goML Part 1

[Class Materials]

https://bit.ly/goML_Jan2022

DAY 1

Mr Seow Khee Wei / Mr Shubham Khare

Before we start…

- **Mute** your microphone when not speaking
- **Unmute** when you are answering questions / or asking questions in class
- Give me **feedback** as I need to know how you are doing so that I can adjust my pace or explain any concepts again.

source

Warm up!

Step 1: Go to the following url

https://bit.ly/goML_warmup

Step 2: facilitator will walk you through the following 2 questions

1) **Write down what you know about or prior experience with Artificial Intelligence and machine learning**

2) **What do you hope to get out of this class.**

5 mins

Introduction

Name
SEOW Khee Wei

Email
seow_khee_wei@rp.edu.sg

Telegram
@kwseow

LinkedIn
www.linkedin.com/in/kwseow

Education

Nvidia Certified Instructor
Advanced Certificate in Learning and Performance
NanoDegree (AI)
MBA
BEng

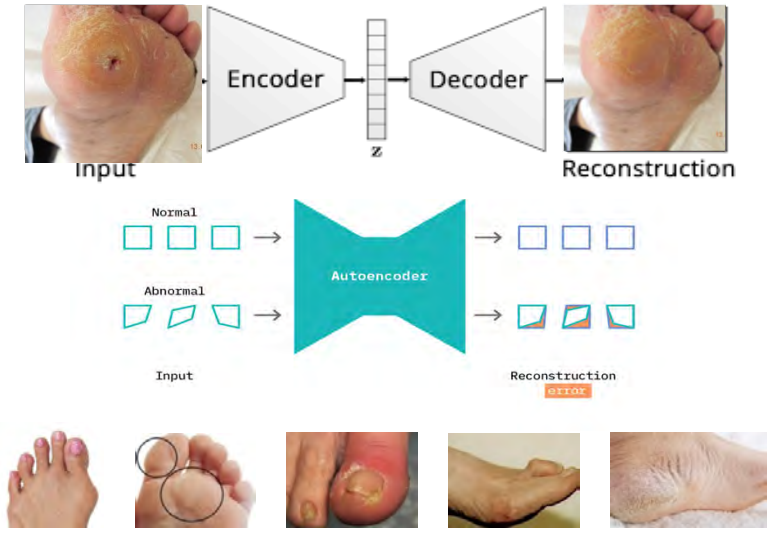
Experience

Assistant Director (Capability and Industry)
Entrepreneur
Programme Chair (Interactive & Digital Media)
Technology Centre Manager (IT Security)
Solution Manager
R&D Engineer

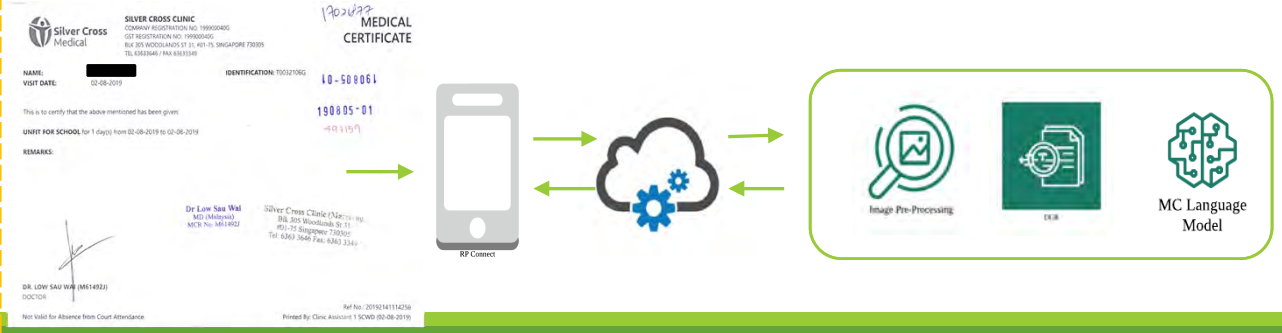
Projects

Scene Understanding

Diabetic Foot At Risk Reconstruction



NER model for Medical Certificates



Programmes

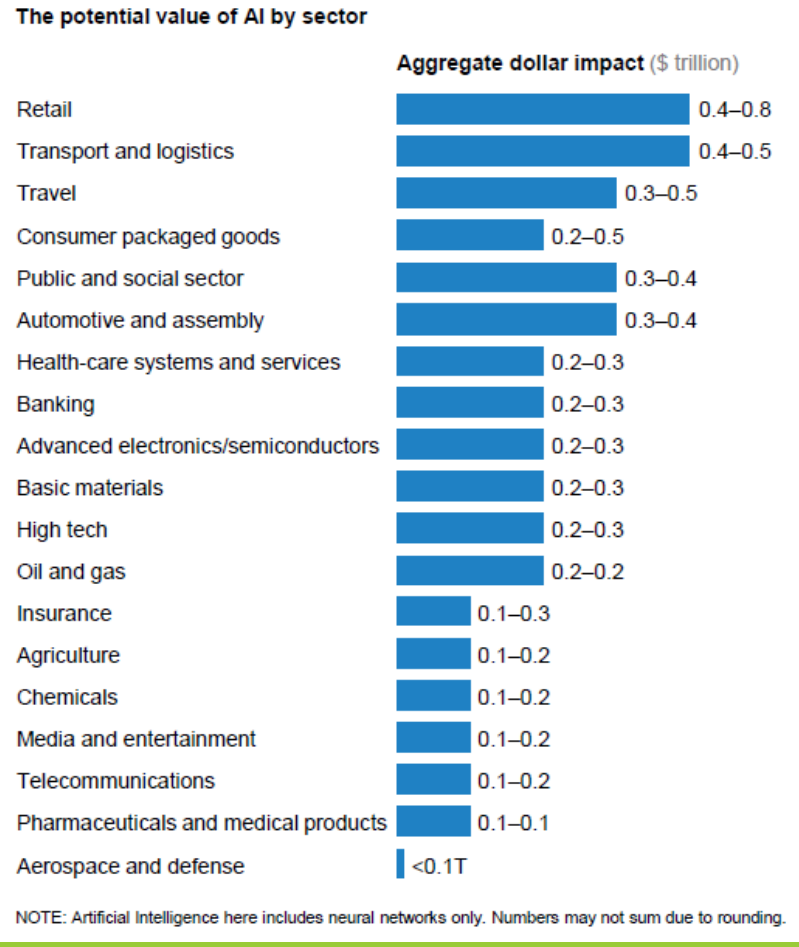
Day 1	What is Data? Types of Machine learning - Supervised and unsupervised learning Understand the common learning methods and how they are used to solve problems. What they can do and what they cannot do Use case sharing Activity – Numpy	Machine learning Workflow Develop a reusable pipeline for project workflow Data Visualization, Preparation and Cleaning Preparing your data for machine learning including feature engineering Activity – Pandas, Matplotlib, Seaborn, data prep
Day 2	Regression techniques - Training a Regression Model using Linear Regression - Training a Regression Model using Neural Network - HDB resale price predictor Classification techniques Activity – - Classification with Logistic Regression - Classification with Neural Network - Multi Class Classification	Model improvement Improve the performance of any model using simple hyperparameter tuning Activity: HyperParameter Create successful projects that matters Brainstorming to find your ML use case ML Project Checklist **Quiz**

Intro to AI and ML

Which industry will not be affected by AI?

AI value creation
By 2030

$13 trillion



[Source: McKinsey Global Institute]

ANI vs AGI

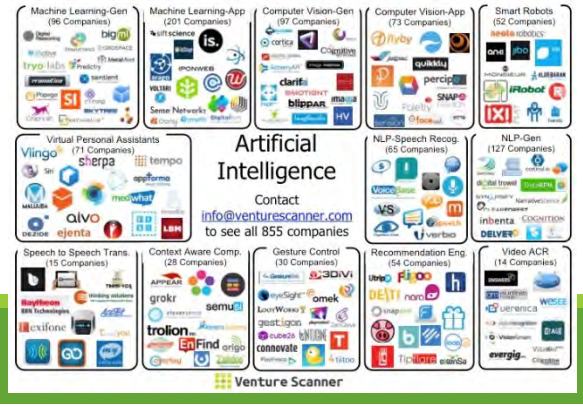
AI

ANI

(Artificial Narrow Intelligence)

E.g. Smart Speaker, self-driving car, web search, AI in farming, route planning for logistic, AI in healthcare, finance

Just using some of the capabilities of AI for a narrow function



AGI

(Artificial General Intelligence)

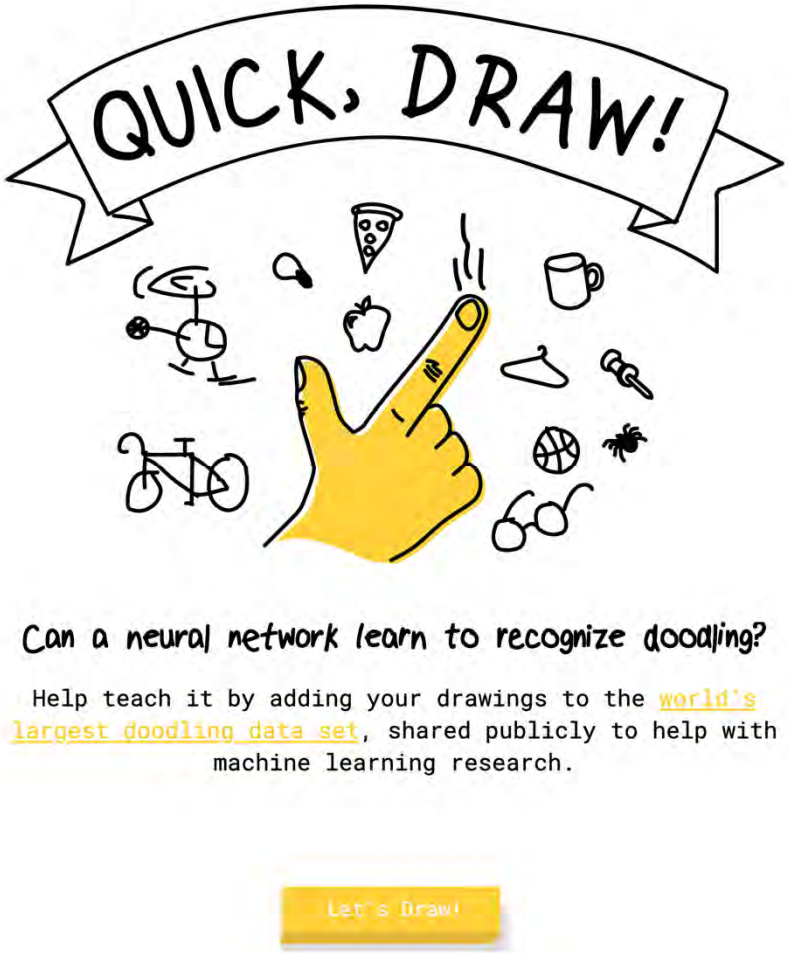
Do anything human can do

Capable of adapting to any situation

Able to respond as a human would

Activity: Quickdraw Game

https://g.co/quickdraw



5 mins

Activity: Discussion

Step 1: Go to the following url

https://bit.ly/activity_21

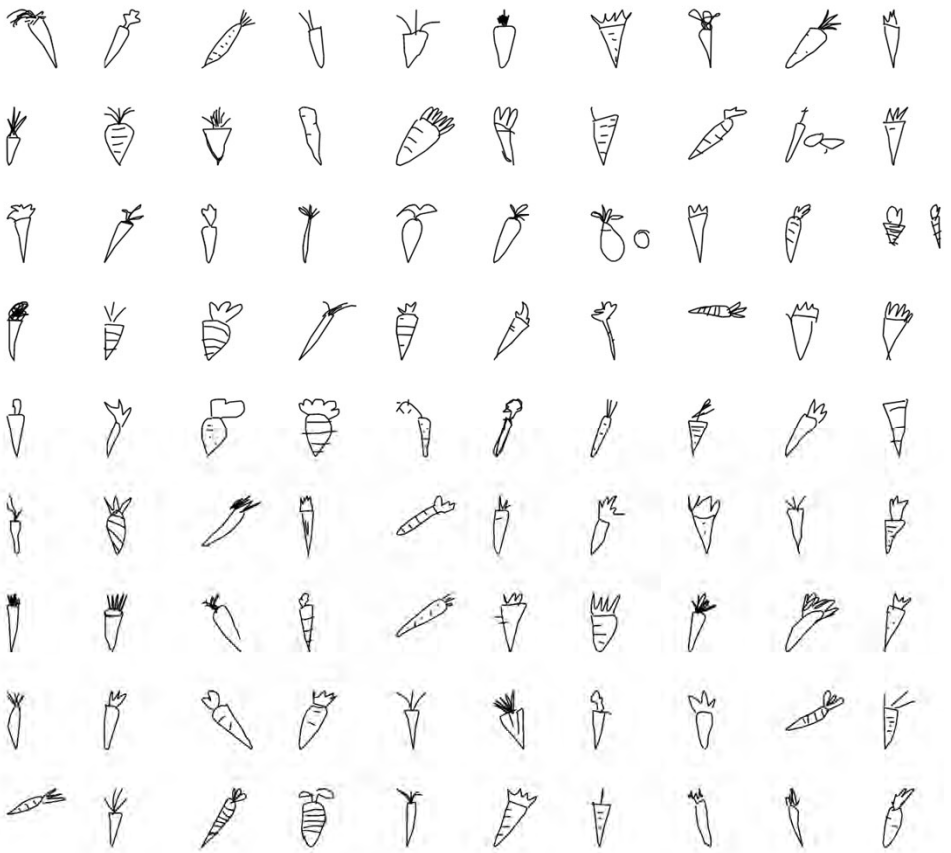
Step 2: Pen down your thots on the following 3 questions

1) **How does the game work?**
2) **How is it recognizing your drawing?**
3) **How could we program this?**

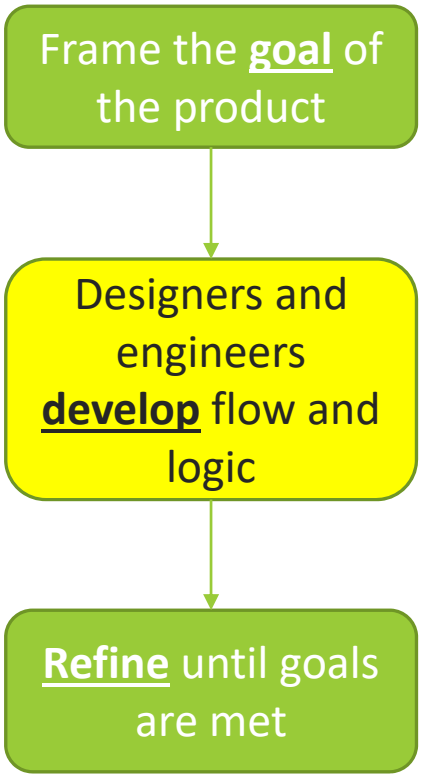
10 mins

How does ML work in Quickdraw?

g.co/quickdrawdata



Rule Based



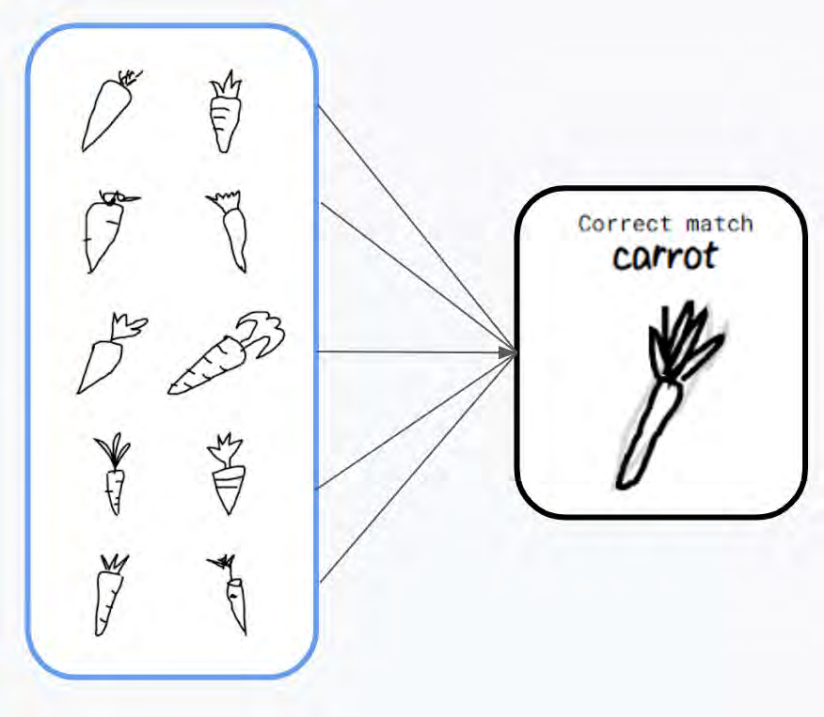

```
if object.height > 10 :
  do x
if object.color is blue :
  do y
if object.numberOfLegs > 2:
  do z
…
```

Machine Learning

Frame the **goal** of the product

Train a model using examples

Refine until goals are met



Which approach to use?

Alphabetising a list of song titles

Rule-based

Machine Learning

Which approach to use?

Classifying an object in a photo

Rule-based

Machine Learning

Which approach to use?

