

Intermediate Python & a Glimpse into AI applications

Class 1

Pepe Bonet Giner

9th January 2023

Index Class 1

Topic 1: What is the course about?

Topic 2: The AI revolution. AI for Business

Topic 3: The Backbone of this new world

Topic 4: Python Recap

Topic 5: Pandas

Topic 6: Documentation

Who am I?



UNIVERSITAT
POLITÈCNICA
DE VALÈNCIA



Maastricht
University



B.Sc. Biotechnology

M.Sc.
Computational Biology



Universitat
Pompeu Fabra
Barcelona

ETH zürich



P.h.D. @ BbgLab
Computational Biology
EMIBA



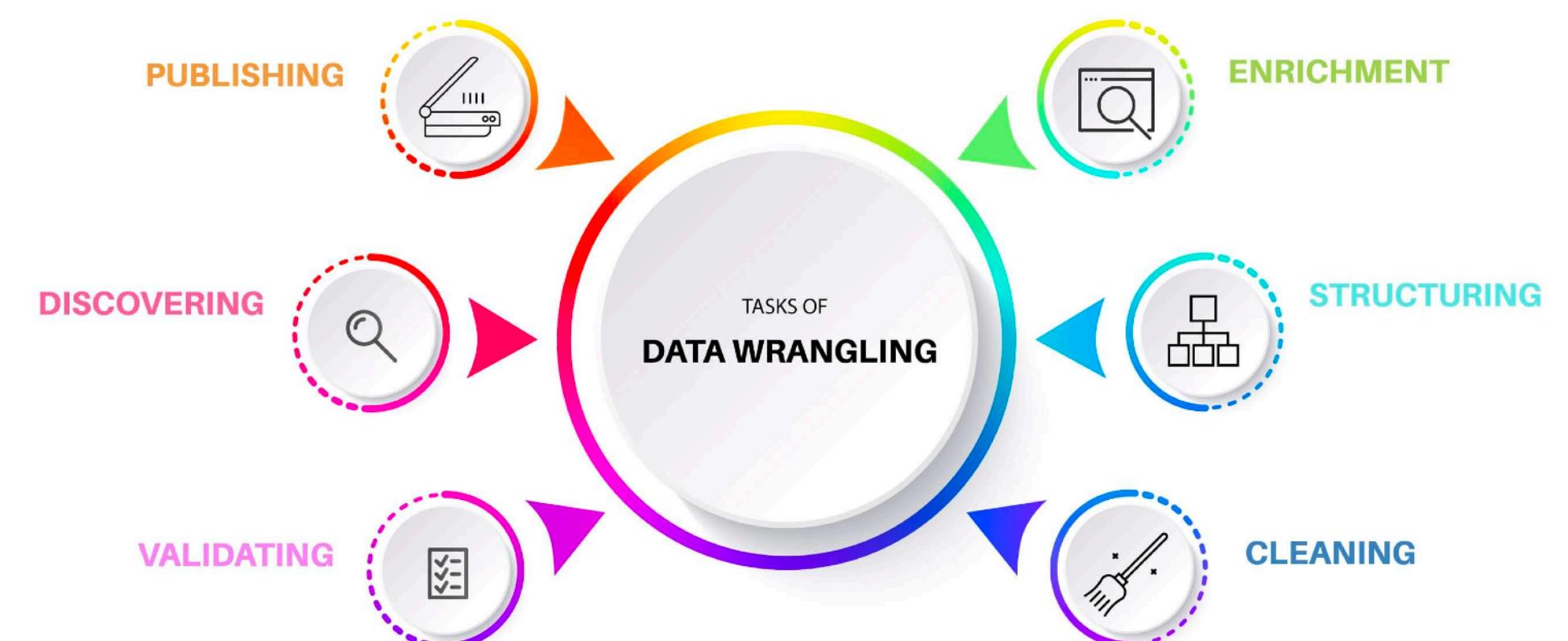
hynts

Hynts Analytics
&
Esade

Topic 1: What is this course about?

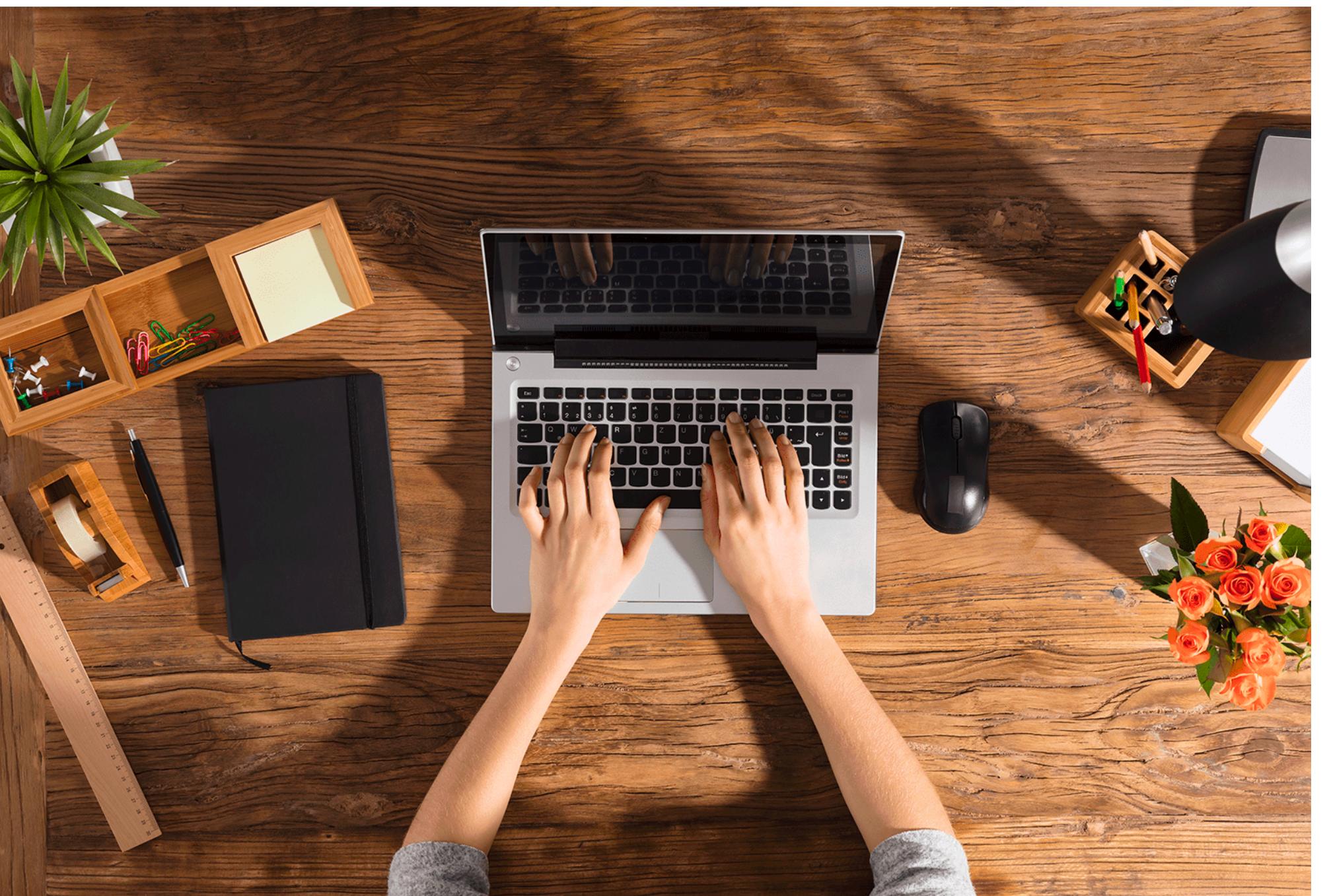
What are we going to learn?

- Programming in the current world. The latest AI applications. Impact of AI in a variety of fields.
- Python fundamentals for data analysis: Pandas, Functions, Data Structures, Matplotlib
- Understanding your data with Python: Cleaning, transforming, and getting value from your data. Data Wrangling & Data Visualization
- Employ simple AI tools to get additional/predictive value from your data



How is it going to be graded?

- **60% Active participation and class attendance:**
 - 15 % Attendance
 - 45 % coding exercises
 - Exercises will be uploaded to the Moodle after every session.



How is it going to be graded?

- **60% Active participation and class attendance:**
 - 15 % Attendance
 - 45 % coding exercises
 - Exercises will be uploaded to the Moodle after every session.
- **40% Final project:**
 - Python code on Jupyter Notebook, working and applying the concepts learned in class on a dataset, explaining the steps taken.
 - A 2-page report summarizing the results, the value extracted from data, and possible applications of AI.
 - Upload both to the Moodle max two weeks after the last lecture.



Final work

Code in Jupyter Notebooks

Report Explaining Results

Class 1. Intermediate Python & AI

Table of contents

- Variables
- Lists
- If-else
- For loops
- While Loops
- Functions

Variables

```
In [5]: a = 10  
        b = 5  
        print(a, b)
```

10 5

```
In [6]: a + b
```

```
Out[6]: 15
```



Study of Police deaths in the USA from 1791 to 2022

Pepe Bonet Giner
9th January 2023

- 1.- Introduction to the dataset
- 2.- Results obtained (in line with the code)
- 3.- Possible further AI applications

Topic 2: The AI revolution. AI for Business

There is something out there affecting us!

- Technology is impacting the world to an extent that we cannot grasp yet. This is having huge implications at different levels.

