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Intermediate Python & a Glimpse into AI applications

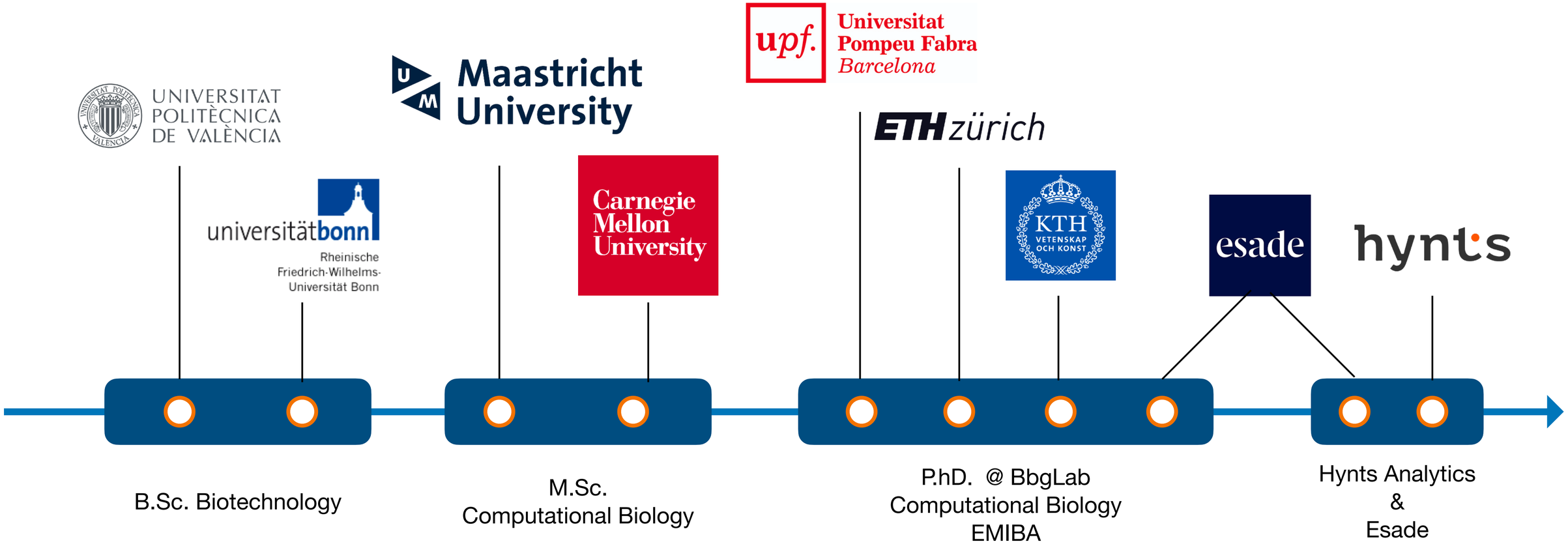
Class 1

Pepe Bonet Giner

9th January 2023

Index Class 1

Who am I?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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 Vizualization
- 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.

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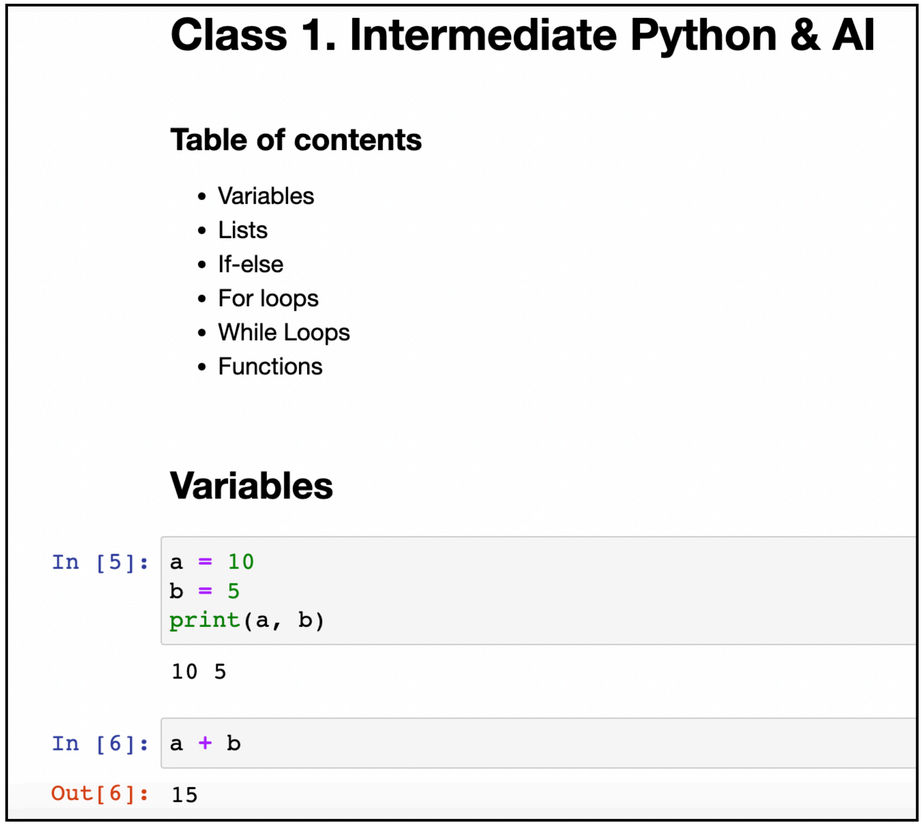
- **40% Final project**:
  - Python code on Jupyter Notebook, working and applying the concepts learned in class on a dataset, explaining the steps taken.
  - A 2-page report summarizing the results, the value extracted from data, and possible applications of AI.
  - Upload both to the Moodle max two weeks after the last lecture.