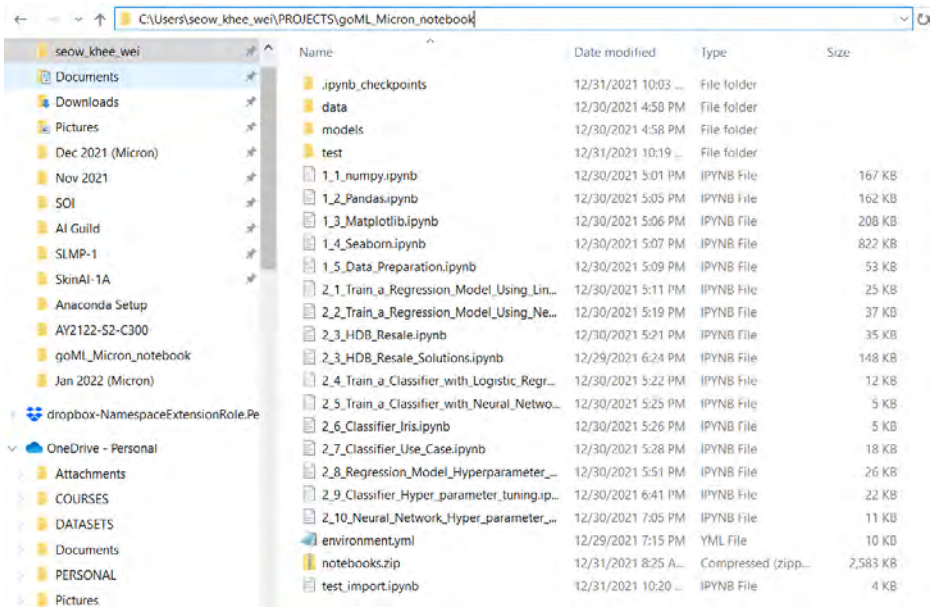
Ranking web search results

Rule-based

Machine Learning

Download notebooks

- Go to https://bit.ly/goML_Jan2021 to download notebooks.zip
- Unzip and copy the whole directory to your home directory or where your jupyter notebook's startup directory.
- You should have the following (in ny case, jupyter notebook starts in c:\Users\seow_khee_wei)



What is Data

Floor area sqm (Sqm)	Storey range	Street name	Remaining lease	Resale price ($)
131	01 TO 03	TAMPINES ST 45	74 years 01 month	540,000
120	10 TO 12	TAMPINES ST 71	74 years 11 months	578,888
119	04 TO 06	TAMPINES ST 71	74 years 10 months	545,000
121	01 TO 03	TAMPINES ST 83	66 years 10 months	520,000
146	04 TO 06	TAMPINES AVE 5	65 years 06 months	768,000
146	07 TO 09	TAMPINES AVE 5	66 years 05 months	755,000
148	04 TO 06	TAMPINES ST 11	63 years 09 months	655,000

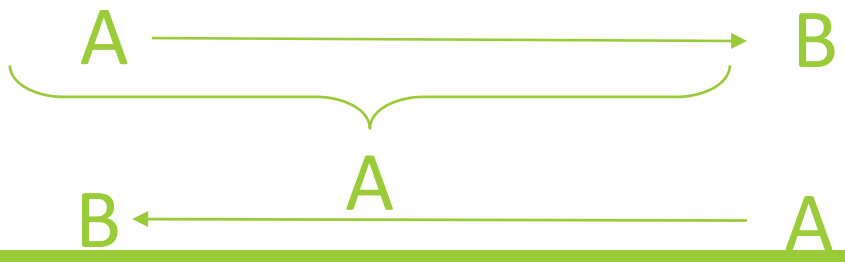


image	label
	cat
	not cat
	cat
	not cat

Data from data.gov.sg

Acquiring data

- Manual labeling


Dog


Not Dog


Dog


Not Dog

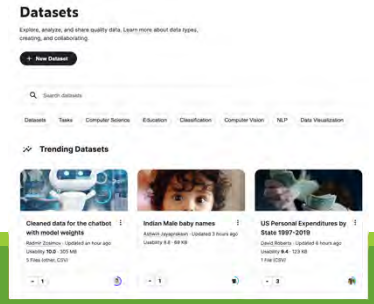
- From observing behaviours

user ID	time	price ($)	purchased
4783	Jan 21 08:15.20	7.95	yes
3893	March 3 11:30.15	10.00	yes
8384	June 11 14:15.05	9.50	no
0931	Aug 2 20:30.55	12.90	yes

- Collecting from machines' log

machine	temperature (°C)	pressure (psi)	machine fault
17987	60	7.65	N
34672	100	25.50	N
08542	140	75.50	Y
98536	165	125.00	Y

- Download from websites/partner ships



Dataset

- Some sites where you can download open dataset

GitHub
https://kwseow.github.io/

Google Dataset Search Beta
https://datasetsearch.research.google.com/

kaggle
https://www.kaggle.com/datasets

KDnuggets™
https://www.kdnuggets.com/datasets/index.html

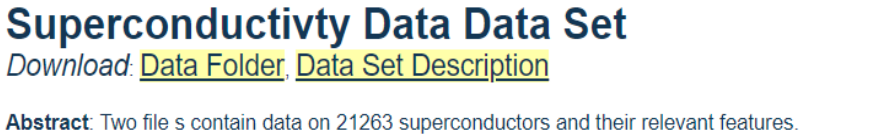
re3data.org
REGISTRY OF RESEARCH DATA REPOSITORIES
https://www.re3data.org/

Mendeley Data
https://data.mendeley.com/

Open Manufacturing Dataset

https://www.kaggle.com/paresh2047/uci-semcom

https://www.kaggle.com/shasun/tool-wear-detection-in-cnc-mill/data



http://archive.ics.uci.edu/ml/datasets/Superconductivty+Data

https://archive.ics.uci.edu/ml/datasets/Gas+sensor+arrays+in+open+sampling+settings

PHM DATA Challenge 18: Etching tool fault detection (PdM)

https://phmsociety.org/conference/annual-conference-of-the-phm-society/annual-conference-of-the-prognostics-and-health-management-society-2018-b/phm-data-challenge-6/

Data is messy

- Garbage in, garbage out

- Data problems
  - Incorrect labels
  - Missing values

size of house (square feet)	# of bedrooms	price (1000$)
523	1	115
645	1	0.001
708	unknown	210
1034	3	unknown
unknown	4	355
2545	unknown	440

structured

- Multiple types of data

Images, audio, text

unstructured

AI Terminology

- Machine Learning vs Data Science

Floor area sqm (Sqm)	Storey range	Street name	Remaining lease	Resale price ($)
131	01 TO 03	TAMPINES ST 45	74 years 01 month	540,000
120	10 TO 12	TAMPINES ST 71	74 years 11 months	578,888
119	04 TO 06	TAMPINES ST 71	74 years 10 months	545,000
121	01 TO 03	TAMPINES ST 83	66 years 10 months	520,000
146	04 TO 06	TAMPINES AVE 5	65 years 06 months	768,000
146	07 TO 09	TAMPINES AVE 5	66 years 05 months	755,000
148	04 TO 06	TAMPINES ST 11	63 years 09 months	655,000

ML: A → B
Running AI system
(e.g. websites / mobile app)

A

DS: Homes with 3 bedrooms are more expensive than homes with 2 bedrooms of a similar size.

B

Foresight

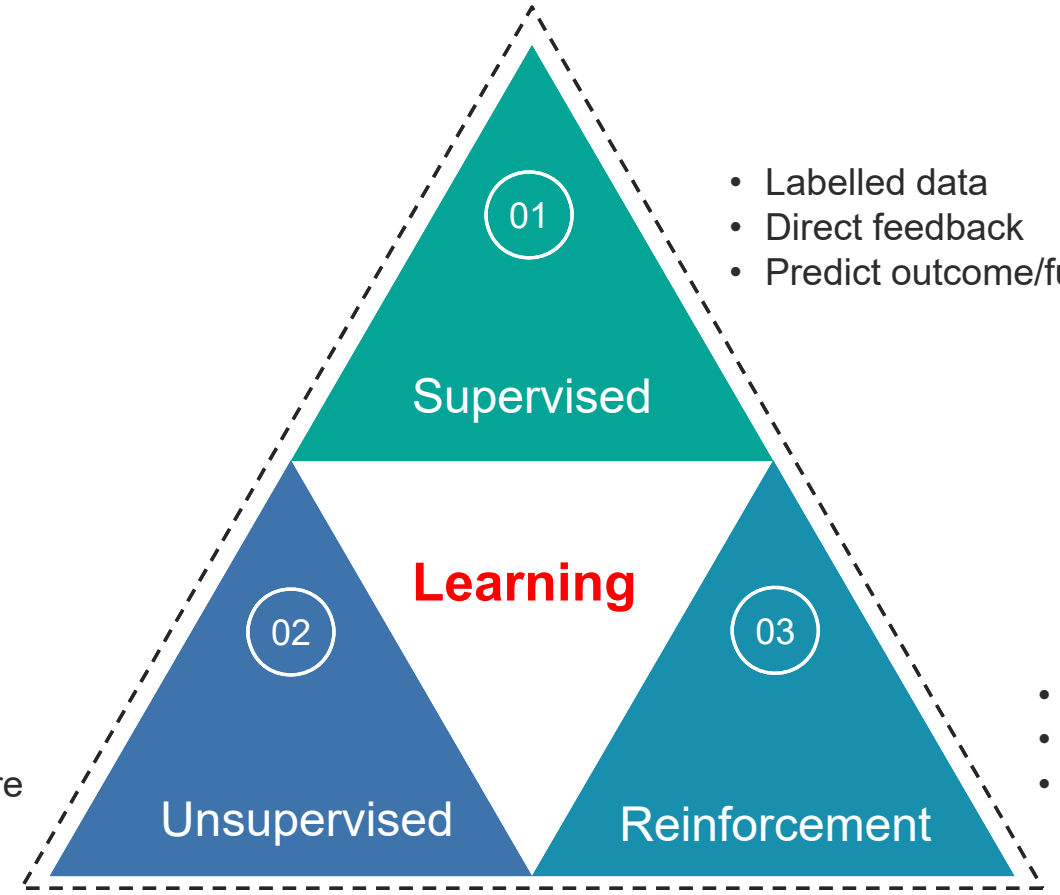
Hindsight/Insight

ML vs DS

- Machine Learning
  - Field of study that gives computers the ability to learn without being explicitly programmed – Arthur Samuel (1959)
  - Often a piece of software

- **Data Science**
  - Science of extracting knowledge and insights from data
  - Often a slide deck

Three kind of machine learning



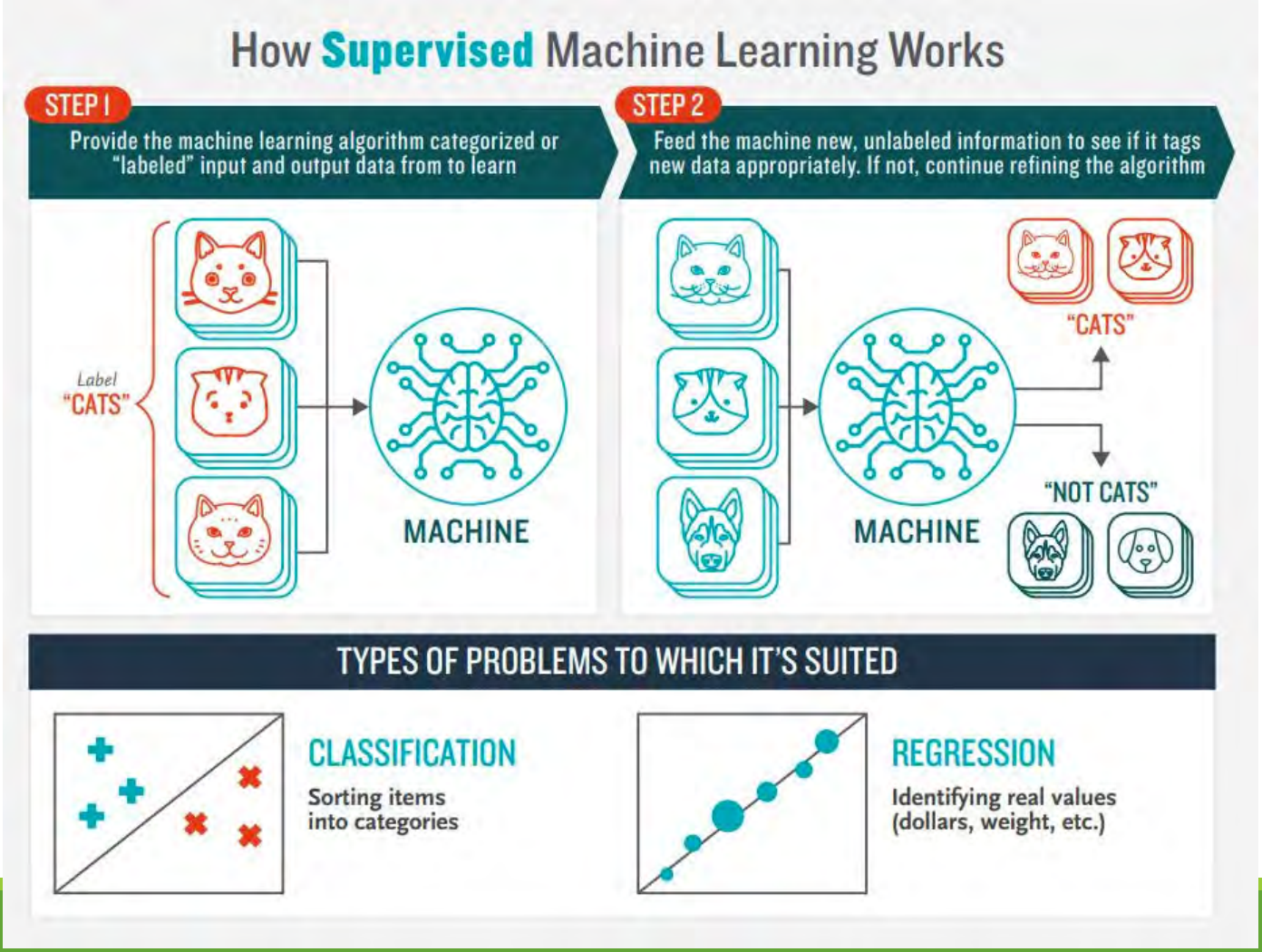
- Labelled data
- Direct feedback
- Predict outcome/future