Present

- Self-driving cars
- Social Media
- E-commerce
- Robots in factories



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Future

- Transportation: Autonomous Vehicles
- Customer Service: Chat Bots
- Education: Personalized Learning
- Healthcare: Personalized Medicine
- VR/AR

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Present

- Self-driving cars
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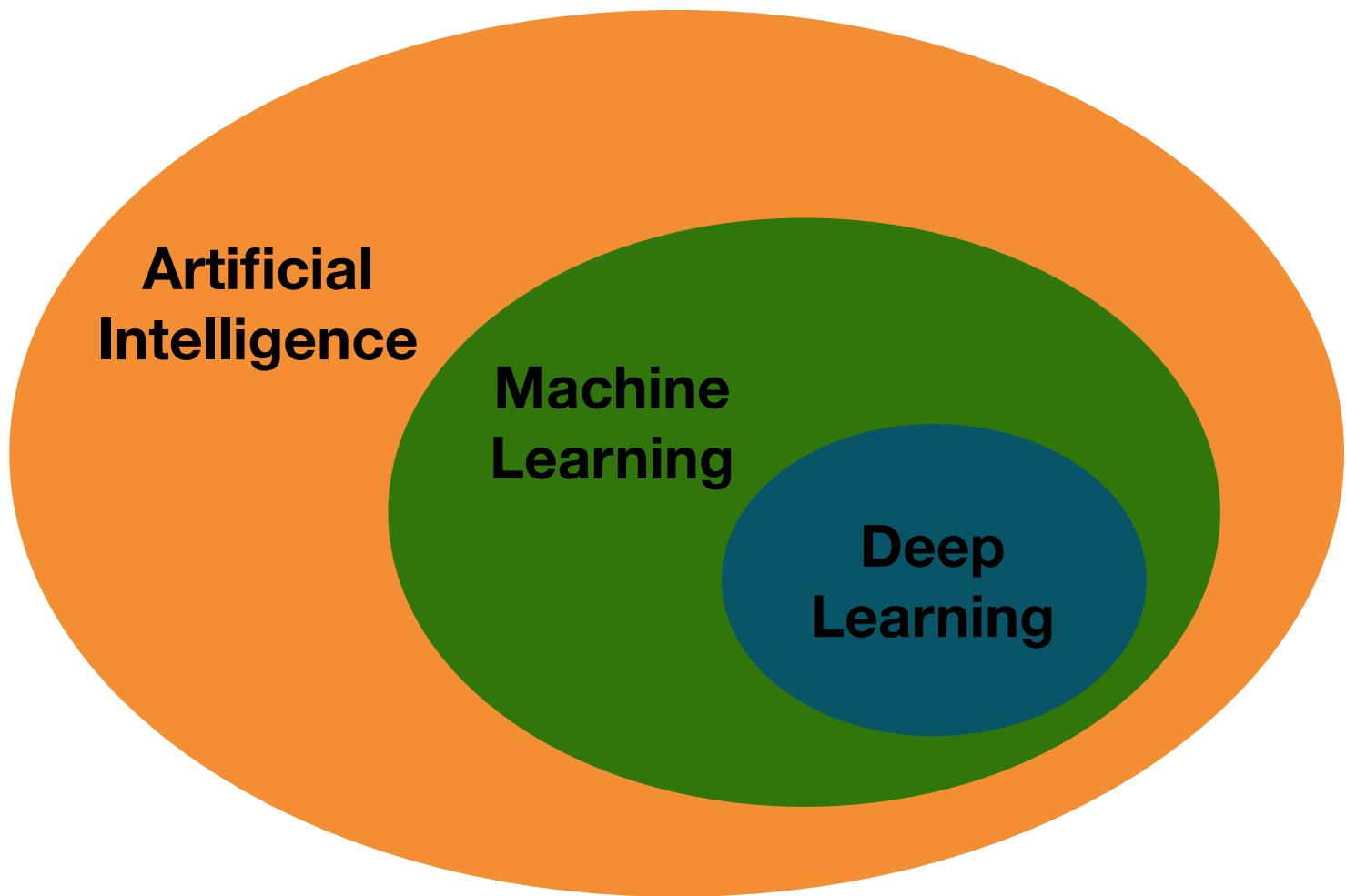
Future

- Transportation: Autonomous Vehicles
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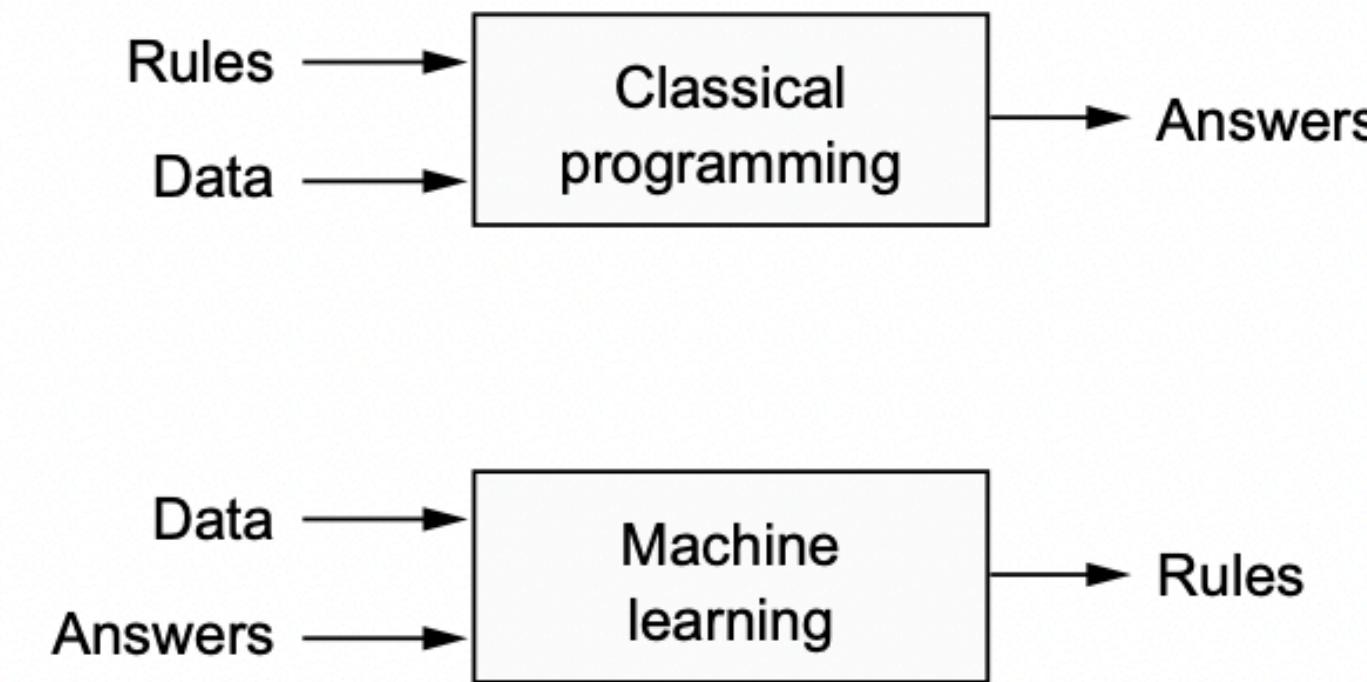
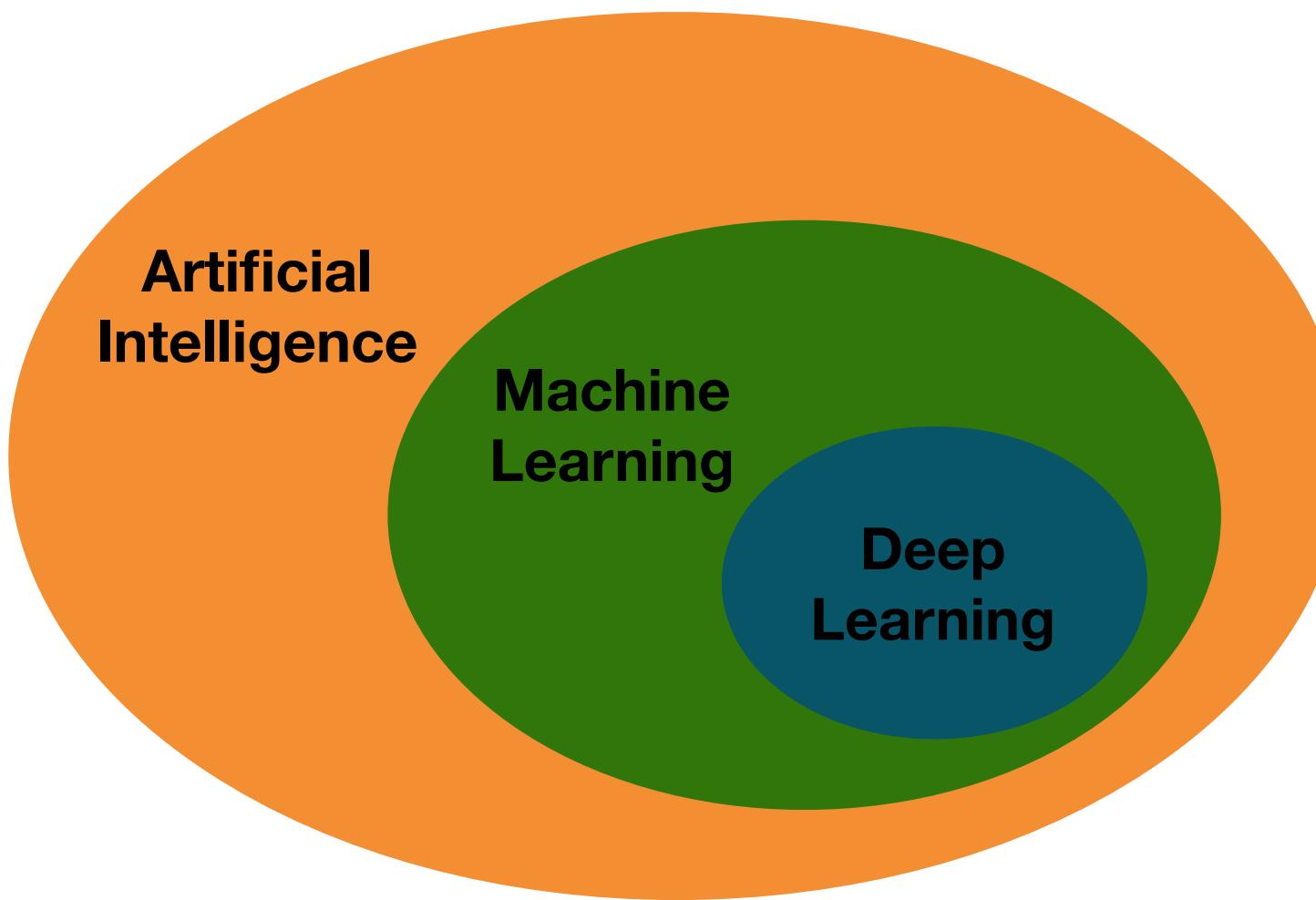
AI is behind many of these disruptions

What is Artificial Intelligence (AI)?