Final work

Code in Jupyter Notebooks

Report Explaining Results



Class 1. Intermediate Python & AI

Table of contents

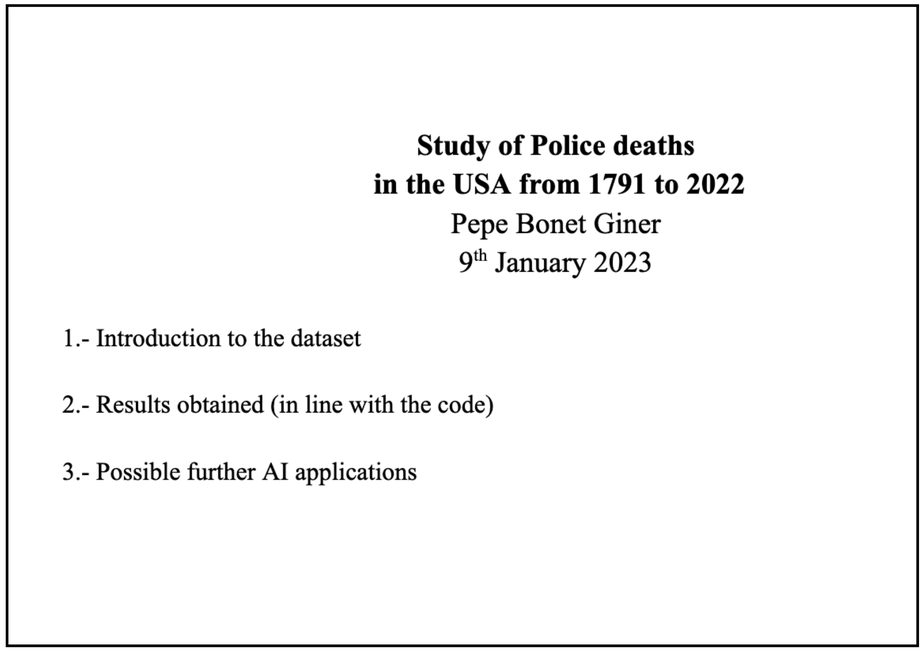
- Variables
- Lists
- If-else
- For loops
- While Loops
- Functions

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

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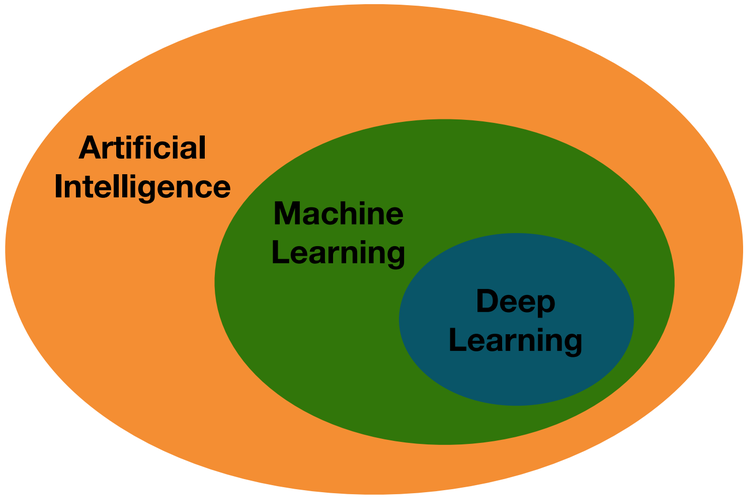
- Customer Service: Chat Bots
- Education: Personalized Learning
- Healthcare: Personalized Medicine
- VR/AR