- No Labels
- No Feedback
- Find hidden structure

- Decision process
- Reward System
- Learn series of actions

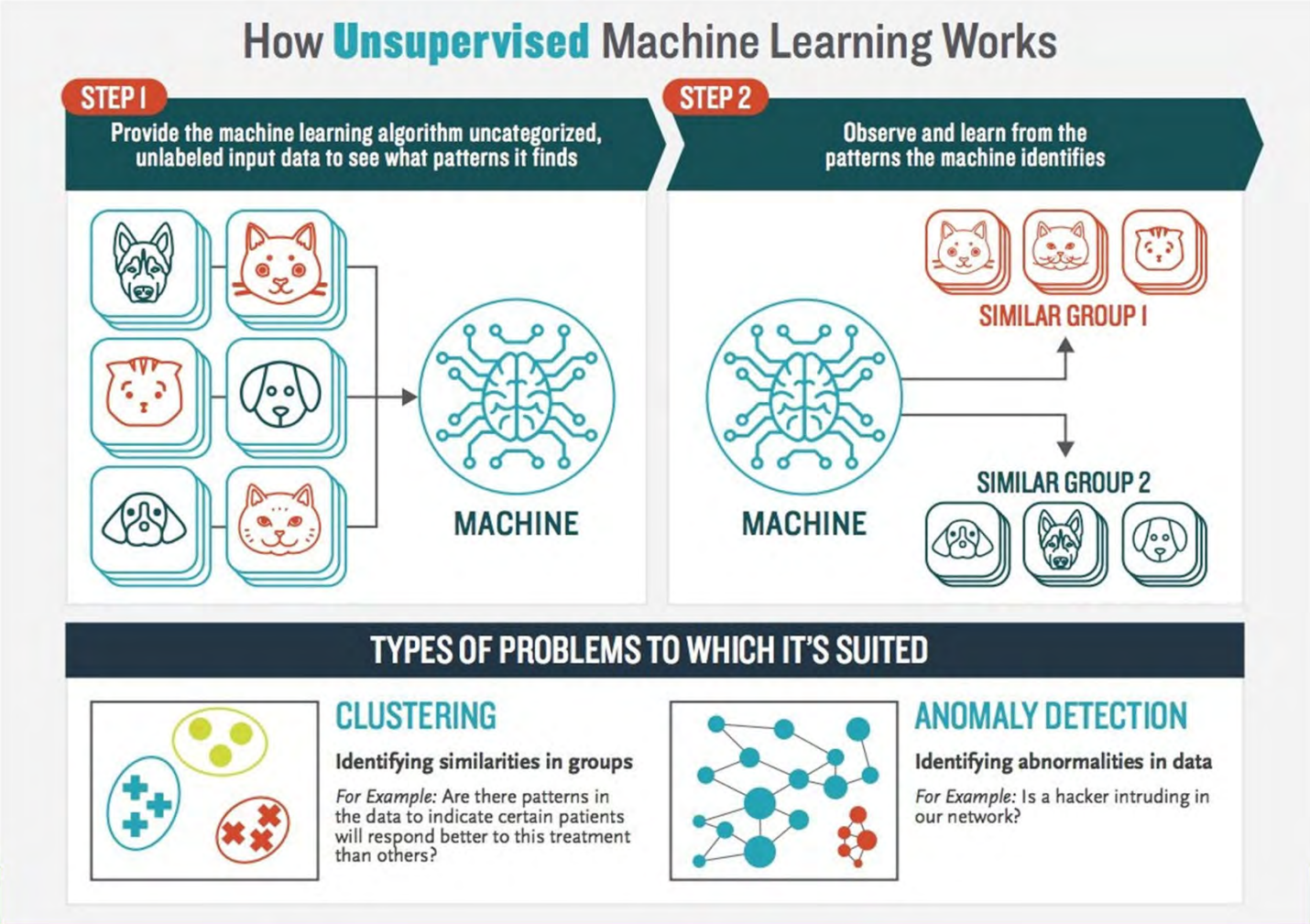
Supervised Learning

Data points have **known** outcome



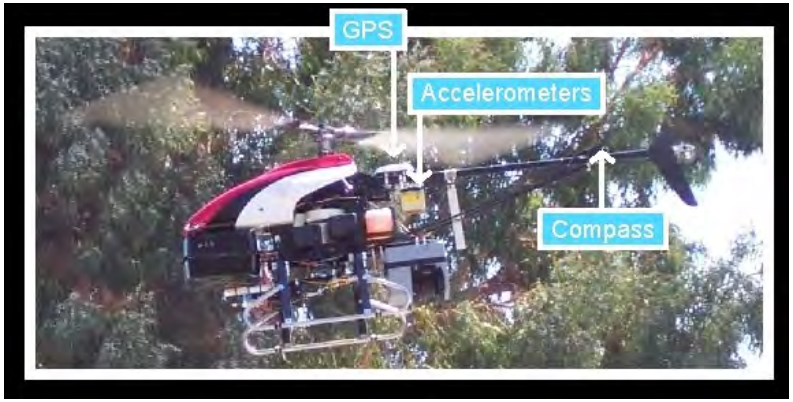
Unsupervised Learning

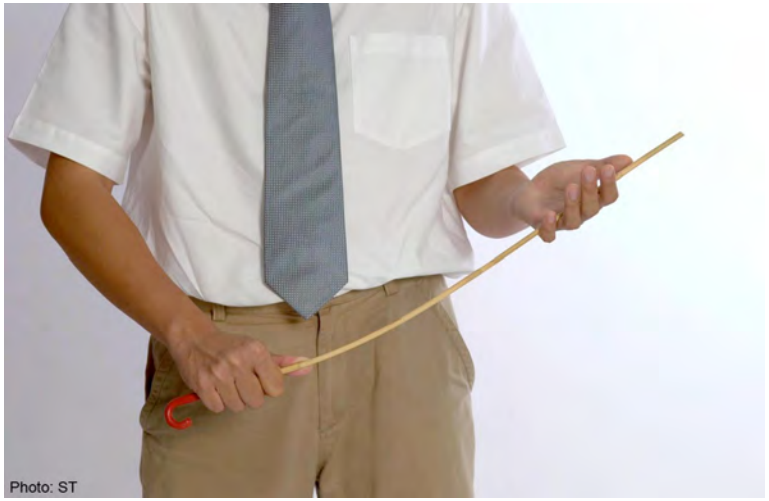
Data points have **unknown** outcome

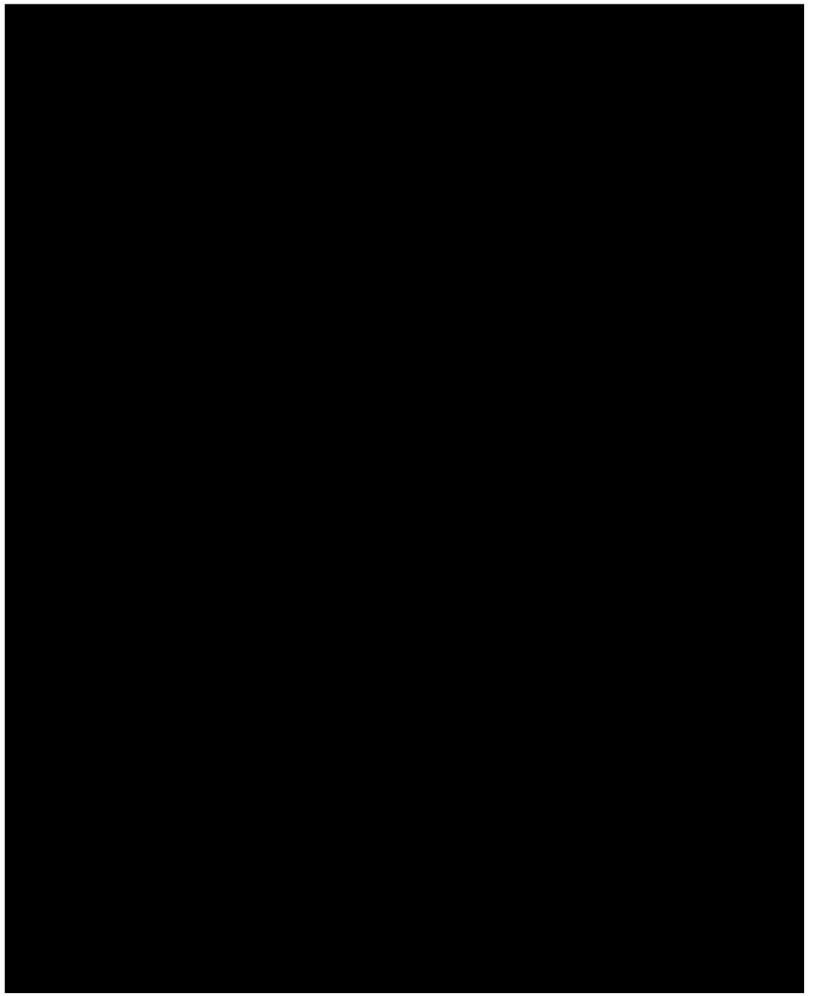


Reinforcement Learning

- Reinforcement learning







Source: https://slidetodoc.com/robots-and-brains-andrew-ng-associate-professor-of/

5 fundamental questions

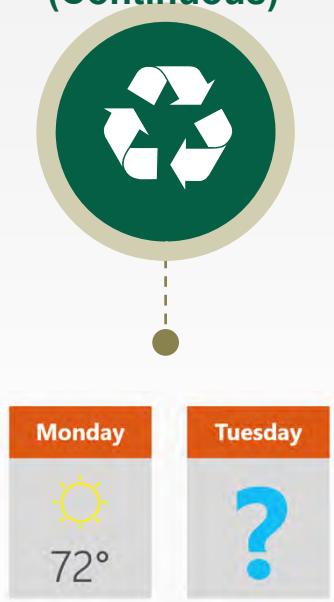
Is this weird? (Anomaly detection)

Is this pressure gauge reading normal?
Is this message from the internet typical?

Is this A or B? (Classification) (discrete values)

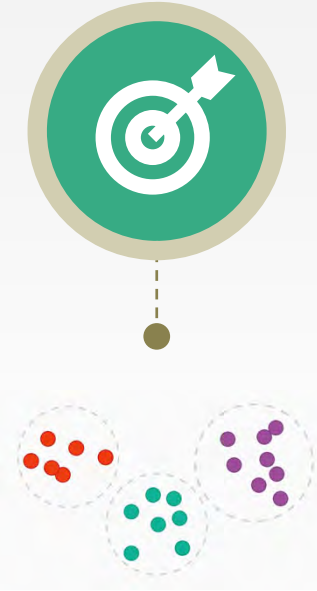
Will this tire fail in the next 1,000 miles: Yes or no?
Which brings in more customers: a $5 coupon or a 25% discount?

How many? How Much? (Regression) (Continuous)



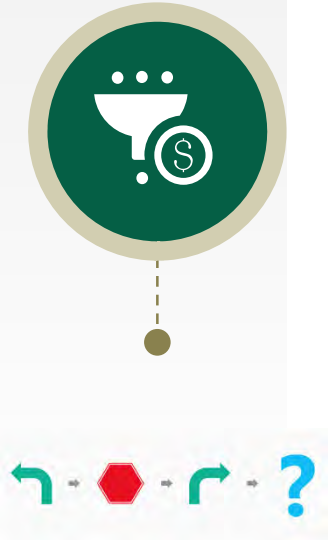
What will the temperature be next Tuesday?
What will my fourth quarter sales be?

How is this organized? (Clustering)



Which viewers like the same types of movies?
Which printer models fail the same way?

What should I do? (Reinforce Learning)



If I'm a self-driving car: At a yellow light, brake or accelerate?
For a robot vacuum: Keep vacuuming, or go back to the charging station?

Type of machine learning

Labeling email as spam or not-spam

- Anomaly Detection
- **Classification**
- Regression
- Clustering
- Reinforcement learning

Type of machine learning

Identifying trends amongst a group of people who have bought a new music release

- Anomaly Detection
- Classification
- Regression
- **Clustering**
- Reinforcement learning

Type of machine learning

Predicting the strength of a password

- Anomaly Detection
- **Classification**
- **Regression**
- Clustering
- Reinforcement learning

Type of machine learning

Does this foot look unusual?

- **Anomaly Detection**
- Classification
- Regression
- Clustering
- Reinforcement learning

Machine Learning Example

- Suppose you wanted to identify fraudulent credit card transactions.
- You could define features to be:
  - Transaction time
  - Transaction amount
  - Transaction location
  - Category of purchase
- The algorithm could learn what feature combinations suggest unusual activity.

Machine Learning Limitations

- Suppose you wanted to determine if an image is of a cat or a dog.
- What features would you use?
- This is where **Deep Learning** can come in.

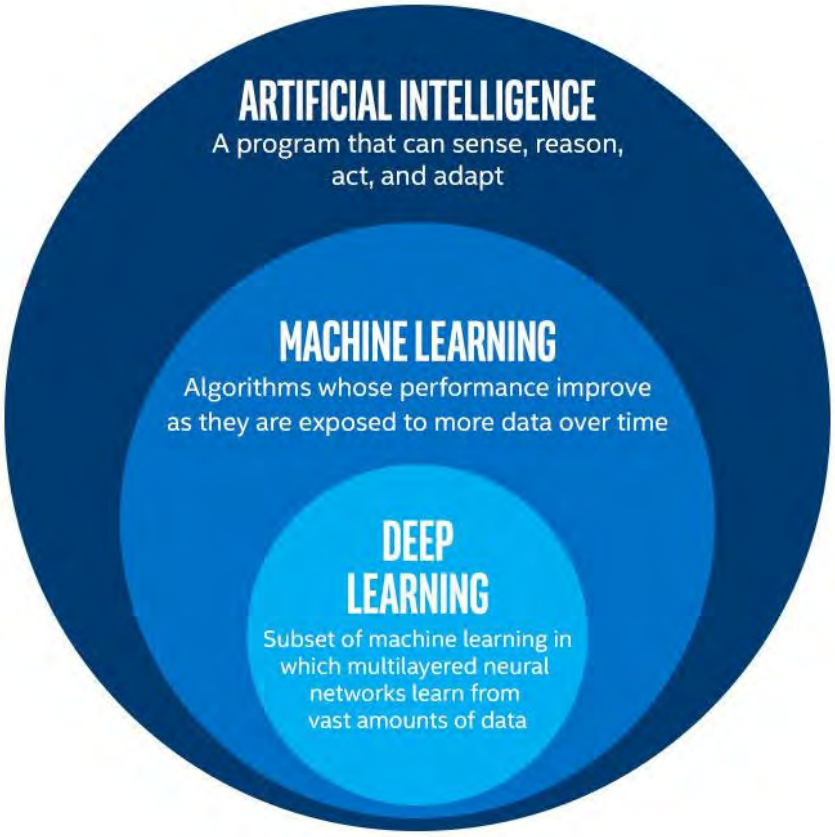
Dog and cat recognition

What is deep learning?

Deep Learning

"Machine learning that involves using very complicated models called "deep neural networks"." (Intel)

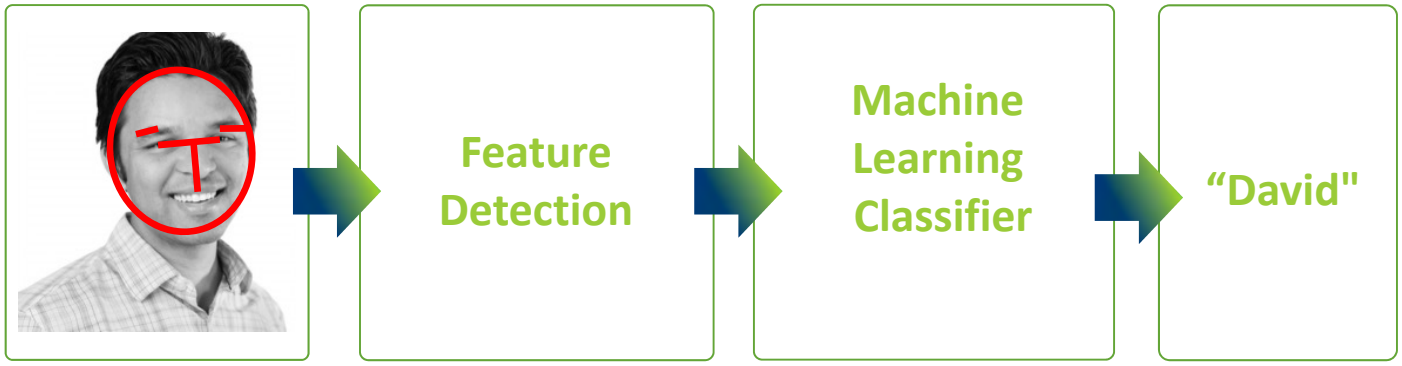
Models determine best representation of original data; in classic machine learning, humans must do this.



Deep Learning Example

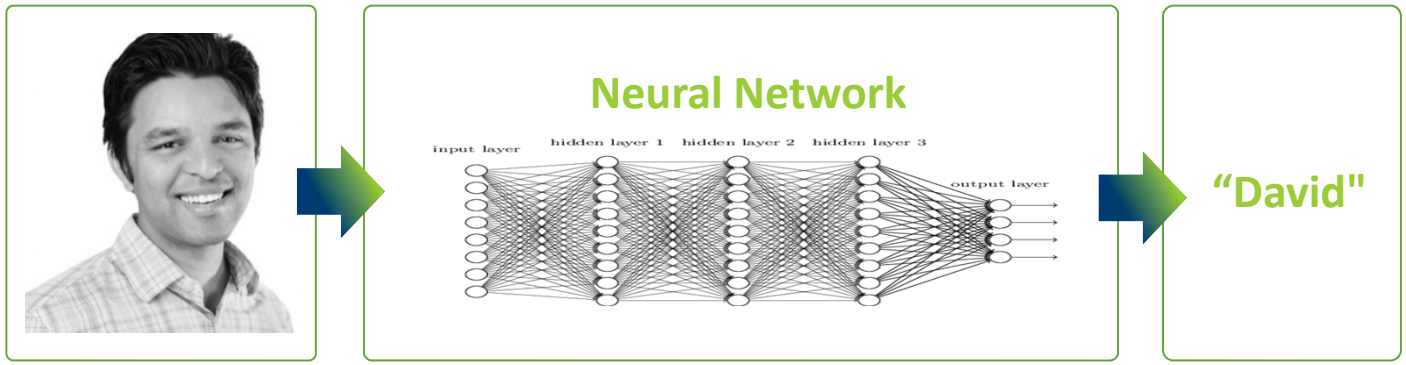
Classic Machine Learning

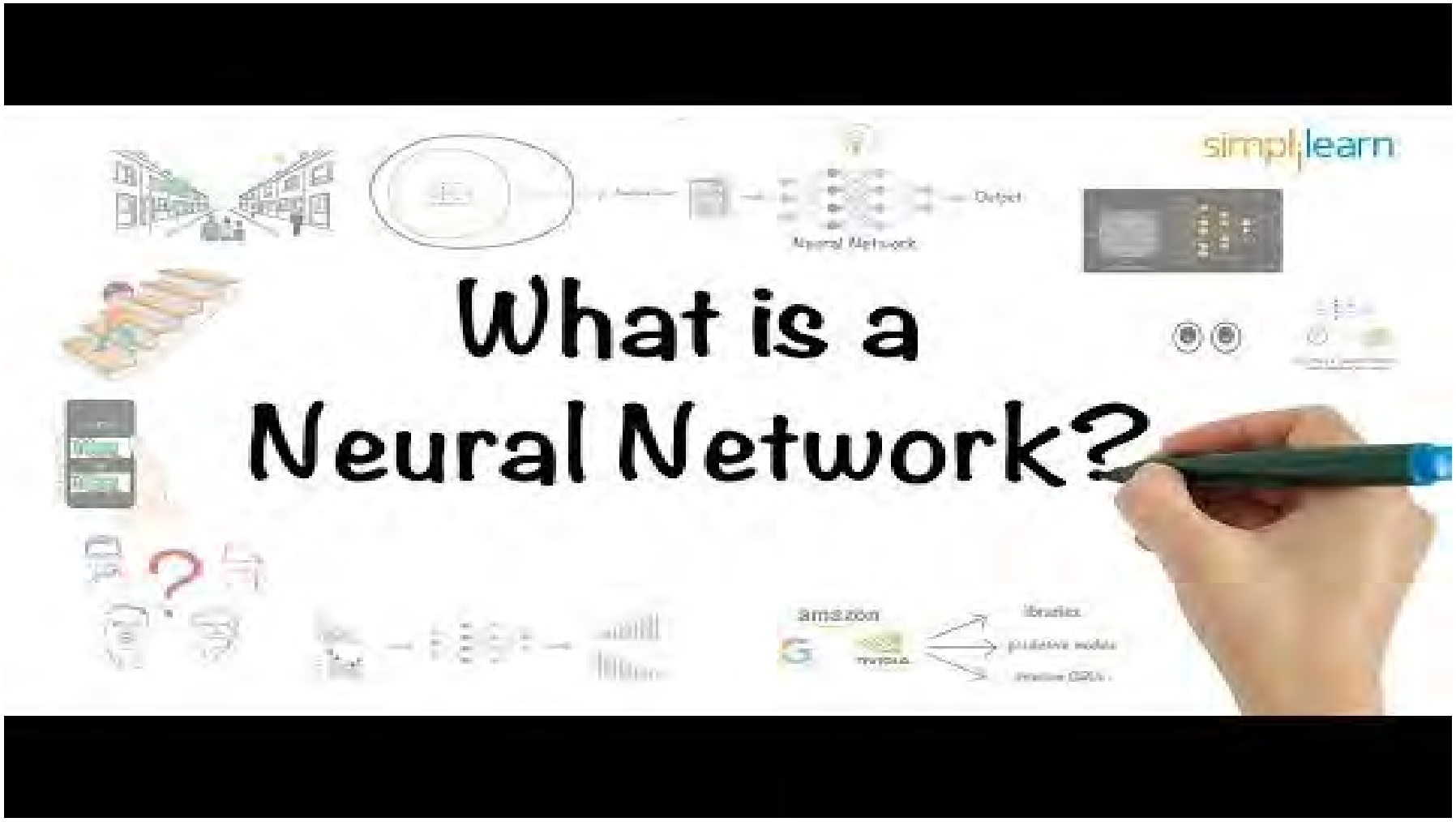
Step 1: Determine features.
Step 2: Feed them through model.



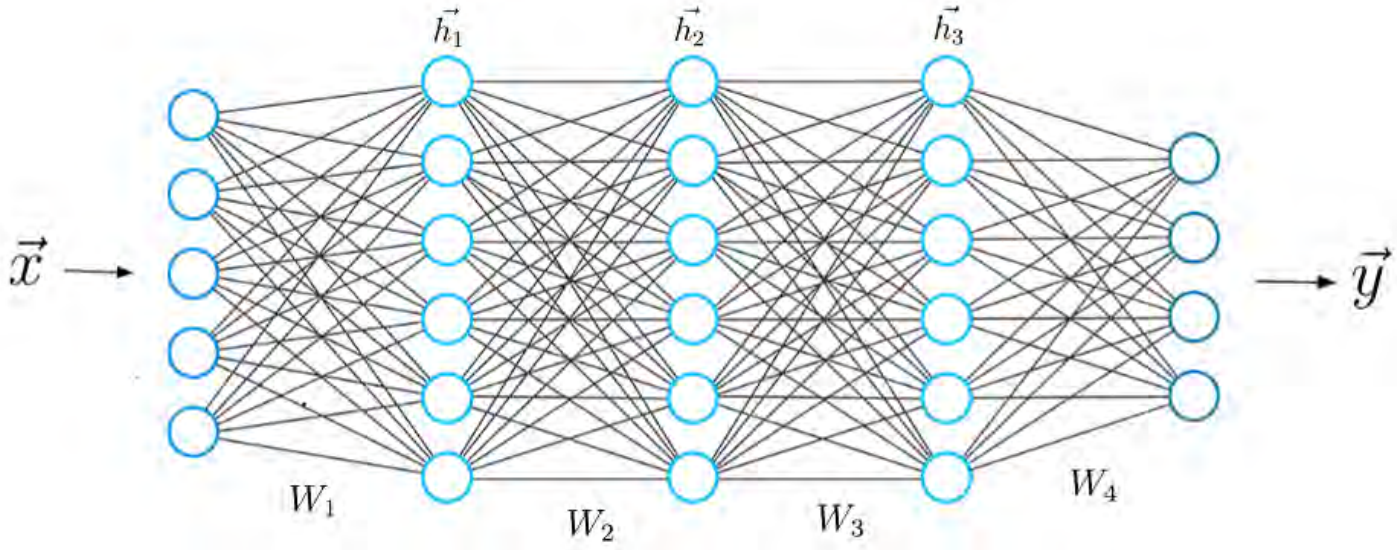
Deep Learning

Steps 1 and 2 are combined into 1 step.