- AI: Effort to automate intellectual tasks normally performed by humans



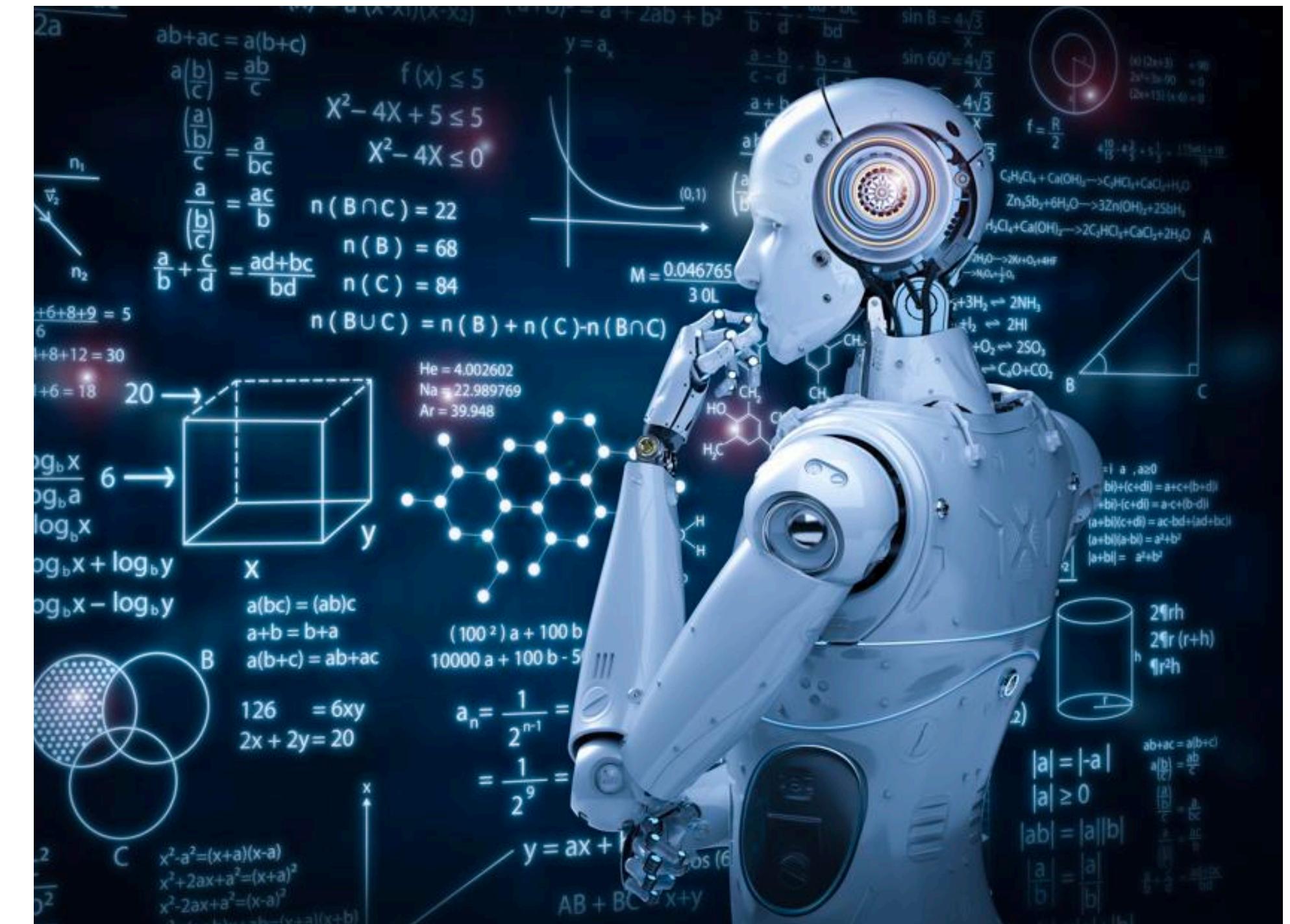
What is Artificial Intelligence (AI)?



- ~ 1950-1980 Symbolic Al. Rules + Data → Answers
- ML: Data + Answers → Rules
- Ability to learn from past data to make future decisions

What this field has achieved so far?

- Near-human-level image classification
- Near-human-level speech transcription
- Near-human-level handwriting transcription
- Dramatically improved machine translation
- Dramatically improved text-to-speech conversion
- Google assistant - Alexa
- Near-human-level autonomous driving
- Superhuman game-playing (AlphaGo, Alphazero, AlphaStar, etc...)



This field is constantly evolving: some of the major AI-powered research milestones in the world



New AI Model Translates 200 Languages, Making Technology Accessible to More People

July 6, 2022

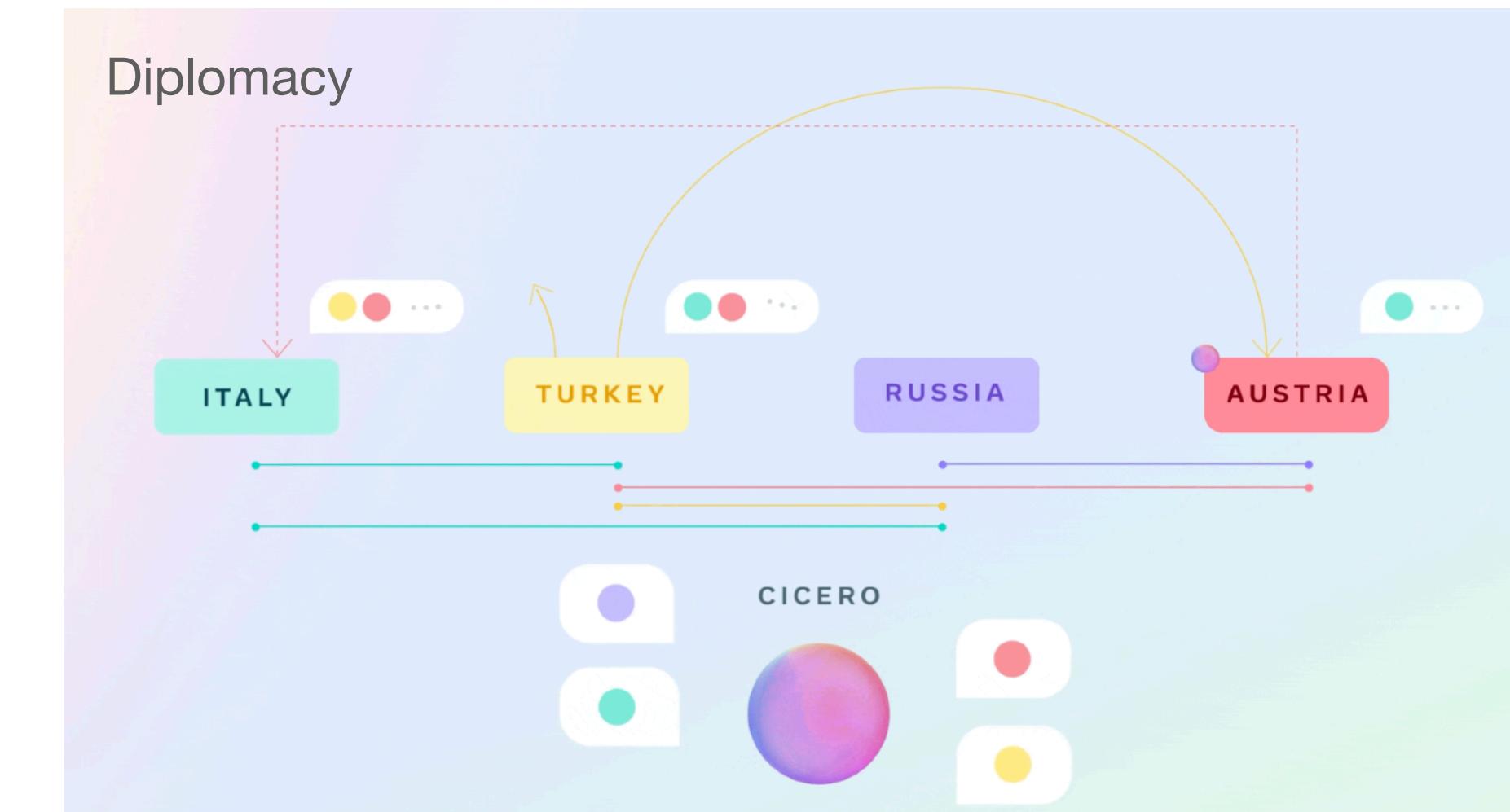
Meta AI Introduces 'Make-A-Video': An Artificial Intelligence System That Generates Videos From Text

By [Ashish kumar](#) - October 3, 2022

RESEARCH

CICERO: An AI agent that negotiates, persuades, and cooperates with people

November 22, 2022



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 Research

Discovering novel algorithms with AlphaTensor

October 5, 2022

Article | [Open Access](#) | [Published: 15 July 2021](#)

Highly accurate protein structure prediction with AlphaFold

P How do I build an intermediate python course



To build an intermediate Python course, you can follow these steps:

1. Determine the target audience for your course. This will help you tailor the content to the appropriate level and focus on the topics that will be most relevant and useful to your students.
2. Outline the main topics that you want to cover in the course. Some potential topics for an intermediate Python course might include object-oriented programming, error handling, data manipulation and visualization, and working with external libraries and APIs.
3. Create a lesson plan for each topic, including a list of objectives, a list of required materials, and a detailed breakdown of the content that you will cover in each lesson.
4. Prepare any necessary teaching materials, such as slides, code examples, and exercises for your students to work on.
5. As you teach the course, be sure to incorporate plenty of hands-on practice and interactive activities to help your students learn the material more effectively.
6. Assess your students' progress through quizzes, exams, and projects, and provide feedback to help them learn and improve.
7. Stay up-to-date on new developments in the Python ecosystem and incorporate relevant updates into your course as needed.