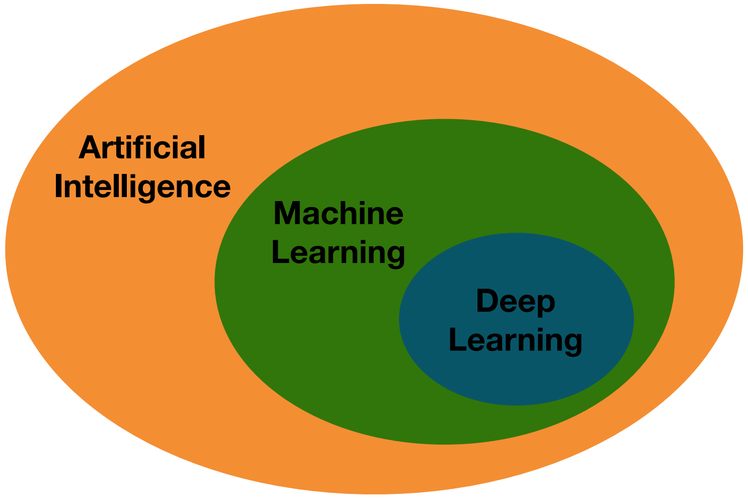
AI is behind many of these disruptions

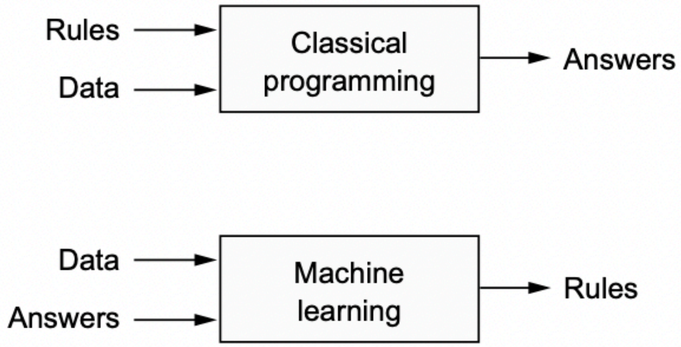
What is Artificial Intelligence (AI)?

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



What is Artificial Intelligence (AI)?

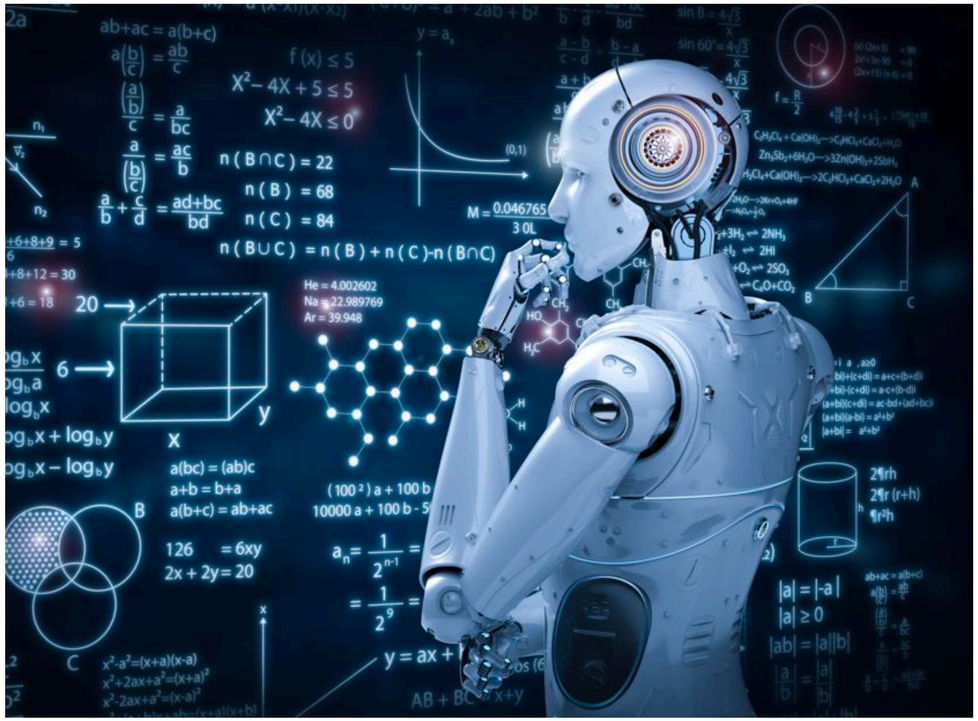




- ~ 1950-1980 Symbolic AI. Rules + Data —> Answers
- ML: Data + Answers —> Rules
- Ability to learn from past data to make future decisions

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

Meta AI

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

July 6, 2022

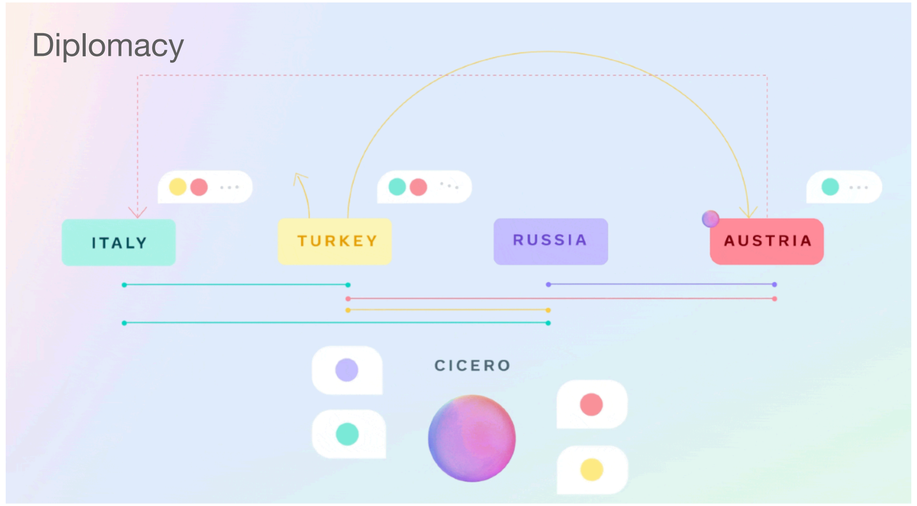
Meta AI Introduces 'Make-A-Video': An Artificial Intelligence System That Generates Videos From Text