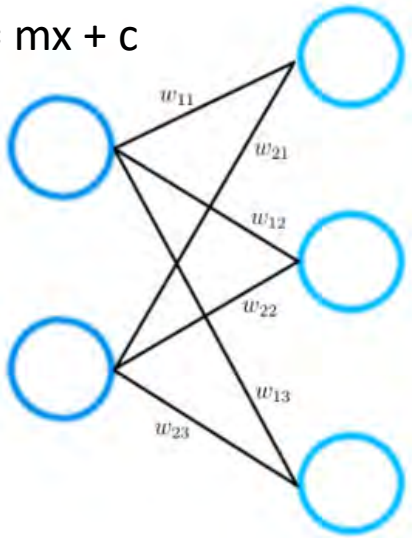

simplilearn
Output
Neural Network
What is a
Neural Network?

Neural Networks

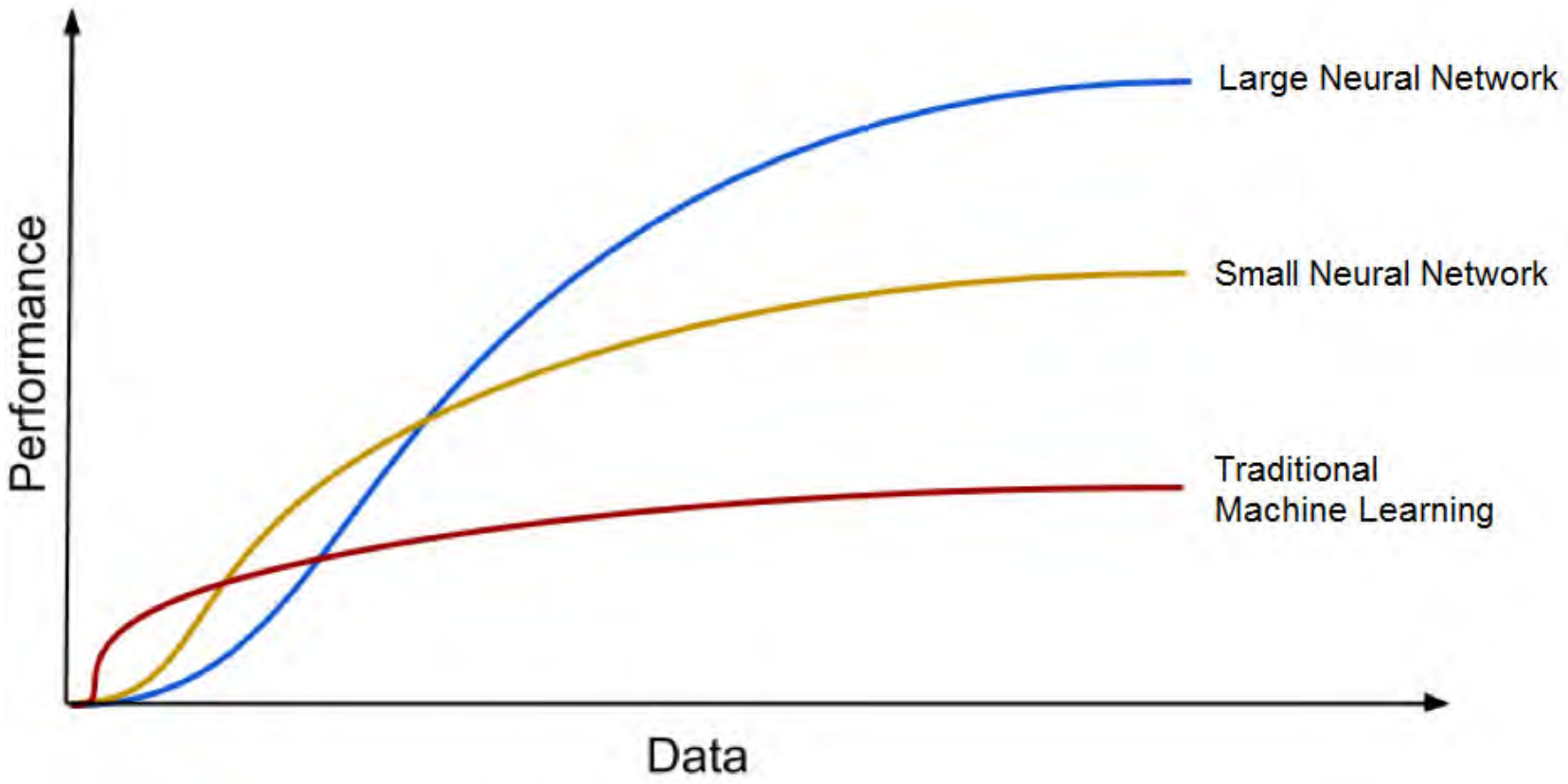


The challenge in training a neural network is finding a set of weights the give the most accurate output.

y = mx + c

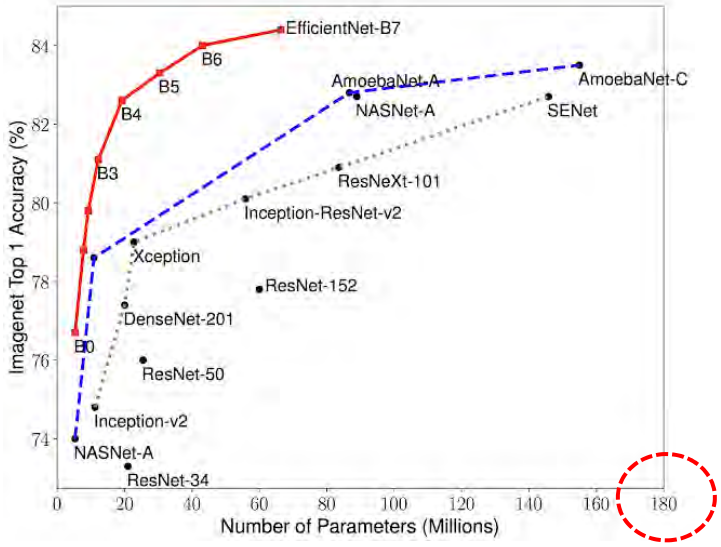


Performance



Deep Learning Algorithms get better with the increasing amount of data.

Size



Huge models, large companies and massive training costs dominate the hottest area of AI today, NLP.

Note: The number of parameters indicates how many different coefficients the algorithm optimizes during the training process.

stateof.ai 2020

Tools

Frameworks

PyTorch

TensorFlow

scikit learn

Visualisation and experiment tracking

TensorBoard

Weights & Biases

neptune.ai

mlflow

AutoML

H2O

dataiku

DataRobot

ML infrastructure and compute

Paperspace

Lambda

FLOYDHUB
The fastest way to build, train, and deploy deep learning models
PyTorch Caffe

colab

Edge On-device Inference

ONNX RUNTIME

Core ML

Cloud inference & ML as a service

Amazon SageMaker

Azure Machine Learning

Google Cloud

Low Code / Code Free

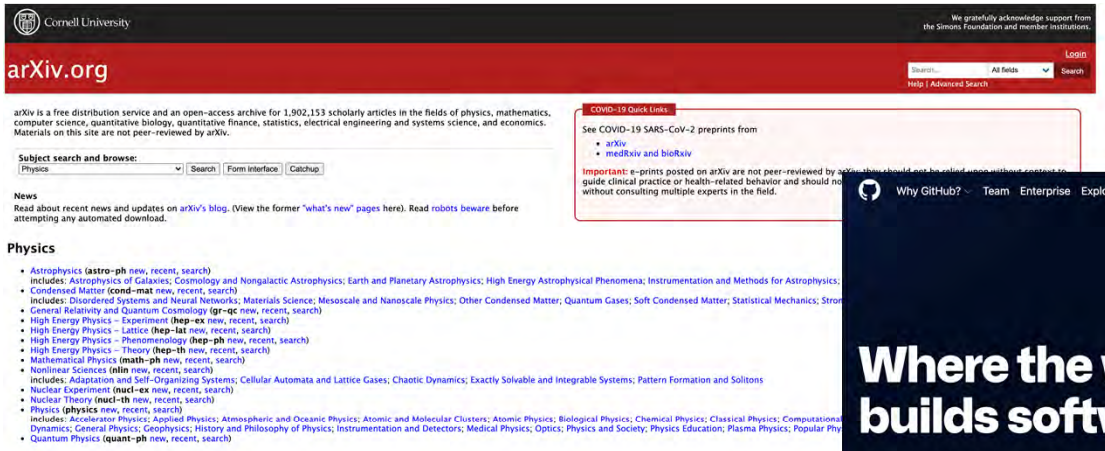
Open for Innovation KNIME

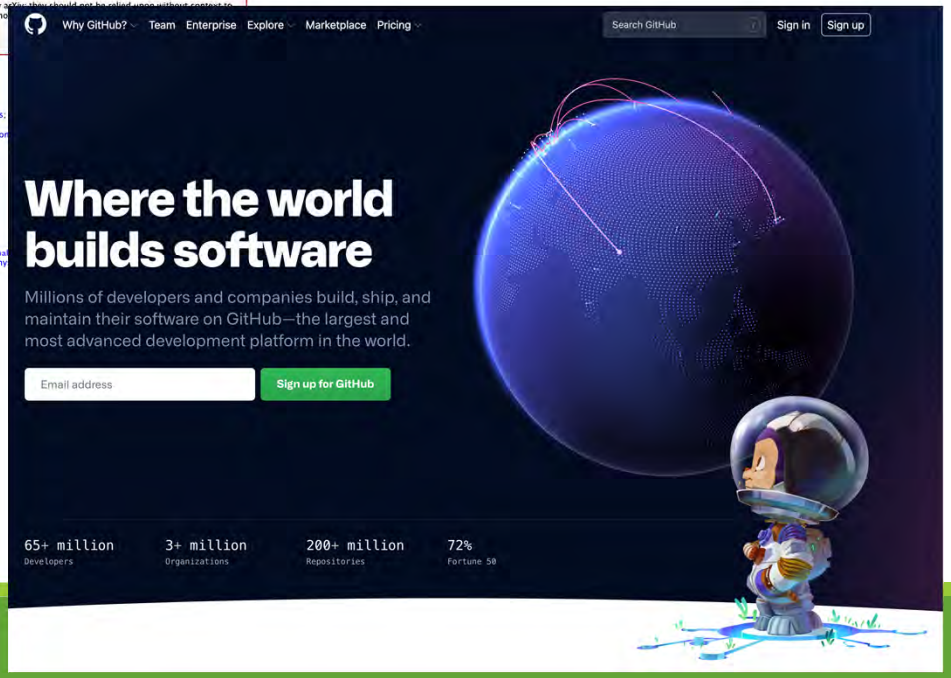
lobe

PELTARION

ML Technical Tools

- Research Publications
  - Arxiv
- Open source repositories
  - Github

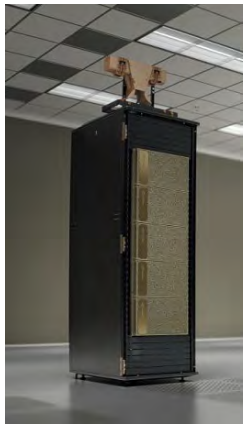




CPU vs GPU

CPU – Central Processing Unit - Computer processor

GPU – Graphical Processing Unit

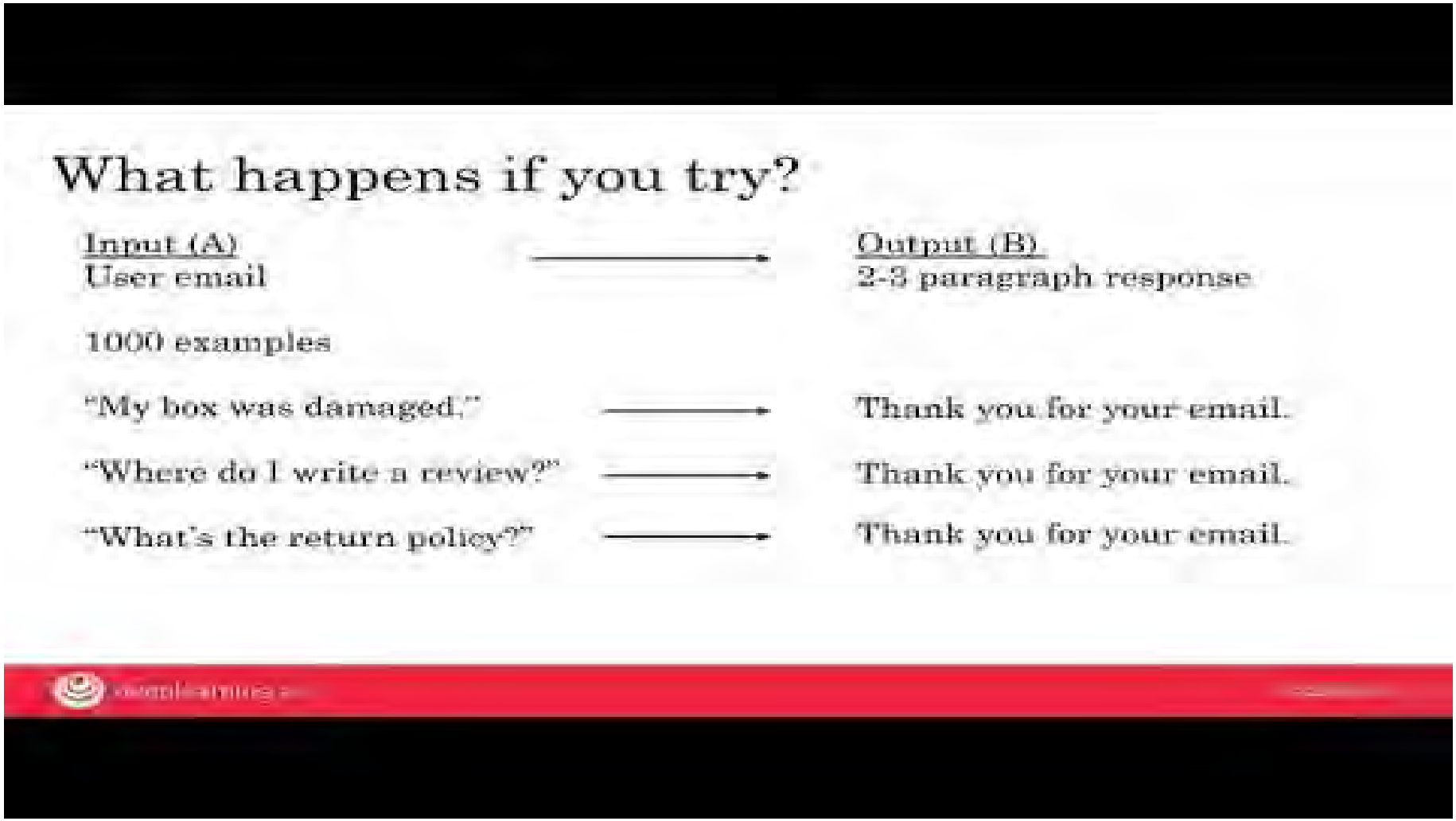


Cloud vs On-premises

10 Mins Break

Back by 11:05

What AI can and cannot do



https://www.youtube.com/watch?v=g89RUEWywPQ

What ML can and cannot do

Input (A)	Output (B)	Application
Email	Spam? (0/1)	Spam filtering
Audio	Text transcripts	Speech Recognition
English	Chinese	Machine Translation
Image, radar info	Position of other cars	Self-driving car
Image of phone	Detect? (0/1)	Visual inspection

Anything you can do with 1 second of thought, we can probably now or soon automate

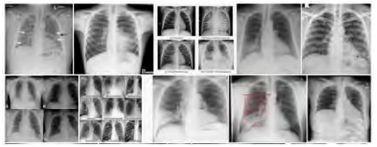
What ML can and cannot do

- The toy arrived two days late, so I wasn't able to give it to my niece for her birthday. Can I return it??

Refund Request

Input text (A) →
Refund/Shipping/Other (B)

Diagnose pneumonia from 10,000 labelled images



Oh, sorry to hear that. I hope your niece had a good birthday. Yes, we can help with ….

Diagnose pneumonia from 10 images of a medical textbook chapter explaining pneumonia

Strengths & Weaknesses of ML

Learning a ”simple” concept (<= 1 sec)

You have lots of data available

Learning complex concepts from small amount of data

Asked to perform on new types of data

Why use AI?