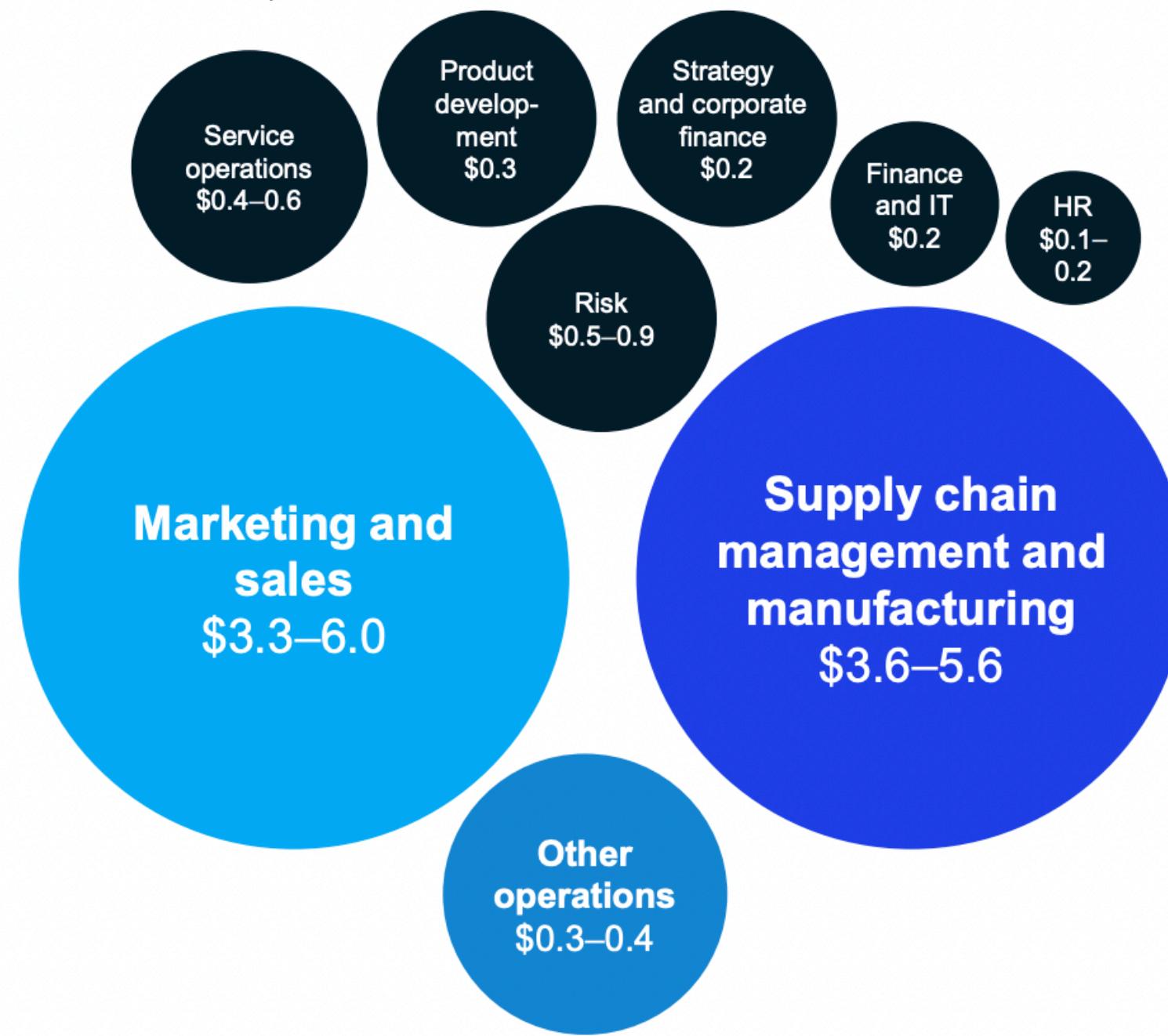
I hope this helps! Let me know if you have any other questions.

This disruption applies to any field. Business in general

The potential value at stake from AI is
\$10 to \$15 trillion ...

Global annual potential, forecast

Value at stake, \$ trillion

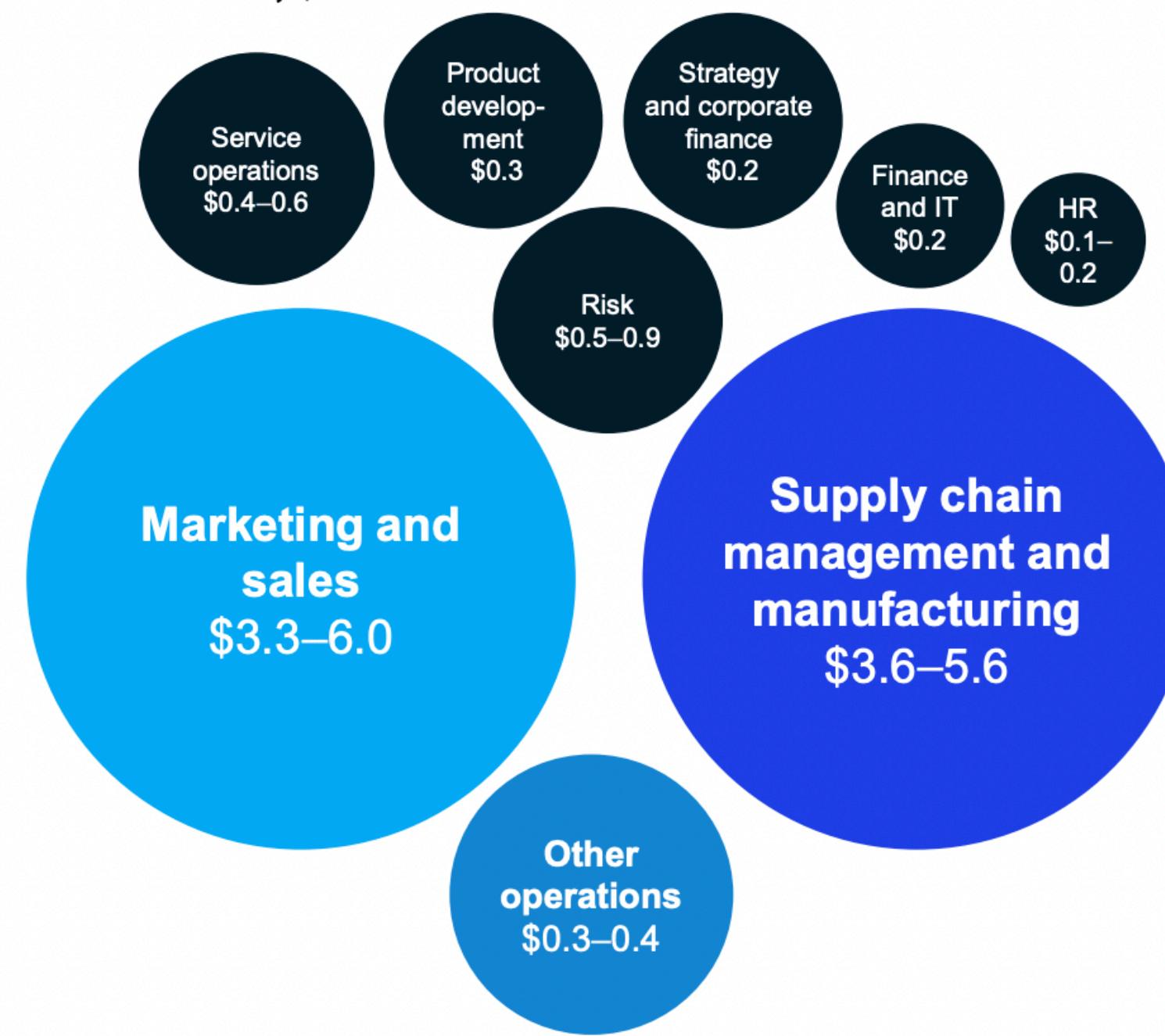


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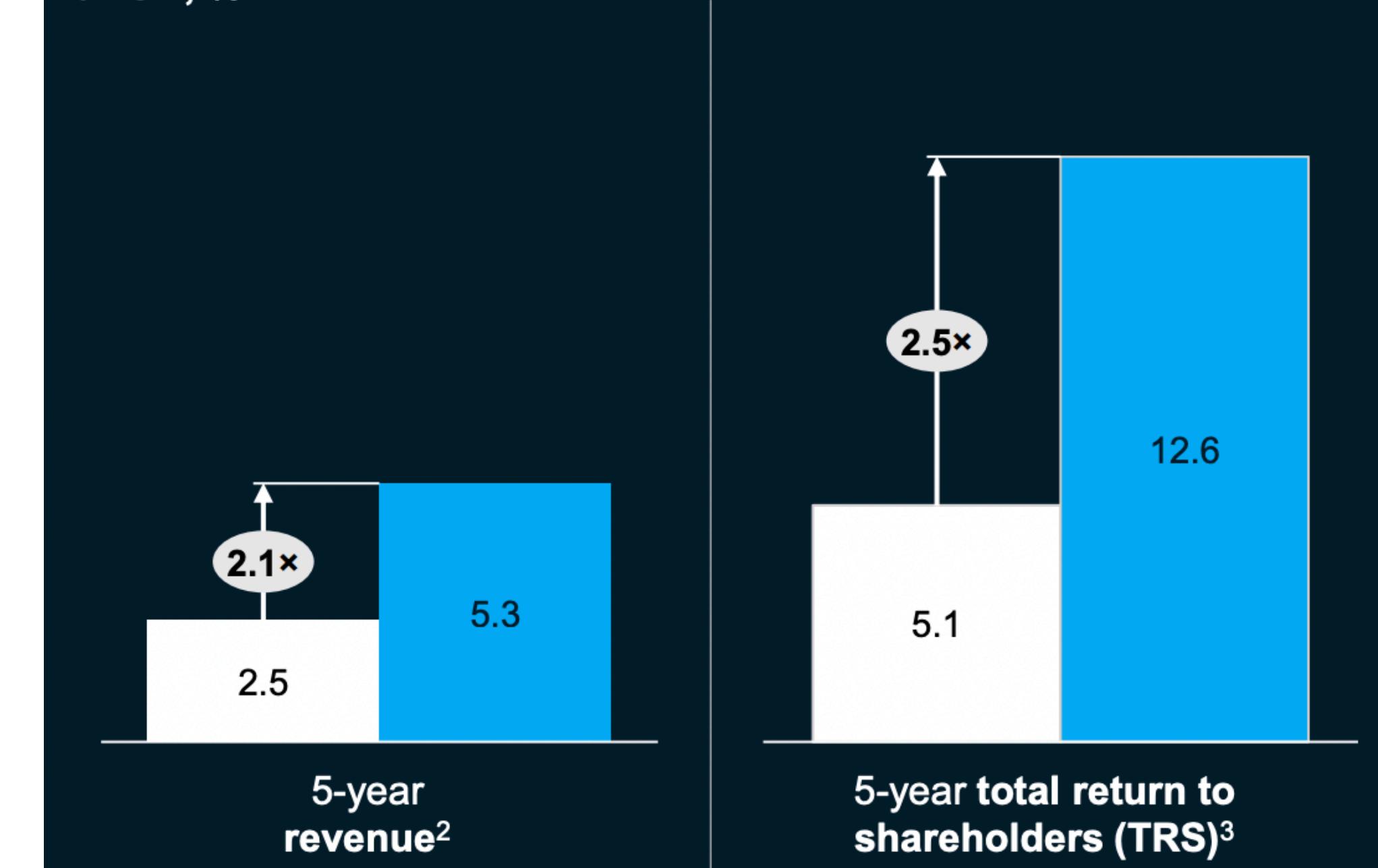
Value at stake, \$ trillion