By **Ashish kumar** - October 3, 2022

RESEARCH

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

November 22, 2022



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

DeepMind

Research

Discovering novel algorithms with AlphaTensor

October 5, 2022

Article | Open Access | Published: 15 July 2021

Highly accurate protein structure prediction with AlphaFold

OpenAI

P How do I build an intermediate python course

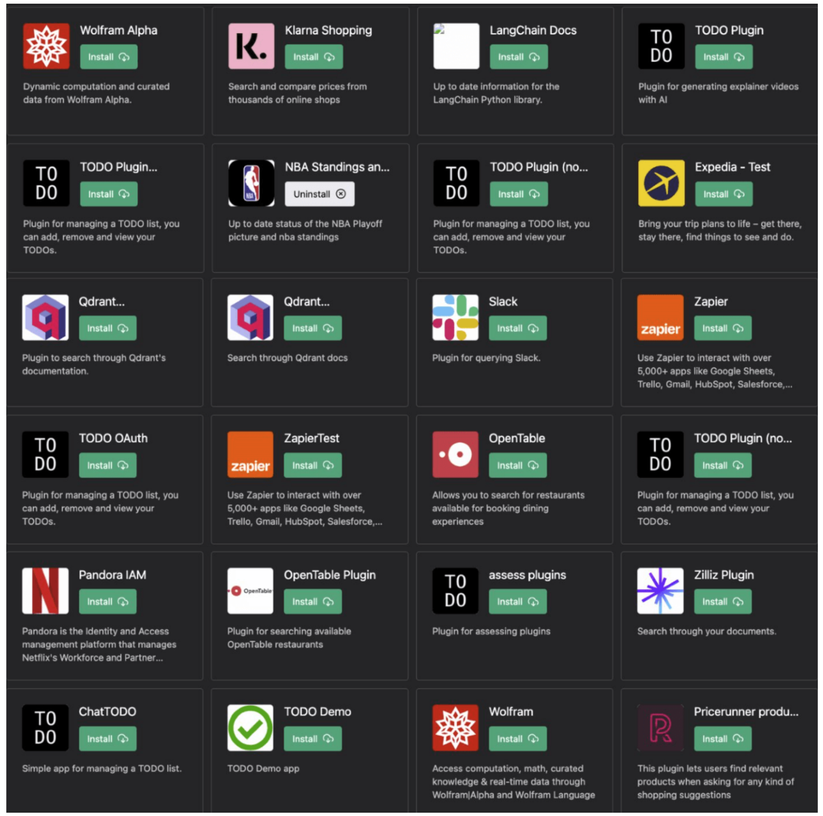
To build an intermediate Python course, you can follow these steps:

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.