Why use AI	When not to use AI
Solve problems that can't be solved with unintelligent, automated systems	***Repetitive, Deterministic Automation Tasks*** ○ Just code it or record it and be done with it
Simple Rules Don't Work ○ If you can use simple rules processing or workflow, you should ○ Machine learning is probabilistic not deterministic	***Formulaic Analytics*** ○ This is what big data Business Intelligence (BI) platforms are for
Requires Object Identification or Classification ○ You can't easily program image recognition. Let the neural network do it.	***Systems that require 100% accuracy*** ○ If it's trained, then it can't be always right
Pattern matching across large quantities of data ○ Could you build advanced programs without AI to do it? Maybe. ML is easier	***Situations with very little training data*** ○ If you can't train it, then machine learning won't work
Probabilistic vs. Deterministic Patterns ○ If behavior doesn't happen the same way every single time, consider AI.	***Situations where hiring a person is easier, cheaper, and faster*** ○ Sometimes the human brain just wins out
Advanced Statistics or Analytics is Too Complex ○ Machine learning does better than non-learning formulas.	***A need to do "AI" without understanding what it is or what it's for*** ○ There's lots of value in AI without being vague

Use case sharing

Case Study : Smart Speaker

"Hey device, tell me a joke"

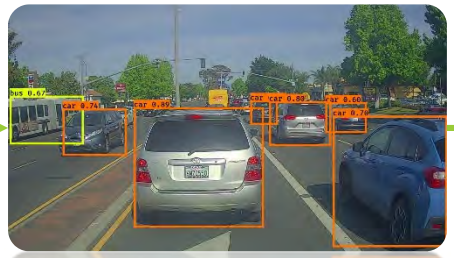
Trigger word, wake word detection	Speech recognition	Intent recognition	Execution
Audio → *"hey device"* ? (0/1)	Audio → *"Tell me a joke"*	*"Tell me a joke"* → Joke? Time? Music? Call? Weather?	A piece of software that can randomly get a joke and tell the user

Case Study : Smart Speaker

"Hey device, set timer for 10 minutes"

Trigger word, wake word detection	Speech recognition	Intent recognition	Execution
Audio → *"hey device"* ? (0/1)	Audio → *"set timer for 10 minutes"*	*"set timer for 10 minutes"* → timer	a) Extract duration "set time for 10 minutes" "let me know when 10 minutes is up" b) Set timer with set duration

Case Study : Self-driving Car



Car detection

Image
Radar
Lidar

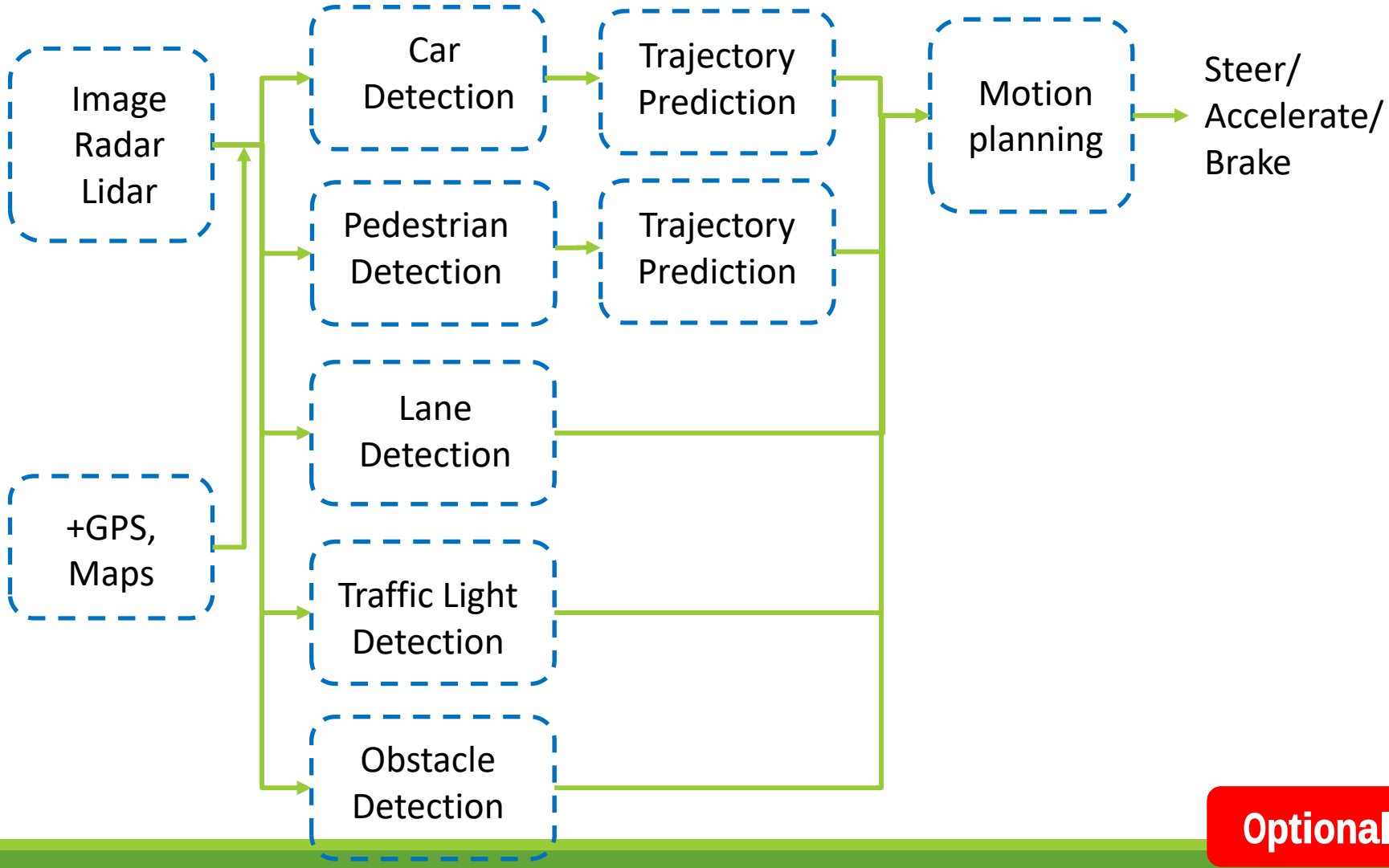
Motion planning

Steer/
Accelerate/
Brake

Pedestrian detection

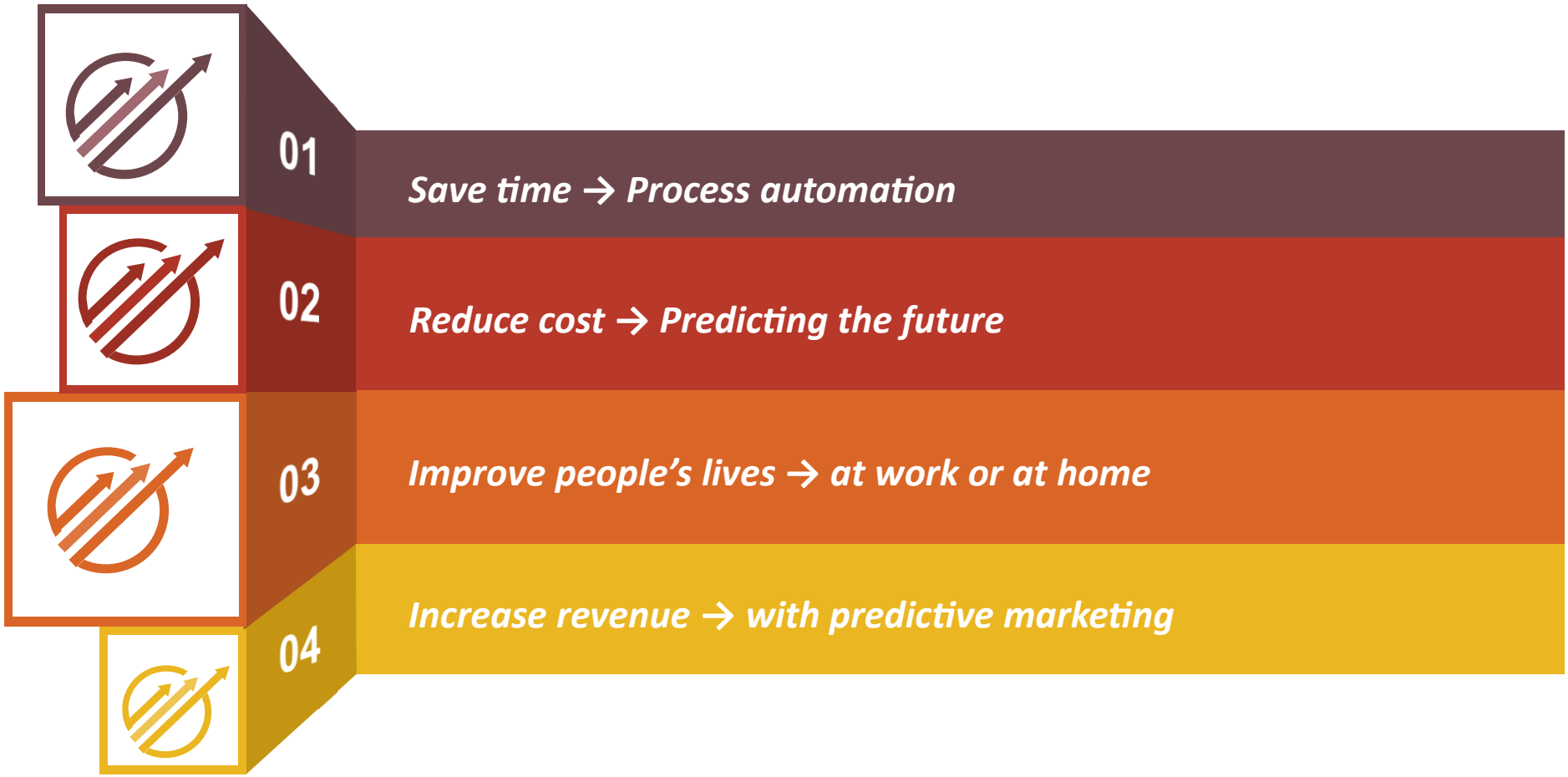
Optional

Case Study : Self-driving Car



Optional

Create successful AI use cases and projects



How?

- Achieving the greater levels of ***productivity***
- Improving ***accuracy***
- Improving ***reliability***
- Eliminating ***drudgery and dull tasks***
- Improving ***relevance***
- Achieving ***greater scale***
- Enabling ***continuous monitoring and auditing***
- Extracting *more value from data*
- Providing ***assistance to those in need***

AI team composition

- Example Roles
  - Software Engineer -> Joke execution, ensure self-driving reliability
  - Machine Learning Engineer -> generate A->B mapping,
  - Machine Learning Researcher -> extend sota in ML
  - Applied ML Scientist -> between the two above.
  - Data Scientist -> still evolving, examine data and provide insights, make presentation to team/executive
  - Data Engineer
    - Organizing data,
    - Make sure data is saved in an easily accessible, secure and cost effective way.
  - AI Product Manager
    - Help decide what to build, what's feasible and valueable

Skills frameworks : https://www.skillsfuture.gov.sg/skills-framework/ict

Data and Artificial Intelligence

https://www.imda.gov.sg/-/media/IMTalent-Portal-Revamp/3-Guidances/Skills-Planning/SF-ICT/ICT-Navigation-Tool-2020.pdf

Optional

AI team composition

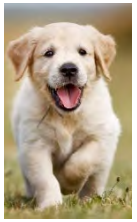
- Getting started with a small team
  - 1 software engineer, or
  - 1 machine learning engineer/data scientist
  - Nobody but yourself

Optional

Major AI Application

Computer Vision

Image classification/Object Recognition



Dog

- Face recognition

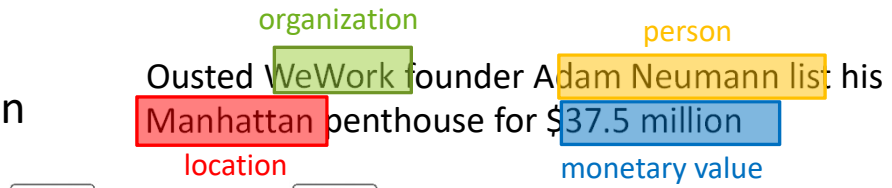
- Object Detection

- Image Segmentation

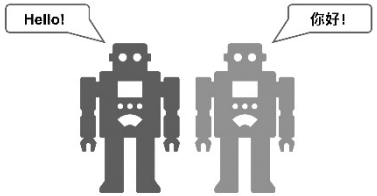
- Style Colorization

Major AI Application

- Natural Language Processing
  - Text Classification
    email → Spam/Non-Spam
    Product description → Product category
  - Sentiment recognition
    "The food was good" → ♥ ♥ ♥ ♥
    "Service was horrible" → ♥
  - Information retrieval
    Web search
  - Name entity recognition



  - Machine translation



NLP task website: https://nlpprogress.com/

Major AI Application

- Speech
  - Speech recognition (speech-to-text)
  - Trigger word/wakeword detection
  - Speaker ID
  - Speech synthesis (text-to-speech, TTS)

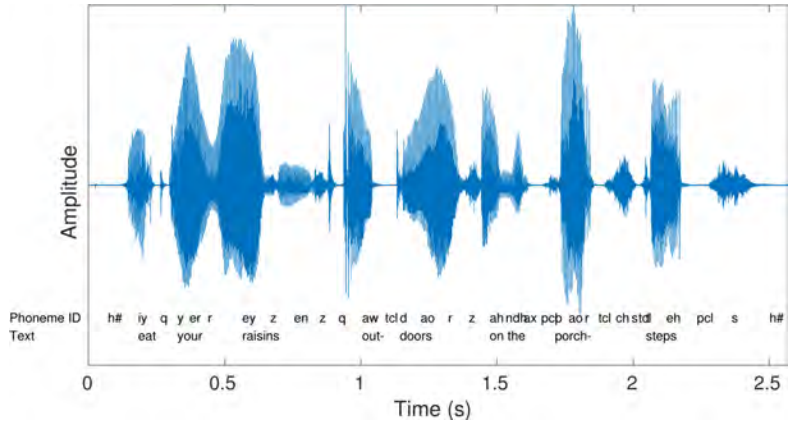


Image source: https://wiki.aalto.fi/display/ITSP/Waveform

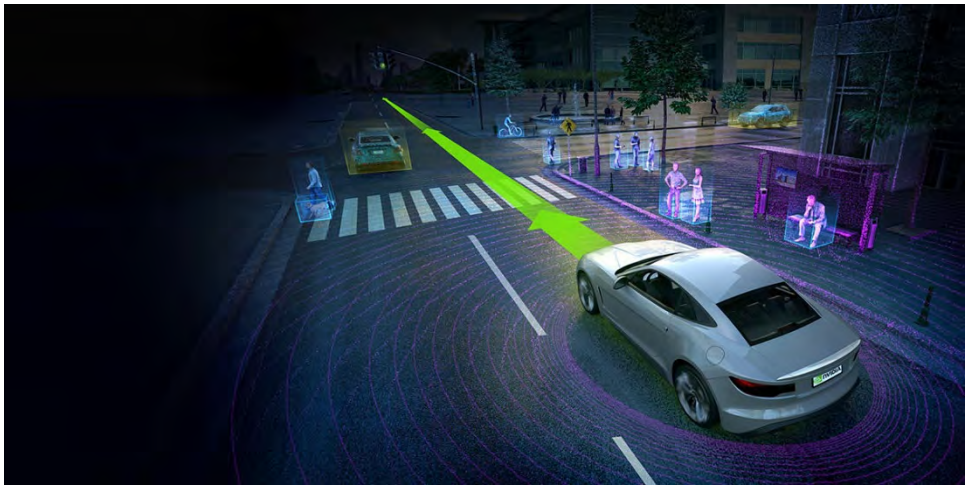
Survey of Major AI Application Area

https://www.youtube.com/watch?v=VDLs4u7l-Aw

Optional

Major AI Application

- Robotics
  - Perception: Figuring out what's in the world around you
  - Motion planning: finding a path for the robot to follow
  - Control: sending commands to the motors to follow a path



Major AI Application

- General Machine Learning
  - Unstructured data (images, audio, text)
  - Structured data

Examples Of AI And ML In Practice

https://www.youtube.com/watch?v=AXgjEW2nA9I

AI/ML workflow

Amazon
Echo / Alexa

Google
Home

Apple
Siri

Baidu
DuerOS

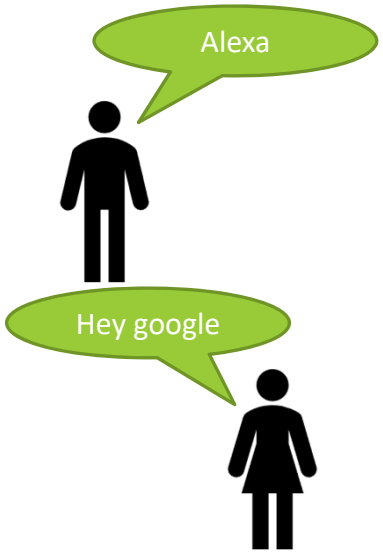
"Hey device, tell me a joke"

Smart Speaker

Collect data

Train model

Deploy model

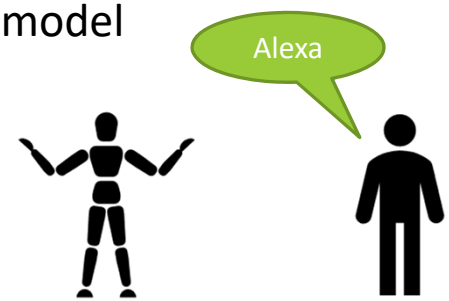


Iterate many times until good enough

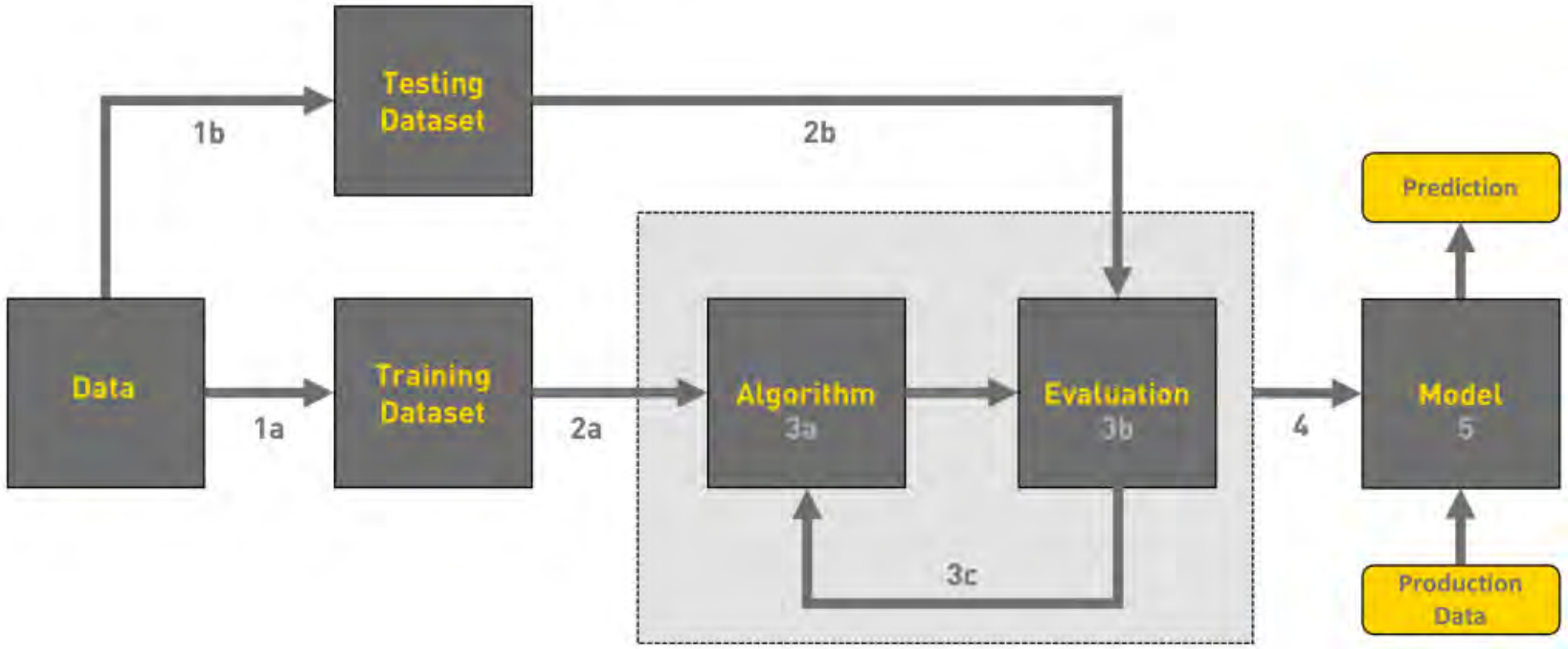
A → B

audio #1 – “Alexa”
audio #2 – “hey google”