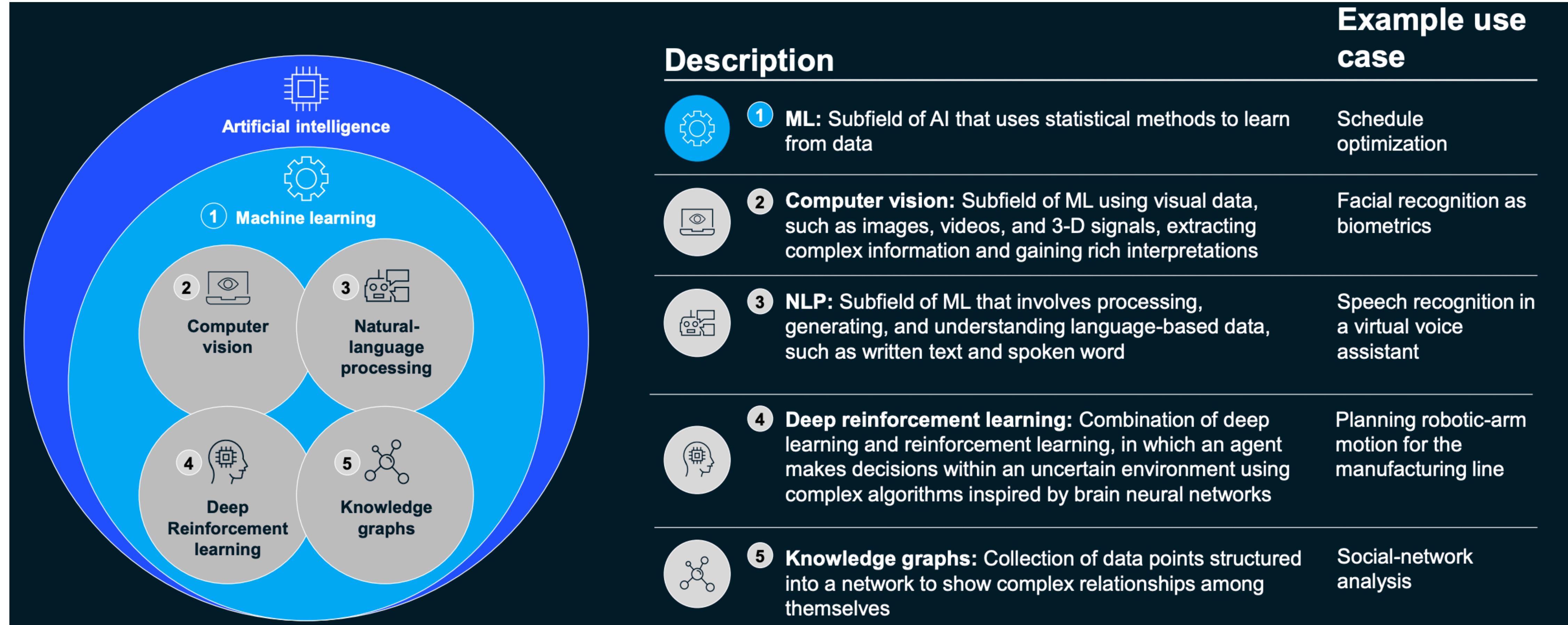
... and leaders adopting AI exhibit stronger financial performance

AI maturity and financial performance ■ Others ■ Analytics leaders¹

CAGR, %



This disruption applies to any field. Business in general



My Take

- AI is changing the world and you will have to live in it
- Chances are your work may be affected by it. It is on you to start early with it.
- I think it should be a must to (Harvard HBS):
 - Know about it
 - Understand what it is useful for
 - How it applies to companies now
 - The implications that can arise



Topic 3: The backbone of this new world

What is driving this AI revolution?

Advances in Hardware



CPU

GPU

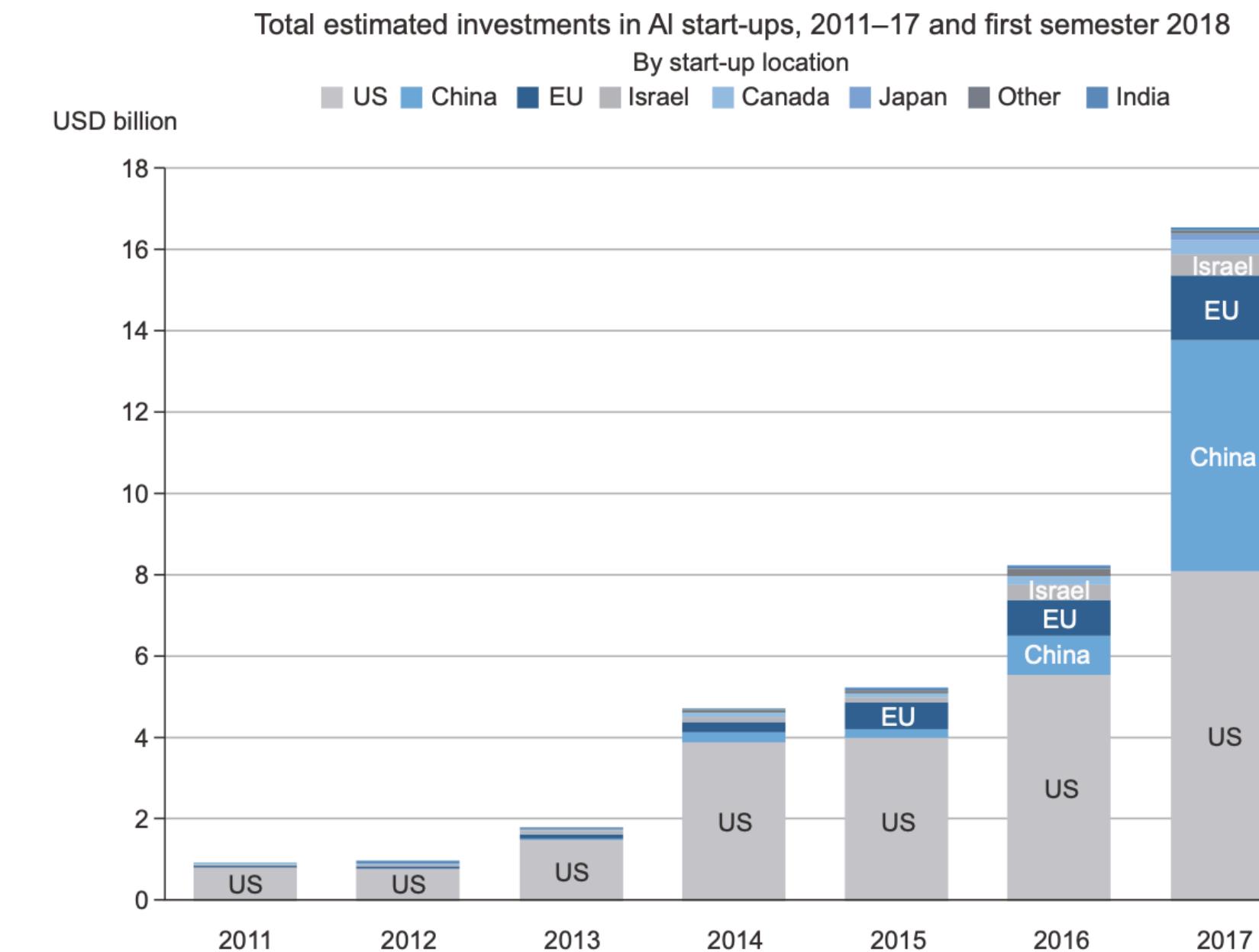
TPU

Cloud Computing



Google Cloud

Investment



Research



Programming languages are behind this revolution as well

- We need to tell the computers to do all of these things
- Programming languages allow us to **communicate with computers**
- A programming language is a **notation system** for writing **computer programs**



What is Python?



- Versatile, and powerful **programming language**
- Concise, and **easy to learn**, use and read
- **Large python community** (Widely used)
- Large number of libraries (Big data, Machine Learning)
- **High demand** in the job market

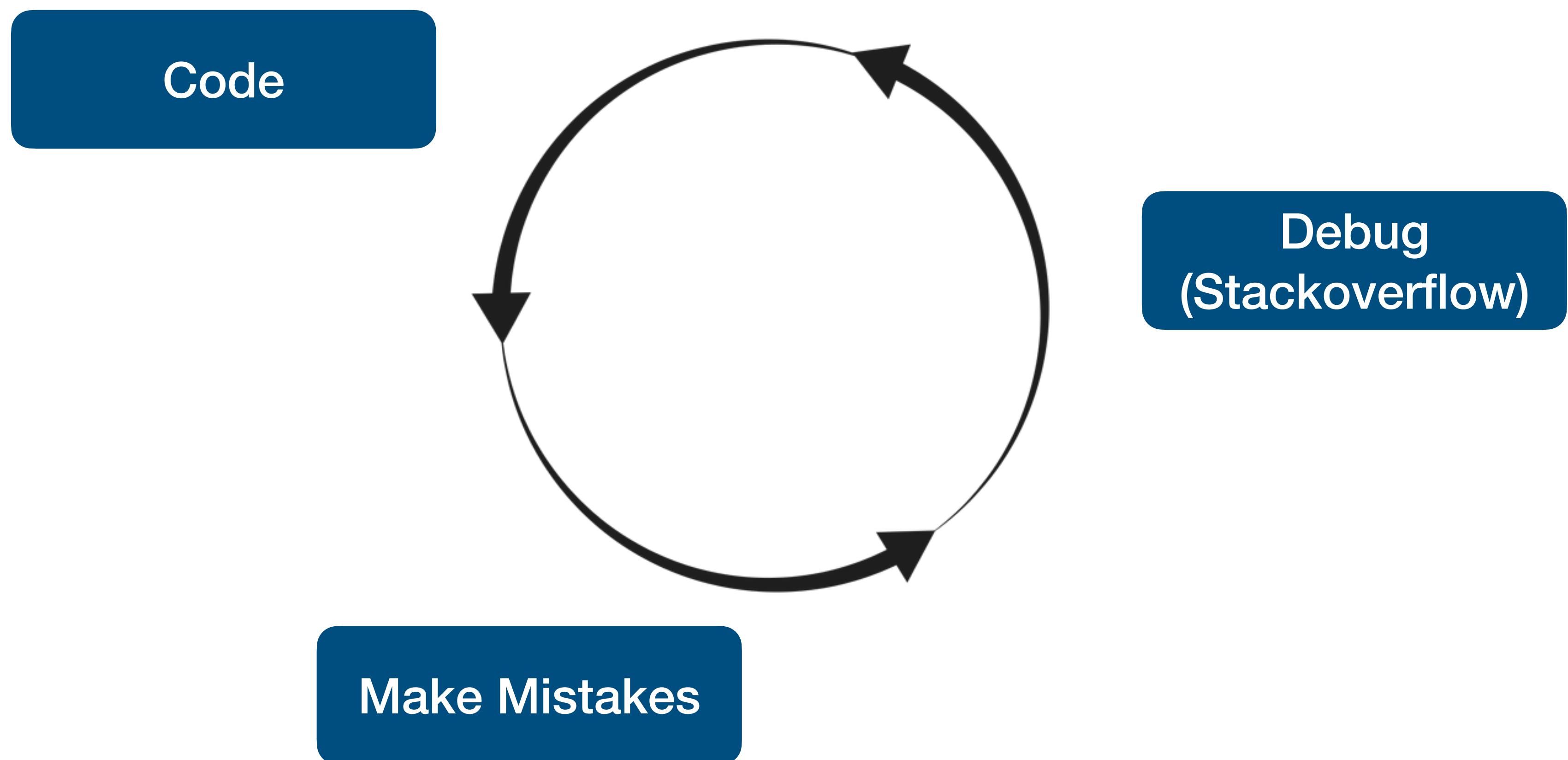
```
import tensorflow as tf
from tensorflow.keras.layers import *
from tensorflow.keras.models import Model, Sequential
from tensorflow.keras.applications.inception_v3 import InceptionV3

class ConvBlock(Model):
    def __init__(self, filters, kernel_size):
        super(ConvBlock, self).__init__()
        self.conv = Conv2D(filters, kernel_size, padding="same",
                          kernel_initializer="lecun_normal")
        self.bn = BatchNormalization()
        self.relu = ReLU()

    def call(self, inputs):
        x = self.conv(inputs)
        x = self.bn(x)
        x = self.relu(x)
        return x
```

How do we learn it?