The ChatGPT boom! The AI race has started

GPT4 Plugins

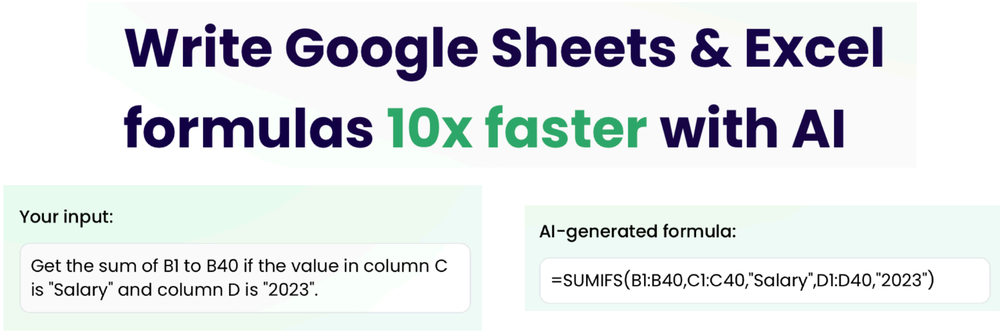


Midjourney

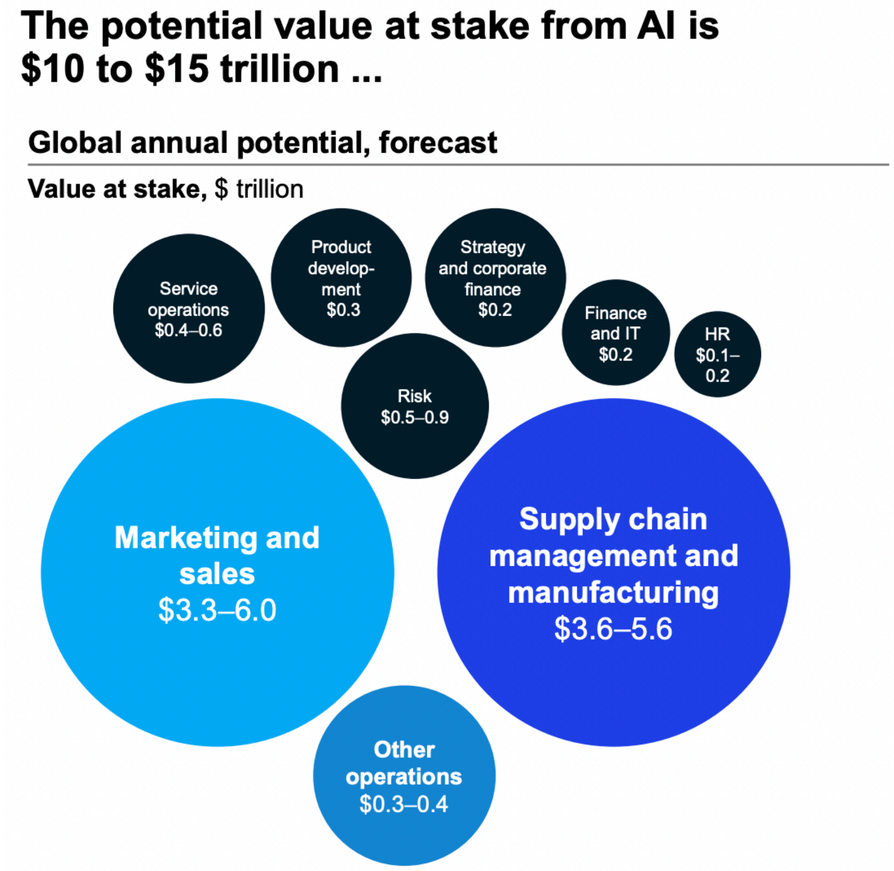
AutoGPT

DoNotPay

Sheet+



This disruption applies to any field. Business in general



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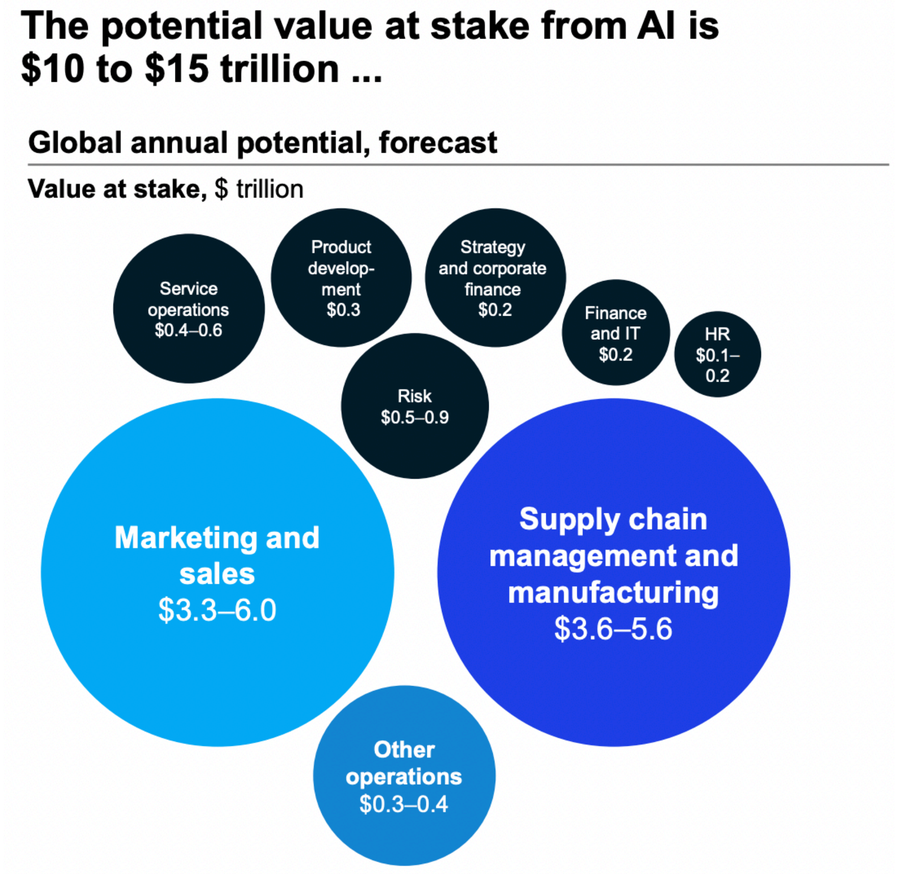