Get data back
Maintain/update model

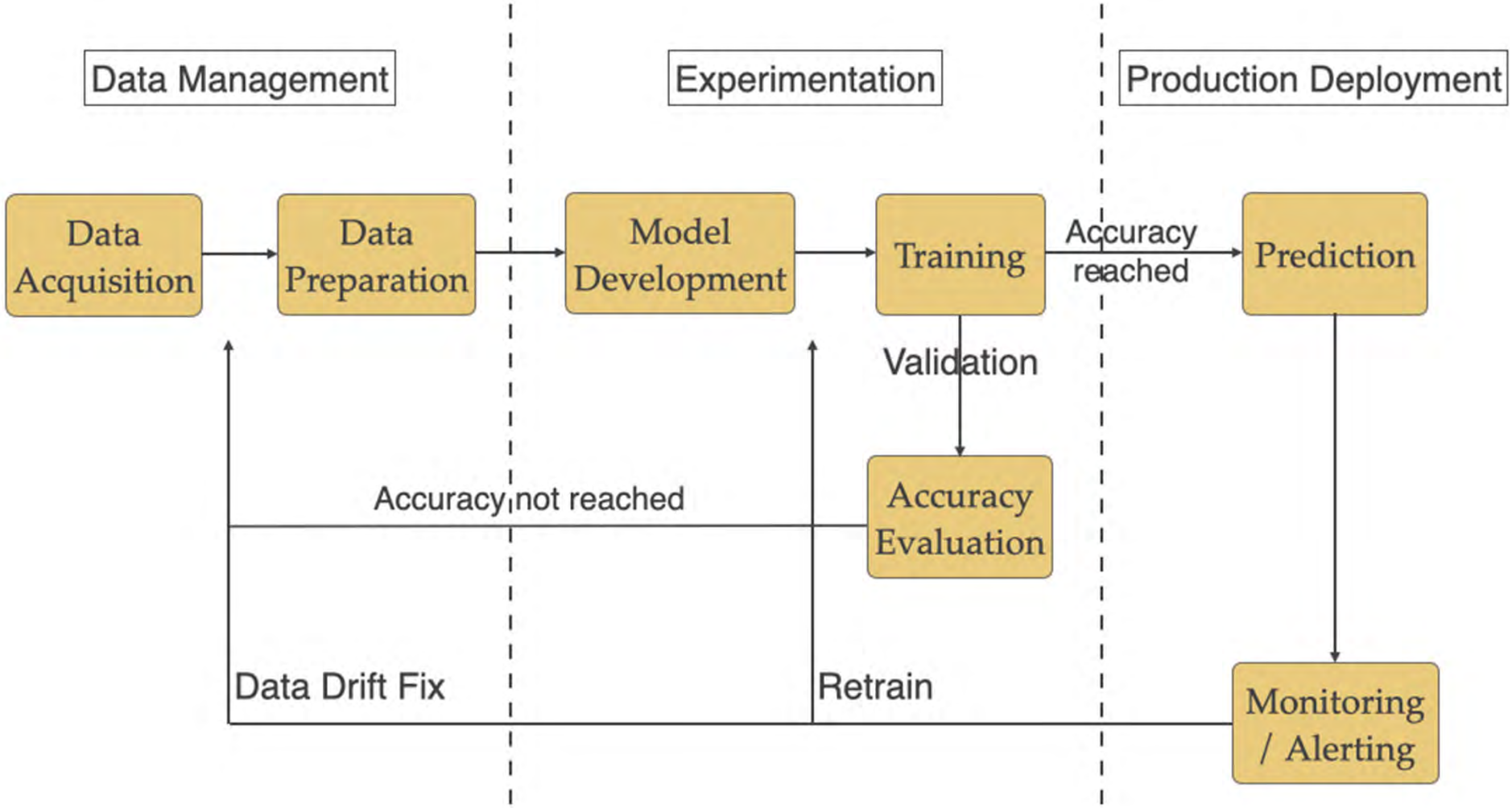


Machine Learning Workflow



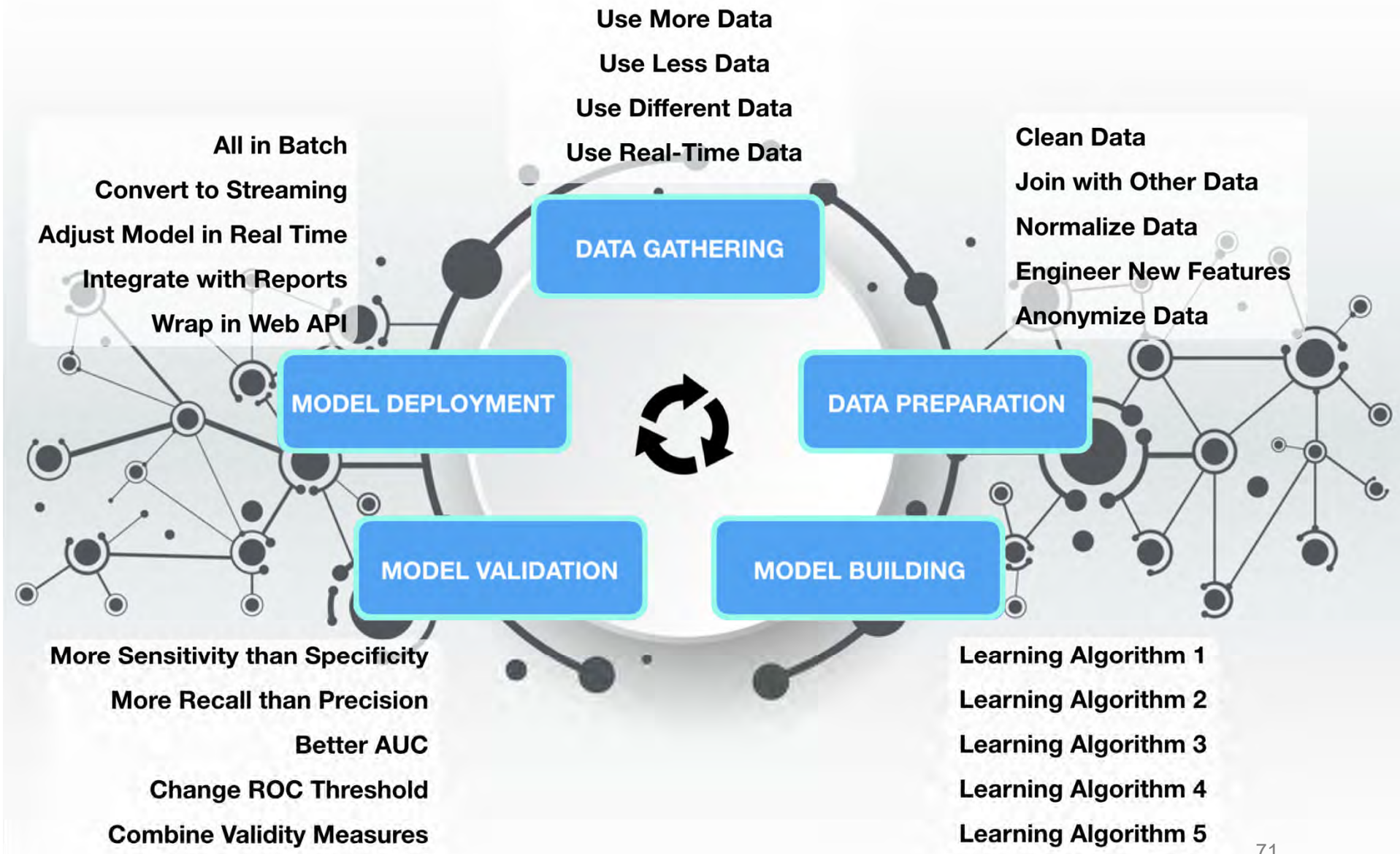
https://towardsdatascience.com/workflow-of-a-machine-learning-project-ec1dba419b94

Machine Learning workflow



Ref: https://towardsdatascience.com/challenges-deploying-machine-learning-models-to-production-ded3f9009cb3

AI/ML Workflow



https://towardsdatascience.com/gui-fying-the-machine-learning-workflow-towards-rapid-discovery-of-viable-pipelines-cab2552c909f

Tools for this workshop

- For this course, we will need the following tools:
  - Numpy
  - Pandas
- We will be focusing on the usage of the tools in this LU and how it can be used.
- The tools are used to input, manipulate and format the data.
- The tools can be used to perform mathematical functions on the data

Relationship between NumPy and Pandas

- Pandas like SciPy and Matplotlib are high level manipulation tools built on top of NumPy
- NumPy is a low level manipulation tool

What is NumPy?

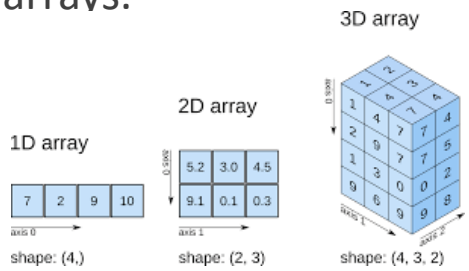
- NumPy is the fundamental package for scientific computing
- Numpy is a Linear Algebra Library for Python
- It is very important to Data Science as almost all of the libraries in the python ecosystem rely on NumPy as one of the key development block
- NumPy is very fast as it has binding to C Libraries

What is included in NumPy?

- Includes functionalities for
  - multidimensional arrays
  - high-level mathematical functions
  - linear algebra operations
  - Fourier transforms
  - pseudorandom number generator

NumPy

- N-dimensional array (**ndarray**) is an important object define in NumPy
- Collection of items of the **same type**
- Items in the collection accessed by **zero-based index**
- Ndarrays comes in **vectors** and **matrices**
  - Vectors: 1d arrays
  - Matrices 2d arrays.



Example of Vectors

$$[1, \quad 2, \quad 3]$$

Example of Matrices

$$\begin{bmatrix} 3, & 4 \\ 5, & 6 \end{bmatrix}$$

- Each item in an ndarray has the **same size memory block**

Python List Vs NumPy Array

- The advantage of NumPy (compared to Python List) are as follows:
  - **requires less memory**
  - **faster to process**
  - **requires less coding**

Usage of NumPy

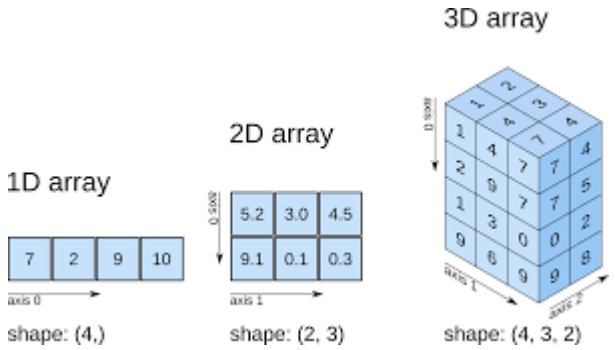
- NumPy arrays are the main way of storing data
- It comes in Vectors and Matrices
- Vectors are 1-D arrays, matrices are 2-D arrays

Example of Vectors

$$[1, \quad 2, \quad 3]$$

Example of Matrices

$$\begin{bmatrix} 3, & 4 \\ 5, & 6 \end{bmatrix}$$



Why we need Structured Data Types

- Define the fields(columns) needed
- Define the data type of the fields(columns) expected from the data
- Needed for reading text files and formatting to the required structure

Built-In Data Type

- NumPy has the following Built-In Data Types:

Data Type	Prefix	Numpy as np
Boolean	‘b’	np.bool_
Integer(signed)	‘I’	np.int
Integer(unsigned)	‘u’	np.uint
Float	‘f’	np.float
Date Time	‘M’	np.datetime64
Unicode String	‘U’	np.Unicode
String	‘S’	np.str

NumPy - Structured data

1. Define the fields (columns) needed
2. Define the data type of the fields (columns) expected from the data

```
student=np.dtype([('name','S20'), ('age', 'i1'), ('marks', 'f4')])
```

3. Adding data to array using the student data type

```
s_array = np.array([('Mary', 21, 50),('John', 18, 75)], dtype=student)
```

NumPy – Accessing Structured data

1. Example:

```
student=np.dtype([('name','S20'), ('age', 'i1'), ('marks', 'f4')])
s_array = np.array([('Mary', 21, 50),('John', 18, 75)], dtype=student)
```

s_array['name'] = [b'Mary' b'John']

s_array[0]['name'] = b'Mary'

s_array[0]['age'] = 21

Activity 1.1 - Numpy

1.1 numpy

- Activity - Numpy

- Creating Numpy arrays
- Methods in Numpy
- Attributes of Array
- Array with Structured data
- Indexing, Slicing and Concatenating Array
- Reading a text file
- Operations
- Statistical Functions

NumPy

Exercises:
- Create an 1-Dimension array of 36 numbers using arange(36) and store in narr1
- Change narr1 to 2-Dimensional Array (4 X 9) and store in narr2
- Change narr1 to 3-Dimensional array (3 X 3 X 4) and store in narr3
- Change narr1 array to 3 Dimensional array (2 X 3 X 3)?
- Advanced Indexing

Step 1:
Watch and listen to the instructor's demonstration

15 mins

Target to finish by 12:30

Step 2:
Work through the activities

30 mins

Individual Activity

60 mins Lunch Break

Lunch break 12:30 - 13:30

Pandas

- A set of Python libraries for data wrangling and analysis
- Useful for early stages of data inspection, preprocessing and data cleaning
- It can work with data from a variety of sources
- It has excellent performance and built-in visualisation features

Save the Panda

Pandas and NumPy

- As mentioned Pandas is built on top of NumPy, with many features that are similar to NumPy
- Likewise, dtype defines the data type that are used in the various Pandas' various Data structure

This is the reason why NumPy is emphasized first

Pandas Data Structure and Dimensions

- Pandas has the following data structures
  - Series
  - Data Frames
  - Panel
- The data structure are built on NumPy
- Pandas reduces the complexities of handling two or higher-dimensional arrays

Overview of Pandas Data Structure and Dimensions

Data Structure	Dimension	Description
Series	1	1D labelled homogeneous array, size immutable. Data is mutable
Data Frames	2	General 2D labelled, data and size mutable tabular structure with potentially heterogeneously typed columns.
Panels	3	General 3D labelled, data and size mutable array.

- All data structures except Series are mutable (can be changed)
- Data Frame is the most common data structure used

Key Points of Series Data Structure

- **One-dimensional** labelled array
- Data needs to be **homogenous**
- The size is **immutable**
- Values of the data are **mutable**

Creation of Series Data Structures

- Series data structures can be created from the following:
  - ndarray
  - dict
  - Scalar

Key Points of **Data Frame** Data Structure

- **Two Dimensional** labelled respectively
- Data can be **heterogeneous**
- **Size and data is mutable**
- Able to perform Arithmetic operations on rows and columns

Columns

Rows

Student ID	Student Name	Student Marks	Student Grade
S001	Tom Hardy	78	B+
S002	Florence Chen	68	C+
S003	S W Koh	83	A
S004	June Loh	43	F

Creation of Data Frame Data Structures

- Data Frame can be created from the following inputs
  - Lists
  - Dict
  - Series
  - Ndarray
  - Another Data Frame

Row Selection and Slicing

- The row from the Dataframe can be retrieved by label or integer
- Use ***loc*** to retrieve by label
- Use ***iloc*** to retrieve by integer

Explanation of Adding Column Code

- A new column can easily added by assigning it to a label as shown in the code

```
df['three']=pd.Series([10,20,30],index=['a','b','c'])
```

The advantage of using the index (label) is to indicate the row of where the elements should be added. The index here is an optional parameter

Deletion of Column from Data Frame

- Using the drop() function
  - Delete a row / column
  - d.drop([column1, column2], axis=1) - delete columns
    - Eg. d = d.drop(['Name', 'Age'], axis = 1)
  - d.drop([row1, row2], axis=0) - delete rows
    - Example: d = d.drop([1, 3, 5], axis = 0)

Sorting the array

- There maybe instances where there is a need to sort the data
  - E.g. Analysing and training certain range of data.
- Two sorting options are available in Pandas:
  - By Label
  - By Actual Value

Sorting by Values

- The array can by sorted by the label(index) using sort_value(). It accept a ‘by’ argument to determine which column to sort
- The array can be sorted by multiple columns. For example:
  - sort_value(by=[‘col1’, ‘col2’])
  - the array will be sorted by col1 followed by col2

Pandas Descriptive Statistics

- Pandas like NumPy has statistical functions

Function	Description
count()	Number of Non Null observations(records)
sum()	Sum of Values
mean()	Mean of Values
median()	Median of values
mode	Mode of Values
std()	Standard Deviation of Values
max()/min()	Maximum and Minimum of values respectively
abs()	Absolute Value
prod()	Product of values
cumsum()/cumprod()	Cumulative sum and product of values respectively

Activity 1.2 – Pandas

Note: You need to start the Jupyter to perform ALL the exercises

(1.2-Pandas)

1 - Creating a Series Data Structure
2 - Accessing Elements in a Series Data Stucture
3 - Creating Data Frames
4 - Loading Data from csv, txt files
5 - Row Selection and Slicing
6 - Deleting Column from Data Frame
7 - Sorting
8 - Merging of Data Frames
9 - Descriptive Statistics