1. Learn by doing (The coding cycle)



How do we learn it?



COURSES

ABOUT

The online coding school that invests in you

Train remotely to become a software engineer or data scientist and pay nothing upfront until you are earning \$50k or more.

START APPLICATION



Python Backbone

- Variables
- Programming mind (indentation)
- Lists, Dictionaries
- Loops: for, if, elif, else, while
- Functions

```
In [7]: my_list = [1, 5, 12, 91, 102]
my_list_length = len(my_list)
for i in range(0,my_list_length):
    print(i, my_list[i] * my_list[i])

0 1
1 25
2 144
3 8281
4 10404
```

Python Libraries

- Pandas
- Numpy
- Scikit Learn
- Tensorflow
- Keras



Let's start!

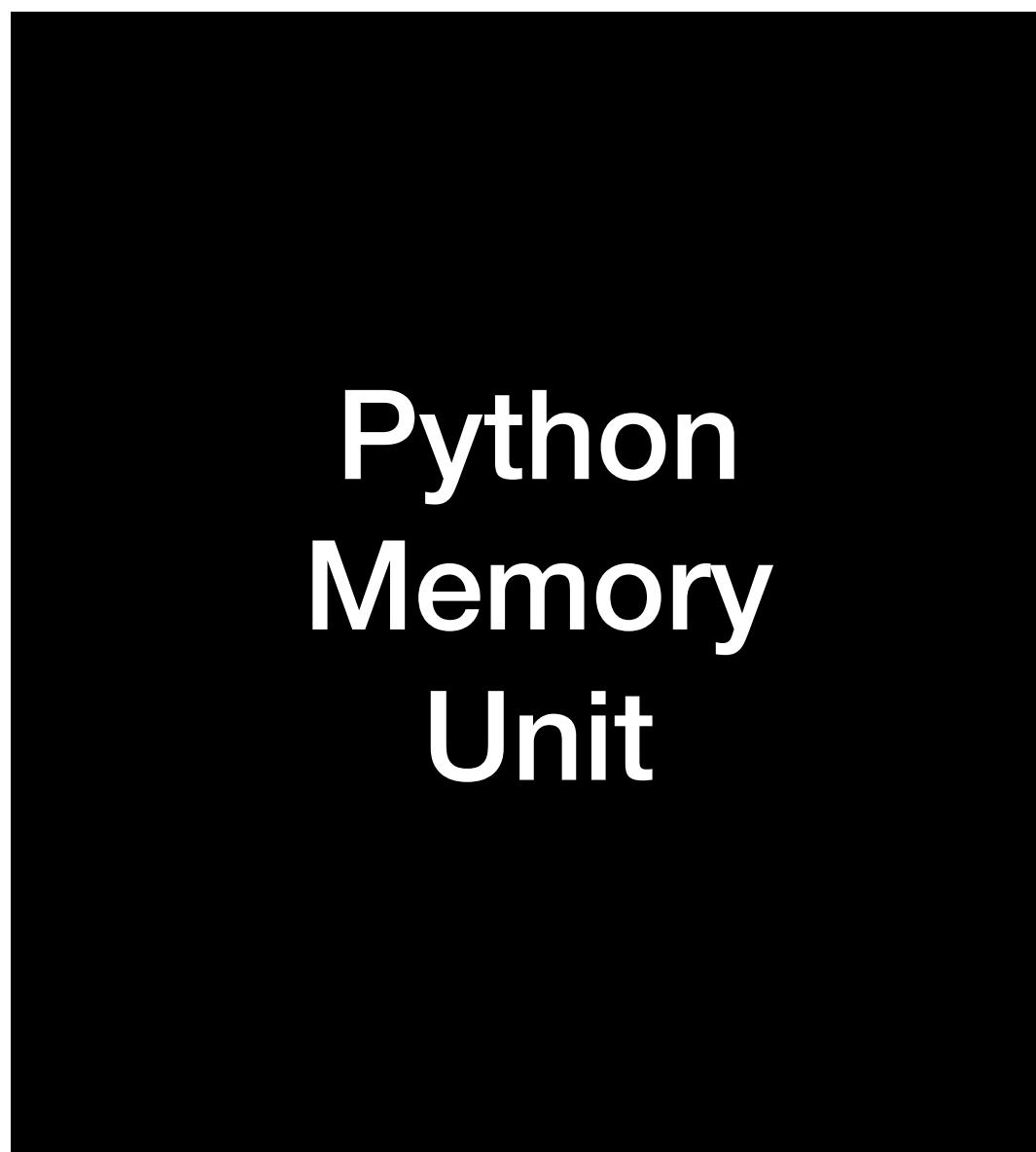
- We will use Jupyter Notebooks (JN) to code in python
- JN is a web-based interactive computing platform.
- The notebook combines live code, equations, narrative text, and visualizations, to provide a friendly user interface to code and share our work.
- Start your first notebook and let's code!



Topic 4: Python Basics Recap

Variables

- What is a variable? A place for storing data values (Numbers, text, DataFrames, Lists, dictionaries...)
- Types of variables: float, int, string/text, boolean, tuple, dict



Tips for Variables

- Name your variables properly
 - Not long names but expressive (meaningful names related to the variable)
 - Allows you to recognize what the variable stores
- Example: **df** is a convention for naming a data frame. Why not: **my_data**

Instead, you can assign variables a value like below and then this will be stored:

```
In [4]: a = 20
In [5]: b = 10
In [6]: print(a, b)
```

20 10

```
In [8]: type(b)
```

```
Out[8]: int
```

```
In [9]: e = 'Hello'
```

```
In [10]: type(e)
```

```
Out[10]: str
```

```
In [11]: f = 1.0
```

```
In [12]: type(f)
```

```
Out[12]: float
```

Operations with variables

- Python can essentially be a calculator
- Regular operators: +, -, /, *, ^, **, %
- The results from operations can be saved as new variables

```
In [16]: a * b
```

```
Out[16]: 200
```

```
In [17]: a + b
```

```
Out[17]: 30
```

The result from operations can be saved as a new variable.

```
In [18]: c = a + b  
print(c)
```

```
30
```

```
In [19]: g = c * 10 * a
```

```
In [20]: print(g)
```

```
6000
```

```
In [21]: g / 10
```

```
Out[21]: 600.0
```

```
In [22]: g % 10
```

```
Out[22]: 0
```

Lists

- One of the building blocks of Python for storing information
- A way of storing multiple items in a single variable

```
Sports = ['Football', 'Basketball', 'Hockey']
```

```
Students = ['Iñigo', 'Tomas', 'Margarita', 'Antonella']
```

- List indexing: Students[0]
- List operations: *append*, *remove*, *count*...

Exercise

- Create a list that you like, append an element and output its second element

Dictionaries

- Another building block of Python for storing information
- Dictionaries are used to store data values in key-value pairs
 - `my_dict = { key : value}`
 - To index dictionaries: `my_dict[key]`
 - List operations: *update, pop, keys, values*

```
my_dict = {
    'Players': ['Messi', 'Ronaldo', 'Maradona'],
    'Goals' : [10, 8, 6]
}
```

```
my_dict
{'Players': ['Messi', 'Ronaldo', 'Maradona'],
 'Goals': [10, 8, 6]}
```

```
my_dict['Players']
['Messi', 'Ronaldo', 'Maradona']
```

```
my_dict.update({'Assists' : [12, 3, 5]})
```

```
my_dict
{'Players': ['Messi', 'Ronaldo', 'Maradona'],
 'Goals': [10, 8, 6],
 'Assists': [12, 3, 5]}
```