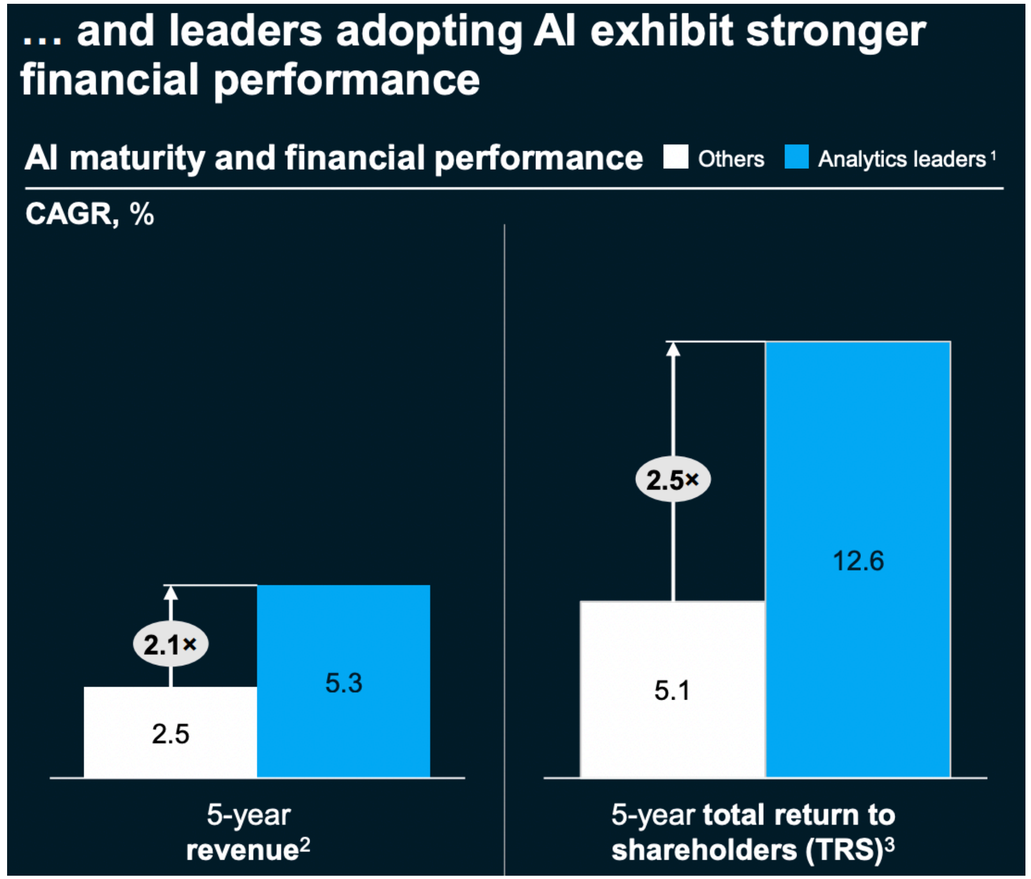

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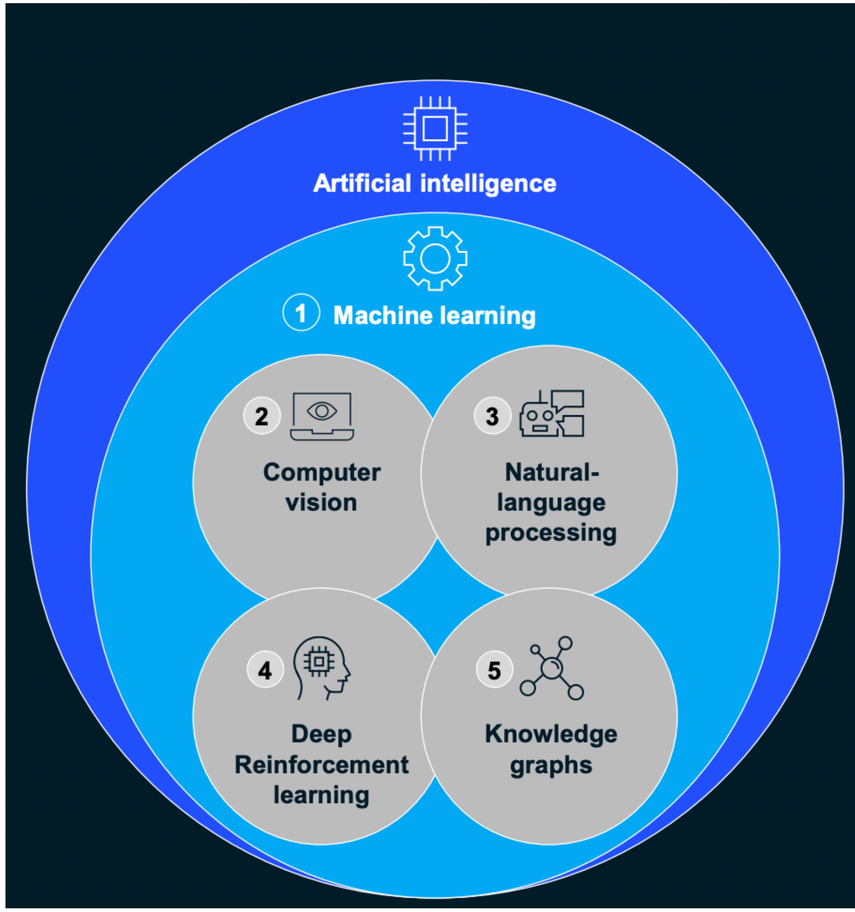

Description	Example use case
1 **ML:** Subfield of AI that uses statistical methods to learn from data	Schedule optimization
2 **Computer vision:** Subfield of ML using visual data, such as images, videos, and 3-D signals, extracting complex information and gaining rich interpretations	Facial recognition as biometrics
3 **NLP:** Subfield of ML that involves processing, generating, and understanding language-based data, such as written text and spoken word	Speech recognition in a virtual voice assistant
4 **Deep reinforcement learning:** Combination of deep learning and reinforcement learning, in which an agent makes decisions within an uncertain environment using complex algorithms inspired by brain neural networks	Planning robotic-arm motion for the manufacturing line
5 **Knowledge graphs:** Collection of data points structured into a network to show complex relationships among themselves	Social-network analysis

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

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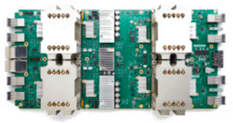
Topic 3: The backbone of this new world

What is driving this AI revolution?