Exercises:
- Complete exercises in colab

Target to finish by 14:35

Step 1:
Watch and listen to the instructor's demonstration

20 mins

Step 2:
Work through the activities

Individual Activity

20 mins

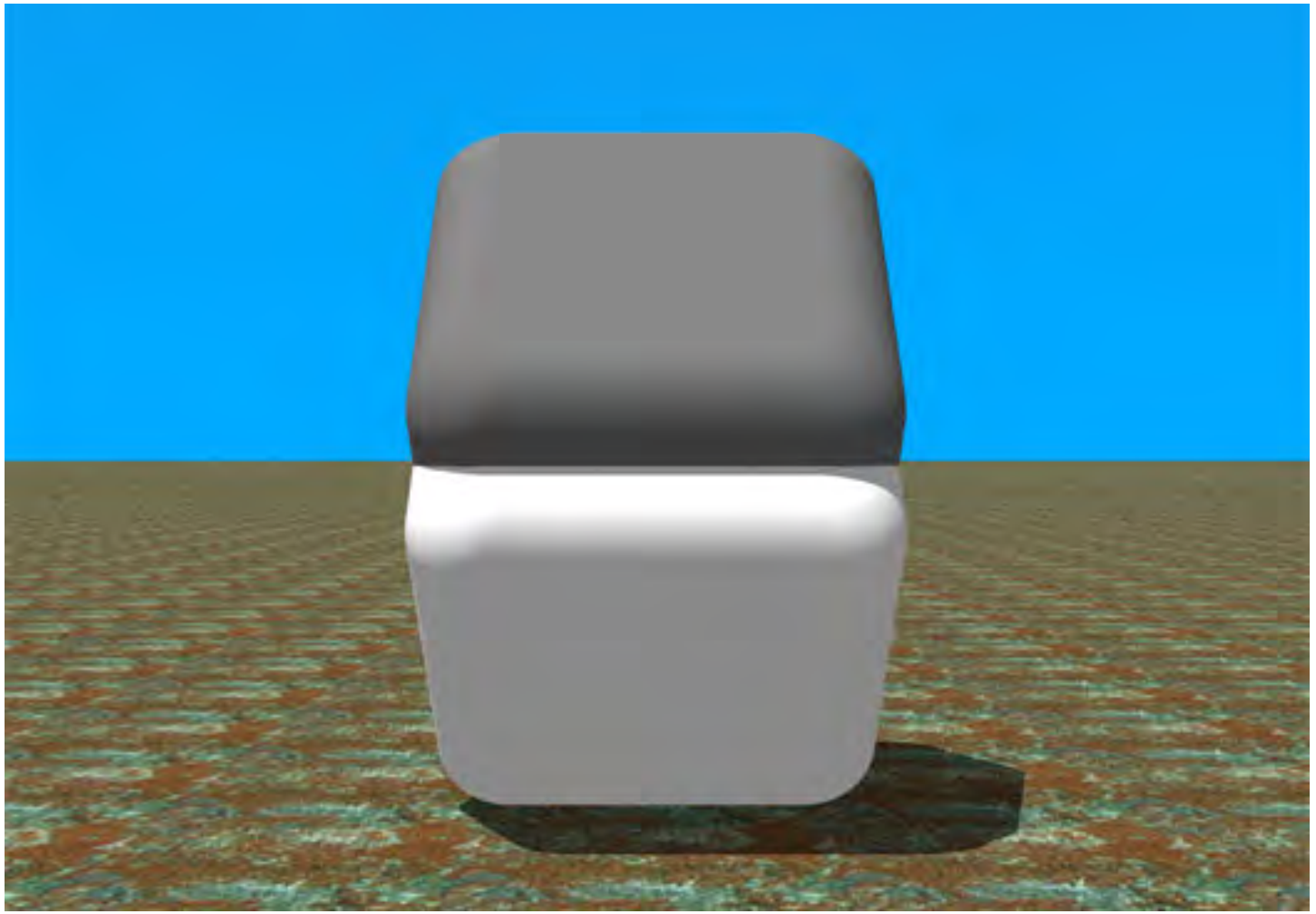
What is Data Visualisation?

Data visualisation is the presentation of **data** in a pictorial or graphical format.

Anytime information is presented in visual format or concept, like a bar graph or pie chart, it is creating data visualisations.

But Data Visualisation is more than just charts and tables! It is an ability to tell a story, connecting one dataset to another!

Seeing is believing… ?



Source: Dr Beau Lotto (www.LottoLab.org) and Jeffrey A. Shaffer, University of Cincinnati

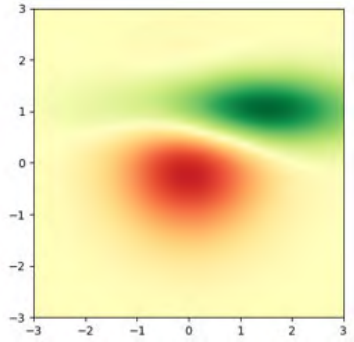
Goals of Data Visualization

- **Explanatory** : Explain data to solve problems.
- **Exploratory** : Explore large data sets for better understanding.

- Data is growing at astronomical rate !
  - How to **manage and present** the data , without losing information, becomes a big challenge.
  - **Too much data** at our disposal could result in the mismanagement in the processing of the data for analysis (especially with inappropriate tools or methods)
- Human Minds work well with Visuals !
  - **Reading charts is easier** than going through pages of rows and columns of numbers

Matplotlib

- In Data Science, very often the data needs to be visualized in order to draw insights from the datasets.
- Basic examples (http://matplotlib.org/examples/)



Installation

- sudo apt-get install libpng12-dev
- sudo apt-get install python-dev
- sudo pip install matplotlib

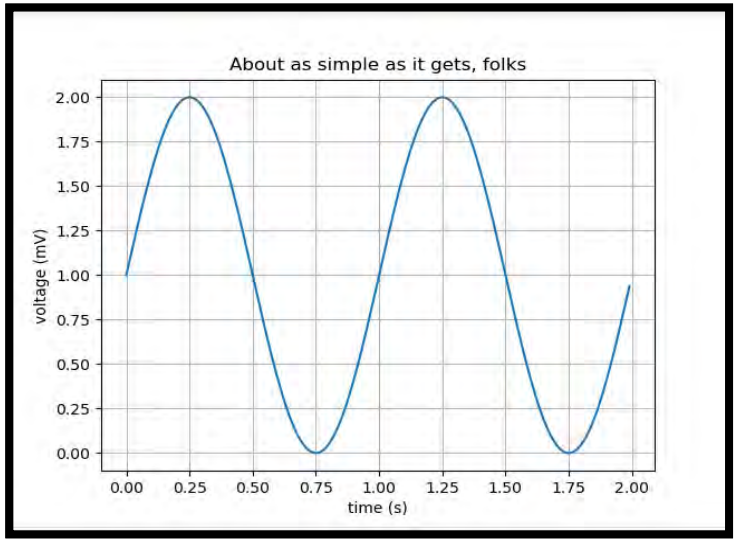
Matplotlib – A simple plot

- Refer to 1.3-Matplotlib

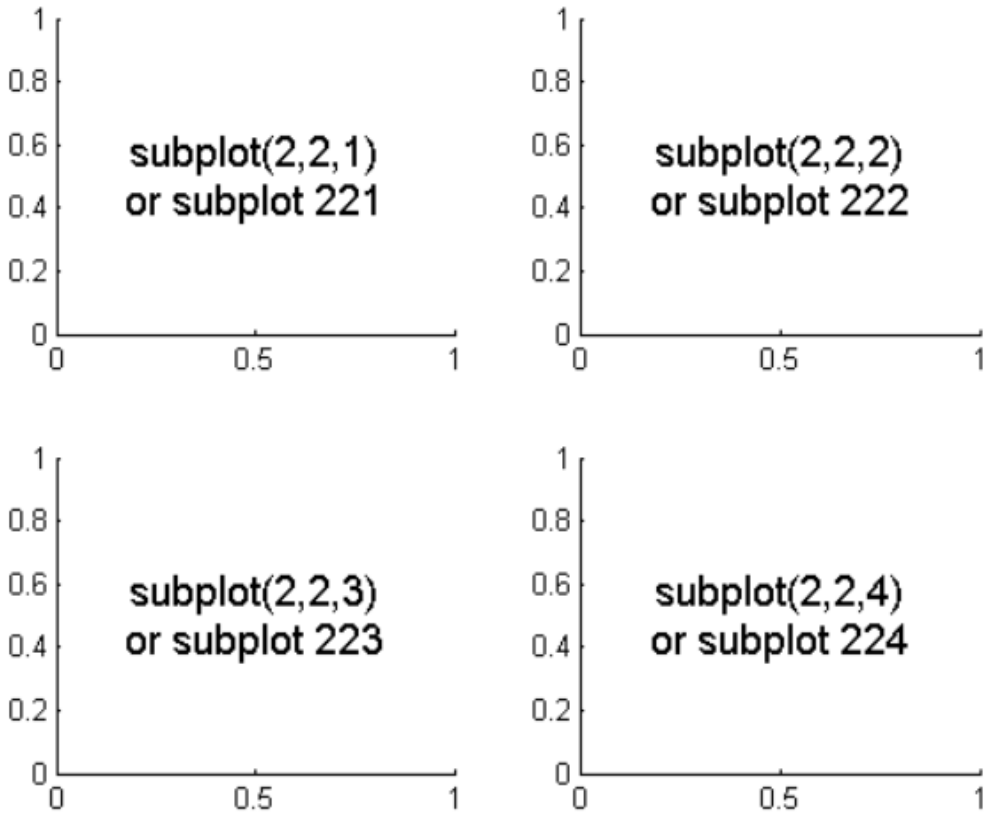
```
from matplotlib import pyplot as plt
years = [1950, 1960, 1970, 1980, 1990, 2000, 2010]
gdp = [300.2, 543.3, 1075.9, 2862.5, 5979.6, 10289.7, 14958.3]

#create a line chart, years on x-axis, gdp on y-axis
plt.plot(years, gdp, color='red', marker='o', linestyle='solid')

#add a title
plt.title("Nominal GDP")

# add a label to the y-axis
plt.ylabel("Billions of $")
plt.show()
```

Matplotlib – A voltage plot

```
import matplotlib.pyplot as plt
import numpy as np

# Data for plotting
t = np.arange(0.0, 2.0, 0.01)
s = 1 + np.sin(2 * np.pi * t)

# Note that using plt.subplots below is equivalent to using
# fig = plt.figure and then ax = fig.add_subplot(111)
fig, ax = plt.subplots()
ax.plot(t, s)

ax.set(xlabel='time (s)', ylabel='voltage (mV)',
       title='About as simple as it gets, folks')
ax.grid()

fig.savefig("test.png")
plt.show()
```



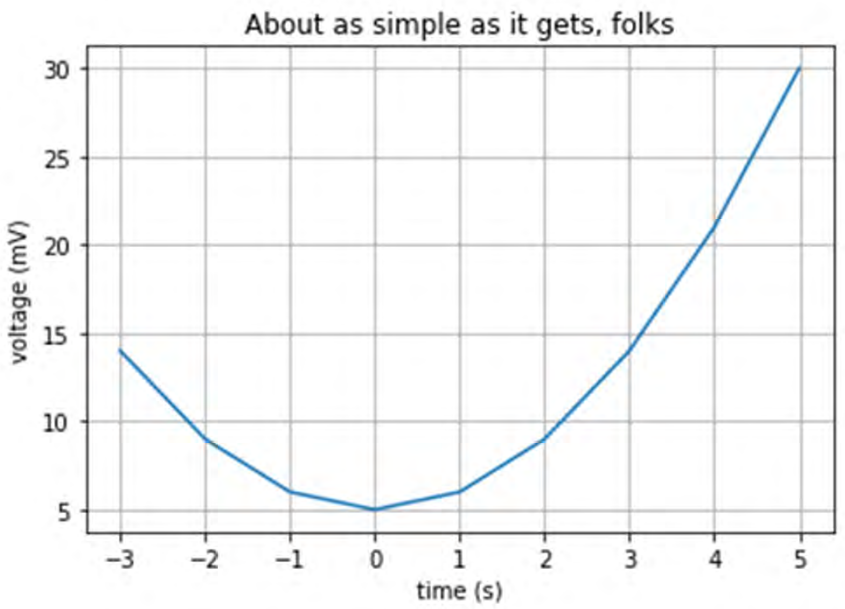
About...subplot(row, column, position)




```
import matplotlib.pyplot as plt
fig = plt.figure()
fig.add_subplot(221)   #top left
fig.add_subplot(222)   #top right
fig.add_subplot(223)   #bottom left
fig.add_subplot(224)   #bottom right
plt.show()
```

(111) = only one subplot or graph

Activity 1.3 – Matplotlib



Exercise:
Use matplotlib to plot the following equation:

$$y = x^2 + 5$$

x-values: -3,-2,-1, 0, 1, 2, 3, 4, 5
y-values: 14,9, 6, 5,6,9,14,21,30

x-label: x axis y-label: y axis

Step 1:
Watch and listen to the instructor's demonstration

15 mins

Step 2:
Work through the activities

Individual Activity

15 mins

15 Mins Break

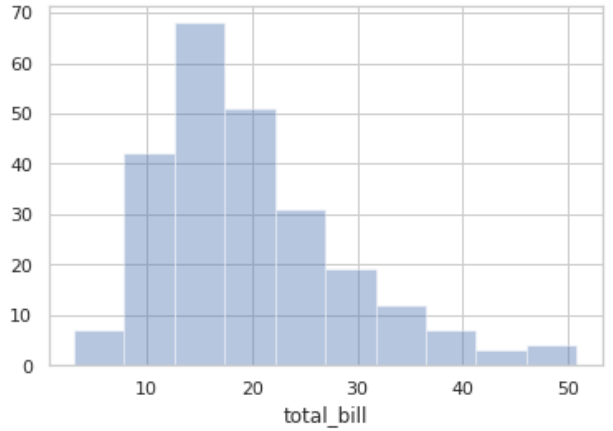
Back by 15:20

Seaborn

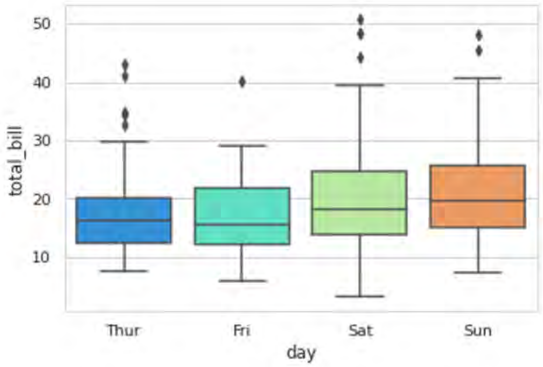
- Python data visualisation library built on top of matplotlib.
- Provides high-level commands, convenient way to create a variety of plot types
- Used typically for statistical data exploration and statistical model fitting.
- Useful and easy options for univariate and bivariate visualization and for comparing data
- Ref: https://github.com/mwaskom/seaborn - documentation and examples

Seaborn

- **Distribution Plots** - to visualise distribution of a data set
  - distplot(…)
  - jointplot(…)
  - pairplot(…)

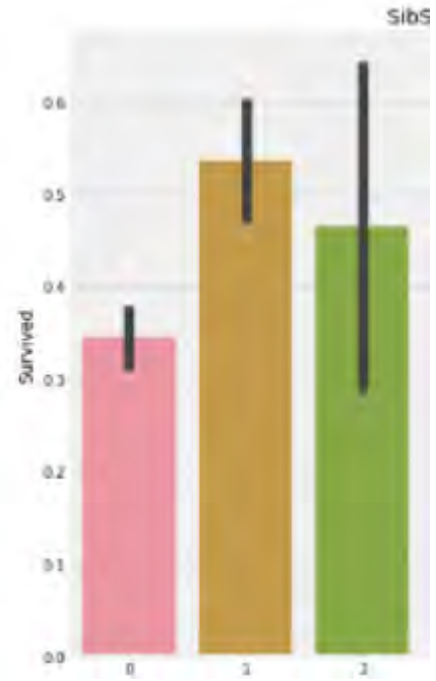


- **Categorical Plots** - to visualise data where one or more variables is “categorical” (divided into discrete groups).
  - countplot(…)
  - barplot(…)
  - boxplot(…)



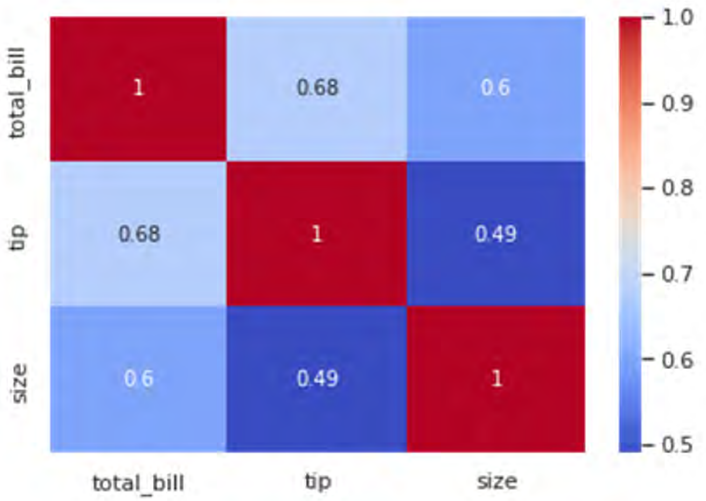
Error bar in barplot

- **Error bar**
  - The error bar is the confidence interval for the variable
  - It is the interval where the 95 % of your variable lies in.
  - How spread the data are around the mean value (small SD bar = low spread, data are clumped around the mean; larger SD bar = larger spread, data are more variable from the mean).

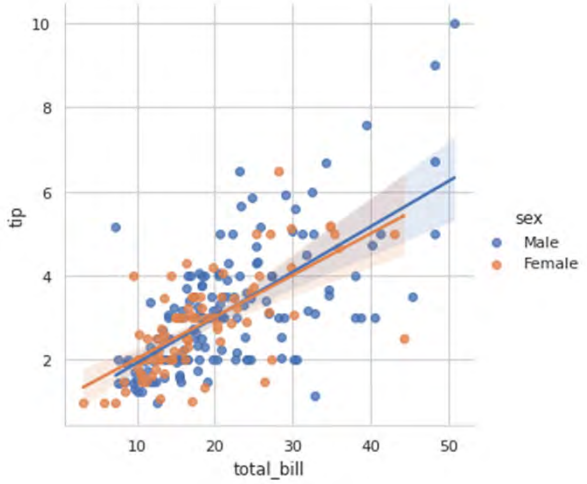


Seaborn

- **Matrix Plots** - to visualise distribution of a matrix data set
  - heatmap(…)
  - clustermap(…)



- **Regression Plots** - to visualise linear regression model or their data and features.
  - lmplot(…)



Activity 1.4 – Seaborn

1 to 5 of 5 entries Filter

index	total_bill	tip	sex	smoker	day	time	size
0	16.99	1.01	Female	No	Sun	Dinner	2
1	10.34	1.66	Male	No	Sun	Dinner	3
2	21.01	3.5	Male	No	Sun	Dinner	3
3	23.68	3.31	Male	No	Sun	Dinner	2
4	24.59	3.61	Female	No	Sun	Dinner	4

Show 25 per page

Like what you see? Visit the data table notebook to learn more about interactive tables.