Exercise

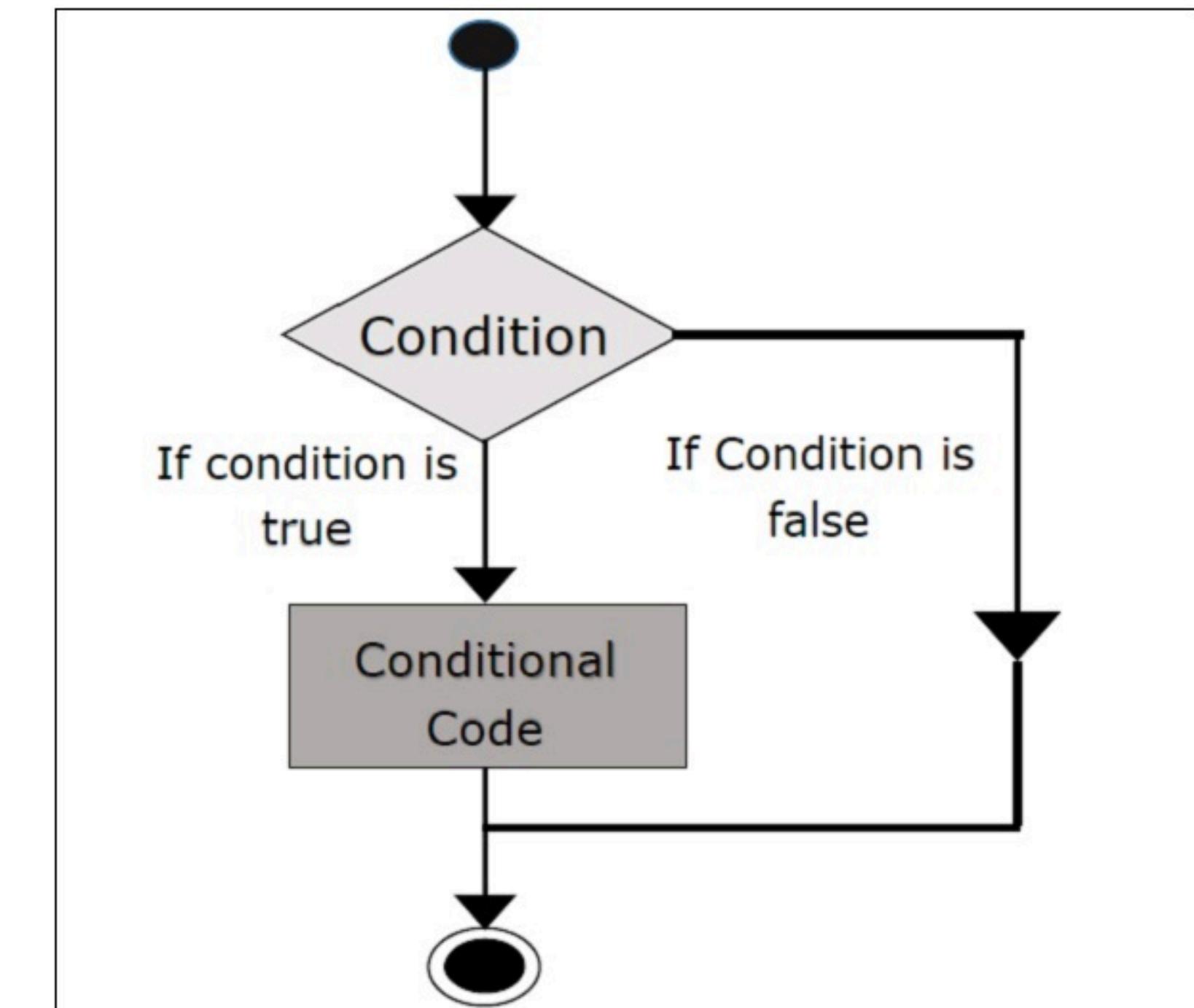
- Create a dictionary, update it with a new key-value pair and print the keys of your dictionary

If-Else statements

- Evaluate test expressions and execute the code only when the test condition is true.
- Suppose two variables **a** and **b**. We can assess:
 - $a == b$, $a != b$, $a > b$, $a < b$, $a \leq b$, $a \geq b$

```
In [26]: if a == 10:  
    print('The variable a is equal to 10')  
else:  
    print('The variable a is different than 10')
```

The variable a is different than 10



Exercise

- Evaluate whether your previous list contains more than 3 items.
 - Help: `len(my_list) > 3`
 - If it is: then print yes. Otherwise (else) print no.

For loops

- For loops are used to iterate over sequences like lists, arrays, dictionaries, or others.

```
In [63]: students = ['Margarita', 'Antonella', 'Tomas', 'Iñigo']
for el in students:
    print(el)
```

```
Margarita
Antonella
Tomas
Iñigo
```

```
In [61]: for el in students:
    if el == 'Iñigo':
        print('This student is Iñigo')
    else:
        print('This is other student')
```

```
This is other student
This is other student
This student is Iñigo
This is other student
This is other student
```

Exercise

- Create a list with numbers in it. `my_list = [0, 1, 2, 3]`
- Iterate over it with a for loop, subtract 2 to every number, and print every number at every iteration.
- Plus points if: Start a new list and save the new numbers on it and print it after the for loop

While Loops

- While loops are used to execute a set of statements as long as a condition is true.
- They are not widely used

```
In [70]: aa = 5
while aa != 0:
    print(aa)
    aa -= 1
print(f'The new value of aa is {aa} as it should be')
```

```
5
4
3
2
1
The new value of aa is 0 as it should be
```

Introduction to functions

- A function is a block of code that only runs when it is called.
- You can pass data, known as parameters, into a function.
- A function can return data as a result.

```
In [78]: def square_root(x):  
    return x ** 0.5
```

```
In [79]: square_root(36)
```

```
Out[79]: 6.0
```

```
In [80]: square_root(16)
```

```
Out[80]: 4.0
```

```
In [71]: def sum_two(my_list):  
    new_list = []  
    for el in my_list:  
        new_list.append(el + 2)  
    return new_list
```

```
In [73]: list1 = [0, 1, 2, 3]  
list2 = [0, -1, -2, -3]
```

```
In [76]: sum_two(list1)
```

```
Out[76]: [2, 3, 4, 5]
```

```
In [77]: sum_two(list2)
```

```
Out[77]: [2, 1, 0, -1]
```

Exercise

- Create a function that computes and returns the square of any number that is passed to the functions.

Topic 5: Pandas

What is Pandas?

- Python package that provides:
 - Fast
 - Flexible
 - Expressive data structures
- To make working with "relational" or "labeled" data both easy and intuitive



Notebook lessons

- 1.- Load a csv/tsv/excel file and explore it
- 2.- Basic Data Exploration
- 3.- Column & row operations
- 4.- Groupby, apply & Lambda function

How do python libraries work



Step 0
Load the package

In [2]: `import pandas as pd`

Python Memory
Unit

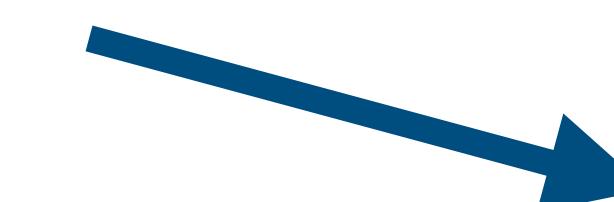
Loads all pandas
functions

Python
Programming
Unit

`import pandas as pd`

Step 1: Load a csv / tsv / excel file

- To work with a dataset in Jupyter Notebook we need to load it.
- We can load any file type: csv, tsv, excel...
- This allows us to start exploring the data



Step 1 Load dataset in Jupyter notebook

```
In [2]: df = pd.read_csv('../datasets/Dataset_credit_scoring.tsv', sep='\t')
```

```
In [3]: df_excel = pd.read_excel('../datasets/Dataset_credit_scoring.xlsx')
```

```
In [12]: df_excel.head()
```

```
Out[12]:
```

	Occupation	Age	Loan_Salary_ratio	Outcome
0	Industrial	34	2.96	Repay
1	Professional	41	4.64	Default
2	Professional	36	3.22	Default
3	Professional	41	3.11	Default
4	Industrial	48	3.80	Default

Rows

Columns

Exercise

- Download the Police Deaths USA dataset from the Moodle, save it in the same folder as your jupyter, load it in your Jupyter, and do head() of the first 4 rows.

Step 2: Data frame exploration

- One the most important things is to learn how to explore the data before taking actions
- To do so there are a set of simple functions that can be employed:
 - `columns`, `index`, `describe()`, `info()`, `dtypes`, `head()`, `tail()`

```
df.columns
```

```
Index(['Rank', 'Name', 'Age', 'End_Of_Watch', 'Day_Of_Week', 'Cause',
       'Department', 'State', 'Tour', 'Badge', 'Weapon', 'Offender',
       'Summary'],
      dtype='object')
```

```
df.shape
```

```
(25623, 13)
```

```
df.index
```

```
RangeIndex(start=0, stop=25623, step=1)
```

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 25623 entries, 0 to 25622
Data columns (total 13 columns):
 #   Column            Non-Null Count  Dtype  
 ---  -- 
 0   Rank              25623 non-null   object 
 1   Name              25623 non-null   object 
 2   Age               22946 non-null   float64
```

Exercise

- Who is the largest age? And the minimum age?

Step 3: Operations with Columns & Rows

- Knowing how to handle the data and easily access the information is essential.
- Exploration will set our next steps to clean the data and build a model

What are the main causes of the murder?

```
df['Cause'].value_counts()
```

Gunfire	12869
Automobile crash	2507
Heart attack	1187
Motorcycle crash	1157
Vehicular assault	976
Struck by vehicle	911
COVID19	812

Which is the most common rank? ↗

```
df['Rank'].value_counts()
```

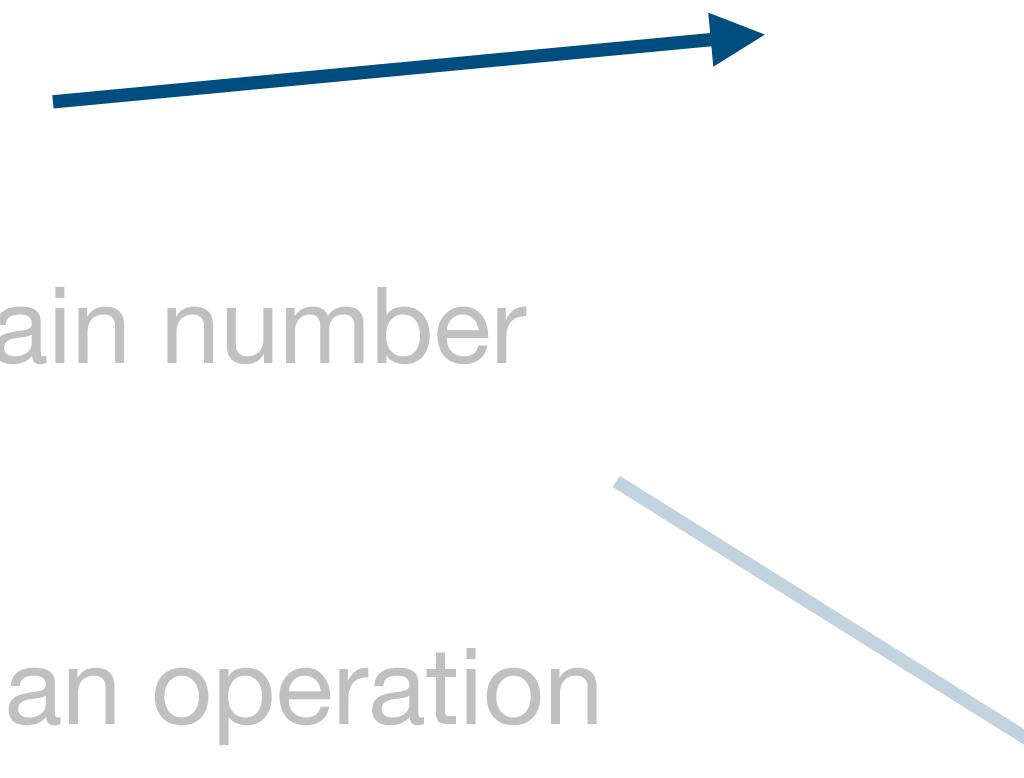
Patrolman	3841
Police Officer	3514
Deputy Sheriff	3215
Officer	1699
Sergeant	1420
...	
Narcotic Agent II	1
Jail Officer	1
Acting Marshal	1
Deputy II	1
Assistant Principal Keeper	1
Name: Rank, Length: 618, dtype: int64	

Exercise

- How many causes of the murder do we have?
- How many ranks are in the dataset?
- Which is the 9th most common rank?
- Which department has the most police deaths?

Step 3: Operations with Columns & Rows

- Separate DataFrames
- Filter Data by selecting a certain number of columns or rows
- Create new columns through an operation