Advances in Hardware

CPU

GPU



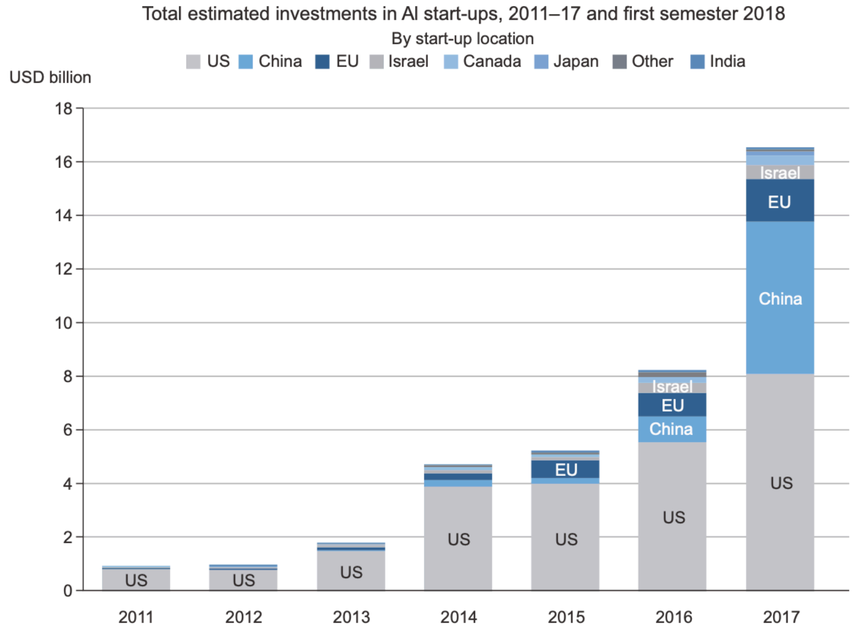
TPU

Research

Cloud Computing

aws Azure Google Cloud

Investment



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?

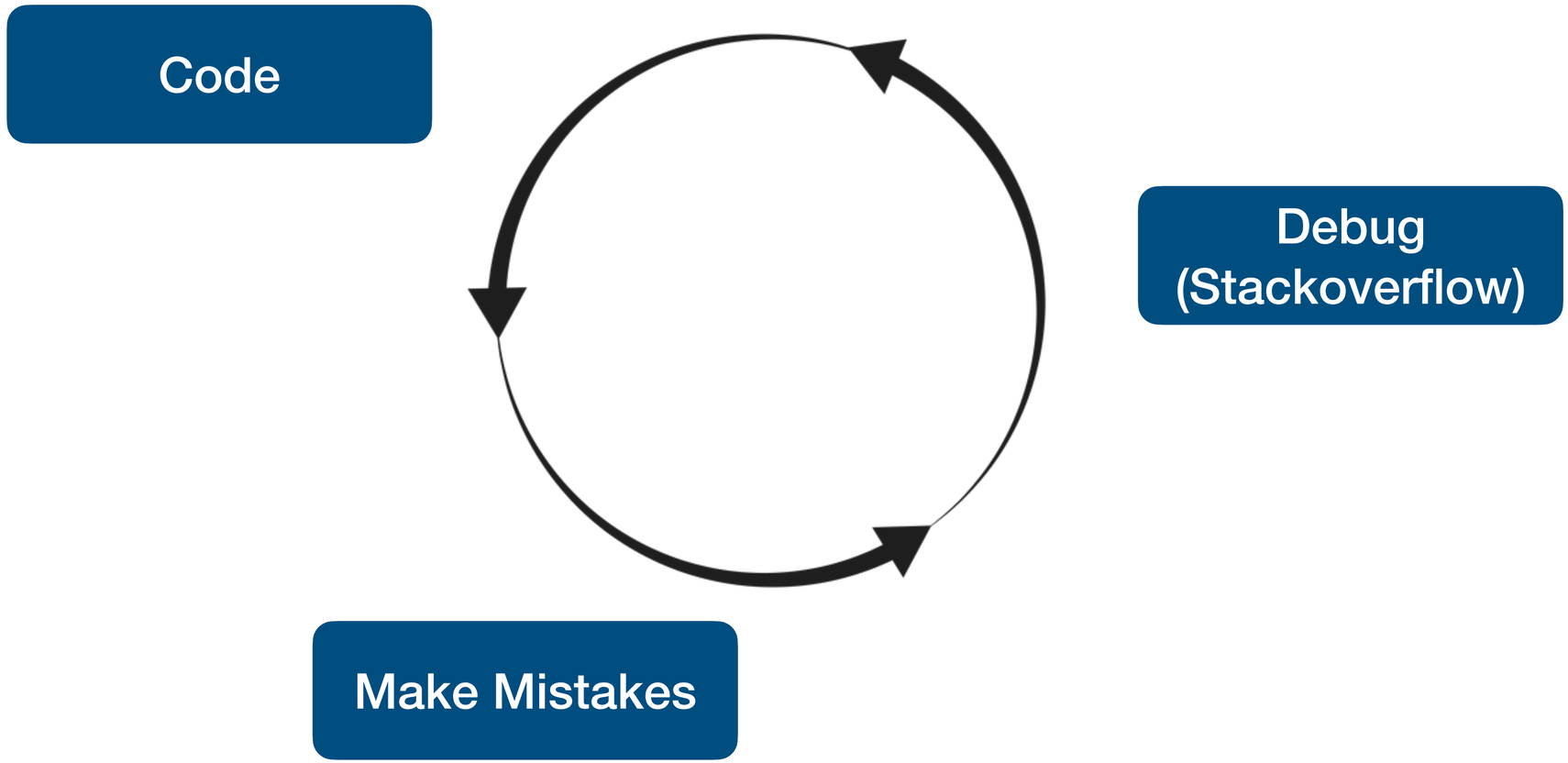
- Versatile, and powerful **programming language**
- Concise, and **easy to learn**, use and read
- **Large** python **community** (Widely used)
- Large number of libraries (Big data, Machine Learning)
- **High demand** in the job market