Step 1:
Watch and listen to the instructor's demonstration

15 mins

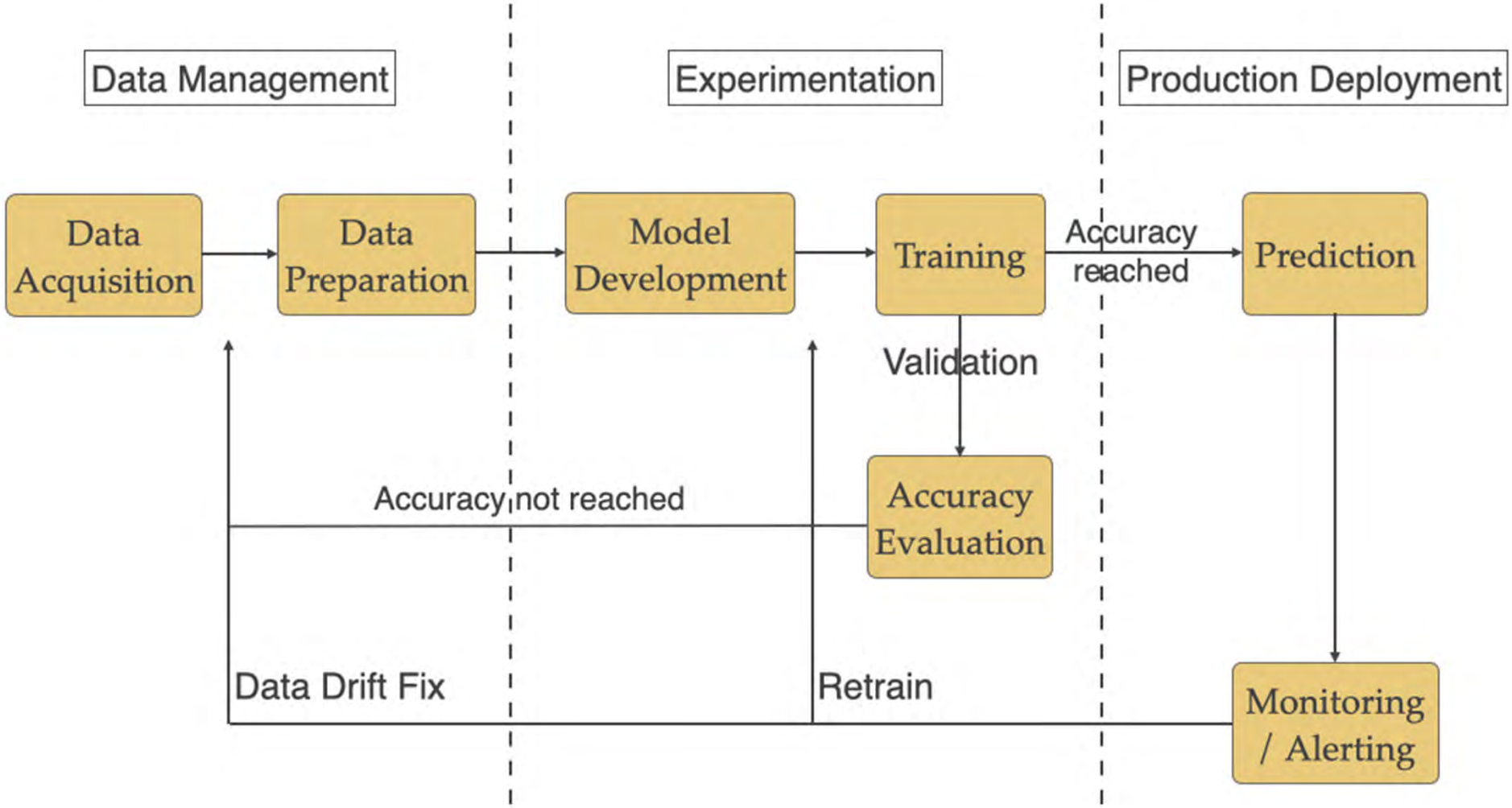
Step 2:
Work through the activities

Individual Activity

15 mins

Data Preparation

Machine Learning workflow



Ref: https://towardsdatascience.com/challenges-deploying-machine-learning-models-to-production-ded3f9009cb3

Data Preparation

- Data can be gathered from many sources and the quality of the data may not be ‘clean’
- Data preparation involves the following
  - Data Cleaning
  - Segmentation of Data for Training, Validation and Testing
- Data scientist will be spending most of the time in data preparation

After the Cleansing

Similarity to data cleansing, we need to clean up the data as the situation when it is gathered may not ideal

Data Cleaning

- Data that are gathered are usually far from ideal as there may be:
  - Incorrect Data Format (e.g. Date should be ivy/mmm/did)
  - Missing Data
  - Incorrect Data Type (e.g. Data is numeric but a string value is given)
  - Data Duplication
  - …. Etc.

It is a tedious tasks that need to be done

https://idatassist.com/avoid-inaccurate-conclusions-through-data-cleaning/

WHY IS IT IMPORTANT!

- Poor data could lead to wrong classification
- When there is wrong classification of data, it will lead to wrong predication and outcome.
- Wrong predication and outcome will be ‘costly’ to the organization

For example, the Land Transport Authority may like to investigate the public transport usage. If the data is not clean, LTA may not have the wrong conclusion and prediction.

Data Cleaning

- In Data Science (e.g. Data Analytics, AI), it will require large amount of data and manually cleaning of these data will be **impossible**
- Tools like Python will be able to **automate** the process of cleaning the data based on ‘rules’
- The data will be manipulated based the **rules** set in the programmed

Explanation to the Data Cleaning Programme

```
# Scenario 1
# This programme is to clean the data from the input file
import pandas as pd
import numpy as np

#Example
df = pd.read_csv('Data/dirty_data.csv')

#Create a duplicate for d
df_Ex1= df.copy()

# Rule 1
# This sets of routines will null all non-numeric values from the individual columns
df_Ex1['floor_size'] = pd.to_numeric(df_Ex1['floor_size'], errors="coerce")

# Scenario 1 Exercise 1: Add the codes required to null all
# ........ COMPLETE CODE ------------
#-------------------------------------


# Computer the means
df_mean=df_Ex1.mean()

# Rule 2
# This set of rountes are to convert null value to the mean value of the columns
df_Ex1.loc[df_Ex1['floor_size'].isnull(),'floor_size'] = df_mean['floor_size']

# Scenario 1 Exercise 2: Add the
# ........ COMPLETE CODE ------------
#-------------------------------------

#Save to CSV file
df_Ex1.to_csv('Data/clean_data_scenario1.csv')
```

Creating a duplicate of the dataframe df
Changes made to df_Ex1 will not change the values of df1

This step will nullify ALL non-numeric or blank values for a particular column

Remember the loc function
df.loc(row, column)

Boolean function that will return the index of row that meet the condition

Save DataFrame to a csv file

Explanation to the Data Cleaning Programme

```
# Scenario 2
# This programme is to clean the data from the input file
import pandas as pd
import numpy as np

#Example
df = pd.read_csv('Data/dirty_data.csv')

#Create a duplicate for dataframe df
df_Ex2 = df.copy()

df_Ex2a = df_Ex2.drop(df_Ex2[df_Ex2['median_income'].str.isalpha()== True].index)
#Complete the cod
# Add the requi    odes for the rest of the columns
```

Drop the rows from the DataFrame

Function that check whether the value is characters

Writing the Data Cleaning Programme

Scenario 1

- Rules for cleaning the data
  - Ensure that all non-numeric characters are nullified
  - Ensure that all nullified values are given the mean values of the respective columns

Scenario 2

- Rules for cleaning the data
  - Remove rows where there are non-numeric value
  - Ensure that all nullified values are given the mean values of the respective columns

Data Preparation for building the model

- Machine Learning will require a model to perform prediction
- The model used are usually statistical algorithms that will perform the ‘prediction’
- Prediction are based on the probability of the data point that matches certain criterion

The last step in Data Preparation

- After the data are ‘cleaned’, it is important that the data split into the following datasets
  - Training
  - Validation
  - Test

  Note in some case. validation is known as the test and test is known as the holding datasets

- It is important to note that the data are randomly split into the respective datasets (Training, Validation and Test)

Purpose of the Respective Datasets

- **Training**
  - Training datasets are used for training the models. For each data that passed through the model, it will ‘refine’ the model.
- **Validation**
  - Validation datasets are used for the checking the model.
- **Testing**
  - Test datasets plays the similar role as the validation datasets but it is to ensure that the model best fit the hypothesis

Normal Ratio of splitting the data:

Training :70% Validation 20% Testing : 10%

Note this ratio is able to change based on requirements

Features of a Data Set

Variables

Observations

price	lotsize	bedrooms	bathrms	stories	driveway	recroom	fullbase
$42,000.00	5850	3	1	2	yes	no	yes
$38,500.00	4000	2	1	1	yes	no	no
$49,500.00	3060	3	1	1	yes	no	no
$60,500.00	6650	3	1	2	yes	yes	no
$61,000.00	6360	2	1	1	yes	no	no
$66,000.00	4160	3	1	1	yes	yes	yes
$66,000.00	3880	3	2	2	yes	no	yes
$69,000.00	4160	3	1	3	yes	no	no
$83,800.00	4800	3	1	1	yes	yes	yes
$88,500.00	5500	3	2	4	yes	yes	no
$90,000.00	7200	3	2	1	yes	no	yes
$30,500.00	3000	2	1	1	no	no	no
$27,000.00	1700	3	1	2	yes	no	no

Quantitative Variables
- Numeric

Qualitative Variables
- Categorical

Ref: Derek Kane, Data Science – EDA & Model Selection

Features of a Data Set

Dependent Variable

Independent Variables

price	lotsize	bedrooms	bathrms	stories	driveway	recroom	fullbase
$42,000.00	5850	3	1	2	yes	no	yes
$38,500.00	4000	2	1	1	yes	no	no
$49,500.00	3060	3	1	1	yes	no	no
$60,500.00	6650	3	1	2	yes	yes	no
$61,000.00	6360	2	1	1	yes	no	no
$66,000.00	4160	3	1	1	yes	yes	yes
$66,000.00	3880	3	2	2	yes	no	yes
$69,000.00	4160	3	1	3	yes	no	no
$83,800.00	4800	3	1	1	yes	yes	yes
$88,500.00	5500	3	2	4	yes	yes	no
$90,000.00	7200	3	2	1	yes	no	yes
$30,500.00	3000	2	1	1	no	no	no
$27,000.00	1700	3	1	2	yes	no	no

The dependent variable is the variable that we are interested in predicting and the independent variables are the variables which may or may not help to predict the dependent variable.

Ref: Derek Kane, Data Science – EDA & Model Selection

Splitting the Dataset

- An important step in predictive model building involves splitting the dataset into a training and testing dataset. The training dataset is used for model building while the testing dataset is for validating the model.
- The purpose is to ensure that the model are validated against data that are not part of model construction.
- To do this, we randomly select observations for training dataset (60%) and the remaining into the test dataset(40%)

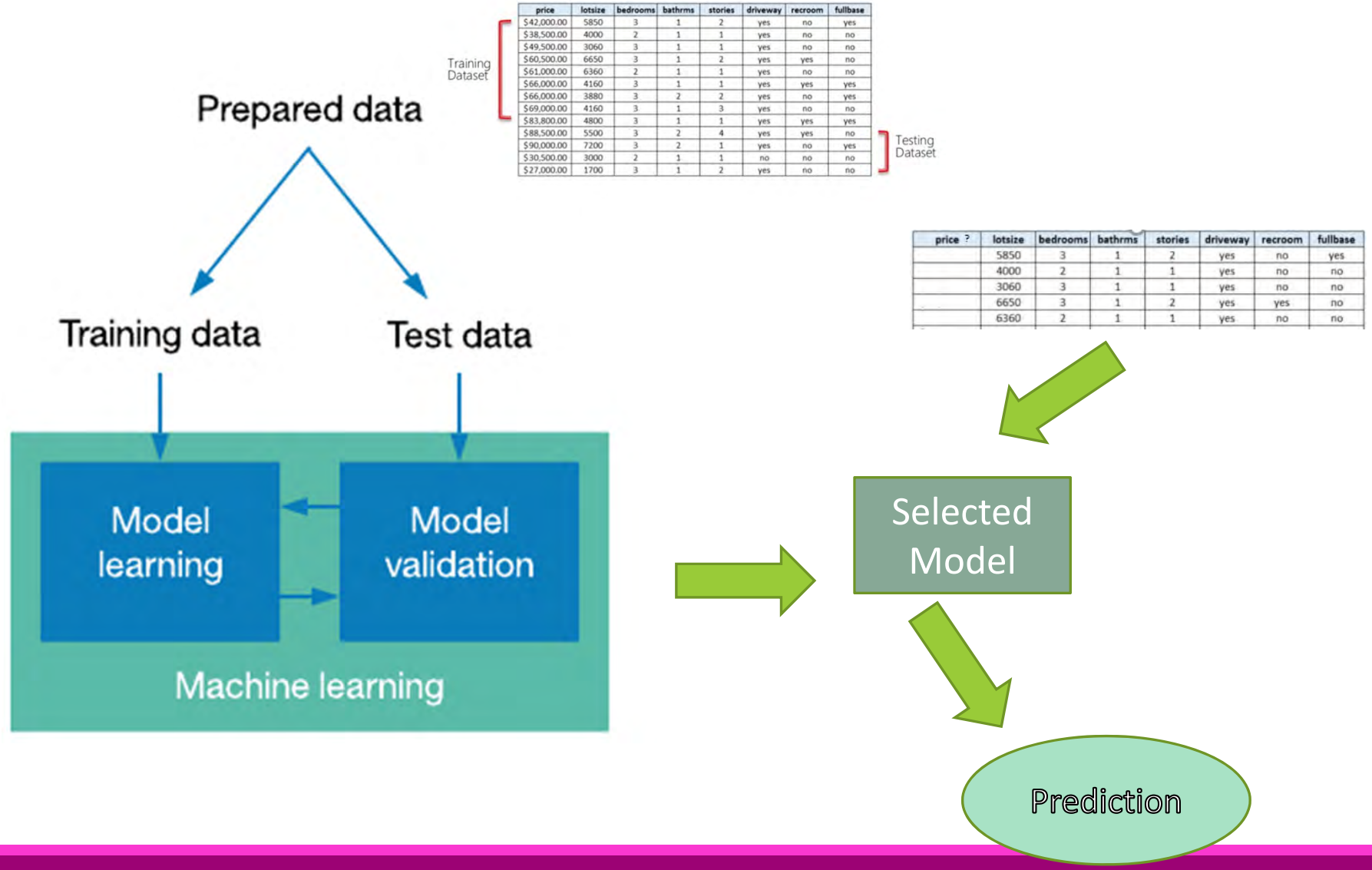
Training Dataset

price	lotsize	bedrooms	bathrms	stories	driveway	recroom	fullbase
$42,000.00	5850	3	1	2	yes	no	yes
$38,500.00	4000	2	1	1	yes	no	no
$49,500.00	3060	3	1	1	yes	no	no
$60,500.00	6650	3	1	2	yes	yes	no
$61,000.00	6360	2	1	1	yes	no	no
$66,000.00	4160	3	1	1	yes	yes	yes
$66,000.00	3880	3	2	2	yes	no	yes
$69,000.00	4160	3	1	3	yes	no	no
$83,800.00	4800	3	1	1	yes	yes	yes
$88,500.00	5500	3	2	4	yes	yes	no
$90,000.00	7200	3	2	1	yes	no	yes
$30,500.00	3000	2	1	1	no	no	no
$27,000.00	1700	3	1	2	yes	no	no

Testing Dataset

Ref: Derek Kane, Data Science – EDA & Model Selection

Training, Testing and Prediction



Example of Data Splitting Programme

- Ratio of Training : Validation: Test is 70:20:10

```
df = pd.read_csv('../Data/out/clean_data_scenario1.csv')

#Create a duplicate for dataframe df
df_Example= df.copy()

train, validate, test = np.split(df_Example.sample(frac=1), [int(.7*len(df_Example)), int(.9*len(df_Example))])
```

Split location in the array

Activity 1.5 – Data Preparation

- 3 cleaning exercises
  - non-numeric characters are set to null
  - non-numeric characters are dropped
  - Splitting the data for training and testing.

Step 1:
Watch and listen to the instructor's demonstration

15 mins

Target to finish by 16:50am

Step 2:
Work through the activities

30 mins

Individual Activity

Debrief

Step 1: Go to the following url

http://bit.ly/dlwp_debrief

Step 2: facilitator will walk you through the following

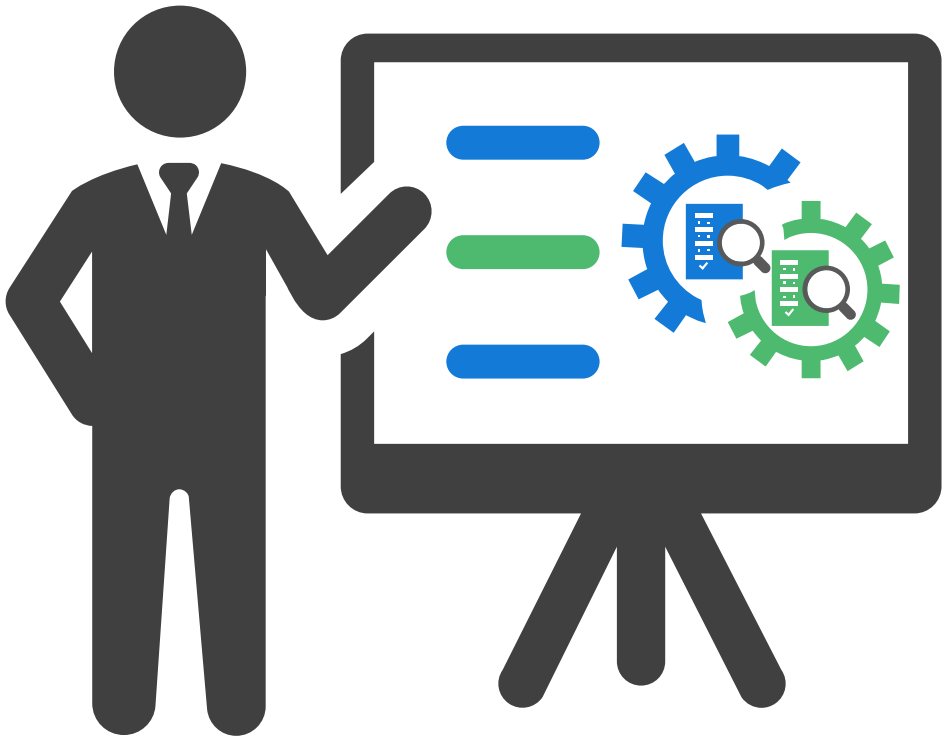
5 mins

Quiz

https://bit.ly/kw_poll

SCAN ME

Q&A



Email
seow_khee_wei@rp.edu.sg

Telegram
@kwseow

Source code:

Thank you