```
new_list = []

for el in df['Age'].tolist():
    if el > 50:
        new_list.append(1)
    else:
        new_list.append(0)

df['Binary age'] = new_list
df.head(2)
```

```
less_50 = df[df['Age'] <= 50]
less_50.head(2)
```

	Rank	Name	Age	End_Of_Watch	Day_Of_Week	Cause
3	Marshal	Robert Forsyth	40.0	1794-01-11	Saturday	Gunfire
5	Sheriff	Robert Maxwell	45.0	1797-11-12	Sunday	Gunfire

```
less_50['Age'].median(), less_50['Age'].max()
(35.0, 50.0)
```

```
new_df = df[['Rank', 'Name', 'Age']]
new_df.head()
```

	Rank	Name	Age
0	Constable	Darius Quimby	NaN
1	Sheriff	Cornelius Hogeboom	53.0
2	Deputy Sheriff	Isaac Smith	NaN
3	Marshal	Robert Forsyth	40.0
4	Deputy Sheriff	Robert Berwick	NaN

```
new_df = df.iloc[0:10]
new_df.shape
```

(10, 13)

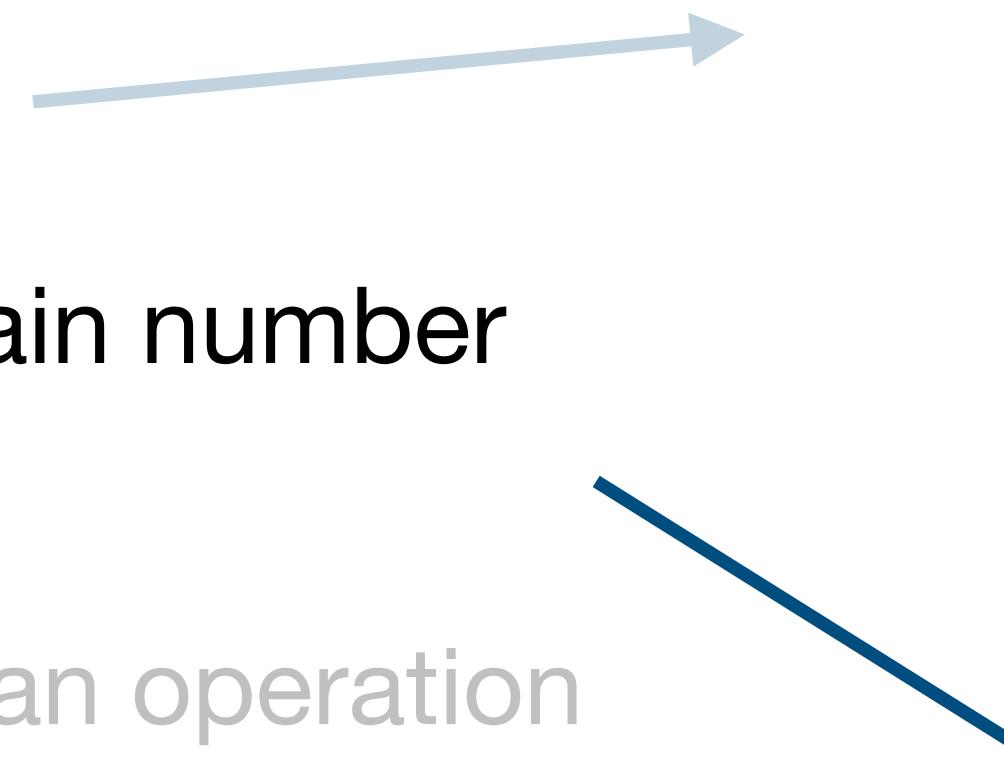
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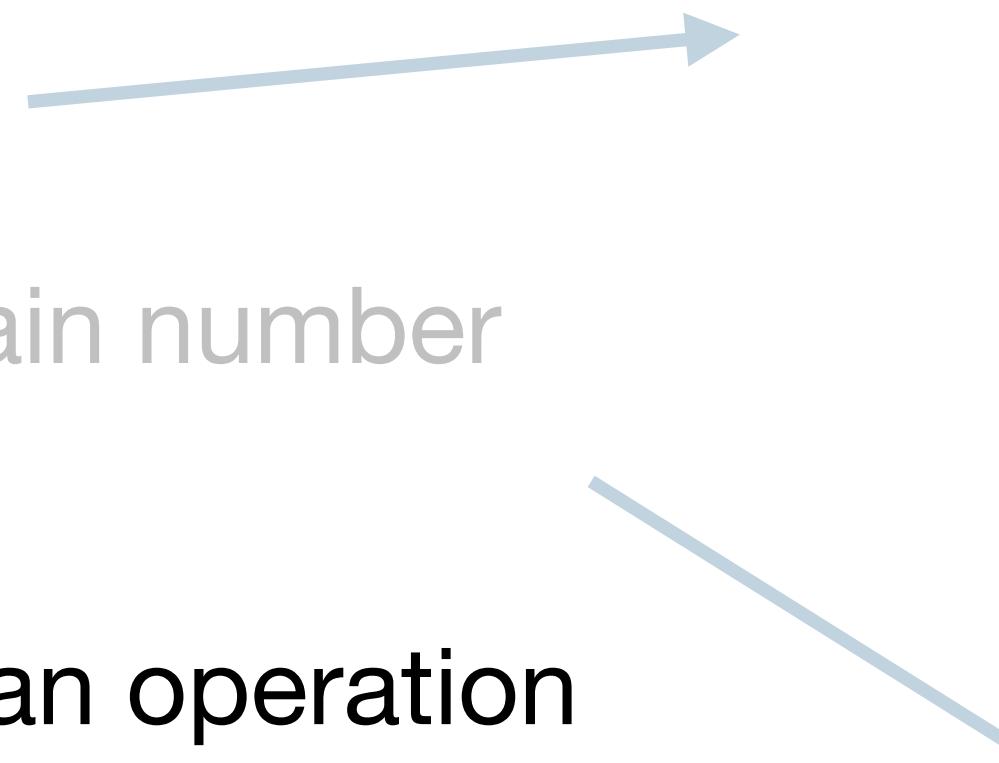
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        new_list.append(1)
    else:
        new_list.append(0)

df['Binary age'] = new_list
df.head(2)
```



```
less_50 = df[df['Age'] <= 50]
less_50.head(2)
```

	Rank	Name	Age	End_Of_Watch	Day_Of_Week	Cause
3	Marshal	Robert Forsyth	40.0	1794-01-11	Saturday	Gunfire
5	Sheriff	Robert Maxwell	45.0	1797-11-12	Sunday	Gunfire

```
less_50['Age'].median(), less_50['Age'].max()

(35.0, 50.0)
```

```
new_df = df[['Rank', 'Name', 'Age']]
new_df.head()
```

	Rank	Name	Age
0	Constable	Darius Quimby	NaN
1	Sheriff	Cornelius Hogeboom	53.0
2	Deputy Sheriff	Isaac Smith	NaN
3	Marshal	Robert Forsyth	40.0
4	Deputy Sheriff	Robert Berwick	NaN

```
new_df = df.iloc[0:10]
new_df.shape
```

(10, 13)

Step 3: Operations with Columns & Rows

- Separate DataFrames
- Filter Data by selecting a certain number of columns or rows
- Create new columns through an operation

```
new_list = []

for el in df['Age'].tolist():
    if el > 50:
        new_list.append(1)
    else:
        new_list.append(0)

df['Binary age'] = new_list
df.head(2)
```

```
less_50 = df[df['Age'] <= 50]
less_50.head(2)
```

	Rank	Name	Age	End_Of_Watch	Day_Of_Week	Cause
3	Marshal	Robert Forsyth	40.0	1794-01-11	Saturday	Gunfire
5	Sheriff	Robert Maxwell	45.0	1797-11-12	Sunday	Gunfire

```
less_50['Age'].median(), less_50['Age'].max()

(35.0, 50.0)
```

```
new_df = df[['Rank', 'Name', 'Age']]
new_df.head()
```

	Rank	Name	Age
0	Constable	Darius Quimby	NaN
1	Sheriff	Cornelius Hogeboom	53.0
2	Deputy Sheriff	Isaac Smith	NaN
3	Marshal	Robert Forsyth	40.0
4	Deputy Sheriff	Robert Berwick	NaN

```
new_df = df.iloc[0:10]
new_df.shape
```

```
(10, 13)
```

Exercise

- There was a mistake when introducing the age of the people. We need to correct them. They ask us to create a new column named `corrected_age` that contains the original age minus 2. Can you do that?

Groupby + apply + Lambda Function

- The groupby operation can be used to group large amounts of data and compute operations on these groups separately.
- "split-apply-combine" operation:
 - Splitting the data into groups based on some criteria
 - Applying a function to each group independently
 - Combining the results into a data structure

```
In [188]: df[df['Outcome'] == 'Repay']['Age'].mean()
```

```
Out[188]: 43.0
```

```
In [189]: df[df['Outcome'] == 'Default']['Age'].mean()
```

```
Out[189]: 38.5
```



```
In [194]: df.groupby('Outcome')['Age'].mean()
```

```
Out[194]: Outcome
           Default    38.5
           Repay     43.0
           Name: Age, dtype: float64
```

```
In [193]: df.groupby('Outcome')['Age'].apply(lambda x: x.sum()/x.count())
```

```
Out[193]: Outcome
           Default    38.5
           Repay     43.0
           Name: Age, dtype: float64
```

Step-by-step in the Jupyter Notebooks

Exercise

- How many different ranks are there if we group by day of the week and age range?

Topic 6: Documentation

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Your instructor Hugo will introduce you to how companies worldwide use Python to gain a competitive edge. Through hands-on coding exercises you'll then learn how to store, manipulate, and explore data using NumPy. Then it's time to level-up as you learn how to visualize your data using Matplotlib, manipulate DataFrames and dictionaries using pandas, and write your own functions and list comprehension. Start this track to add these essential Python skills to your data science toolbox.

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