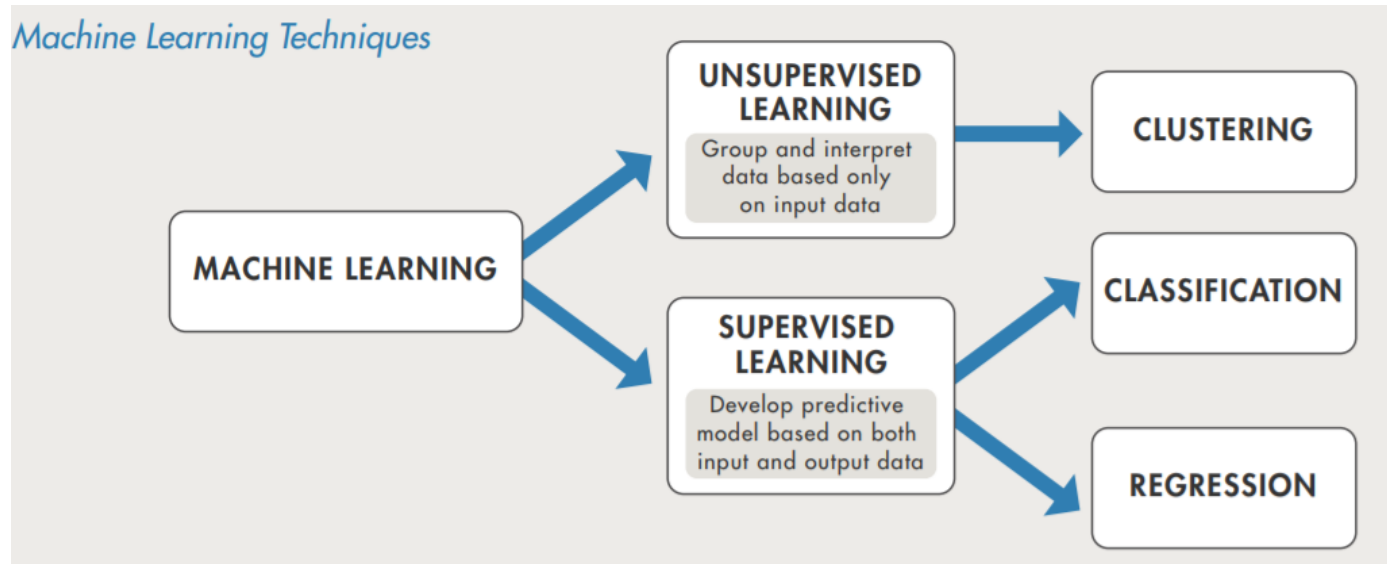
# Maximizing Your Learning of AI in Health Care!

- 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!

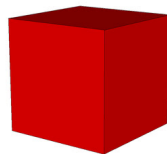
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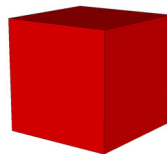
# Supervised vs Unsupervised Learning



# Supervised Learning



# Un-Supervised Learning



## In-class Breakout (5 minutes)

### Specific bottlenecks in health care

What are some specific bottlenecks in health care that you can think of where data analytics and AI can help? Think of the whole health care pipeline - from health care providers, to hospitals, to insurance to patients. What are some opportunities and what are some challenges? Which challenges can data science help with and which challenges require policy changes or fixing other infrastructure issues?

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- ML is a pre-requisite for this course. So recap will be high-level and quick!



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- Guest lectures (about 4-6 planned this quarter) will shed light on state of health care and challenges from experts
- Any questions/thoughts/suggestions?