PYTHON

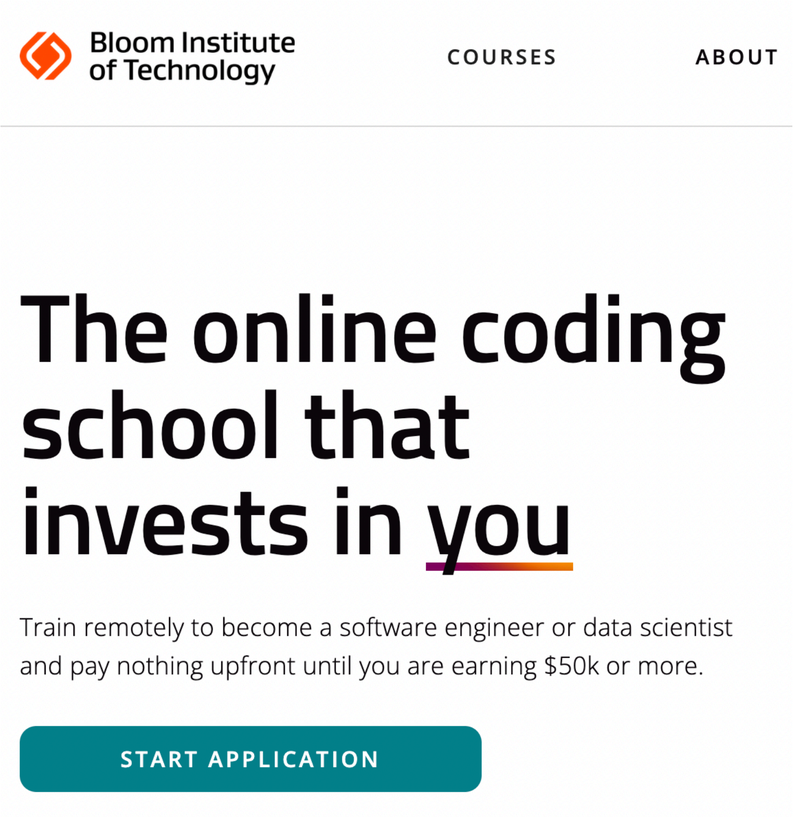
```python
import tensorflow as tf
from tensorflow.keras.layers import *
from tensorflow.keras.models import Model, Sequential
from tensorflow.keras.applications.inception_v3 import InceptionV3


class ConvBlock(Model):

    def __init__(self, filters, kernel_size):
        super(ConvBlock, self).__init__()
        self.conv = Conv1D(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?



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!

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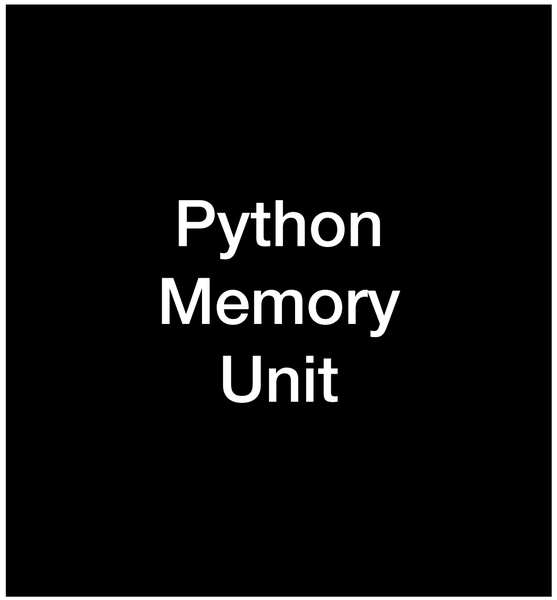
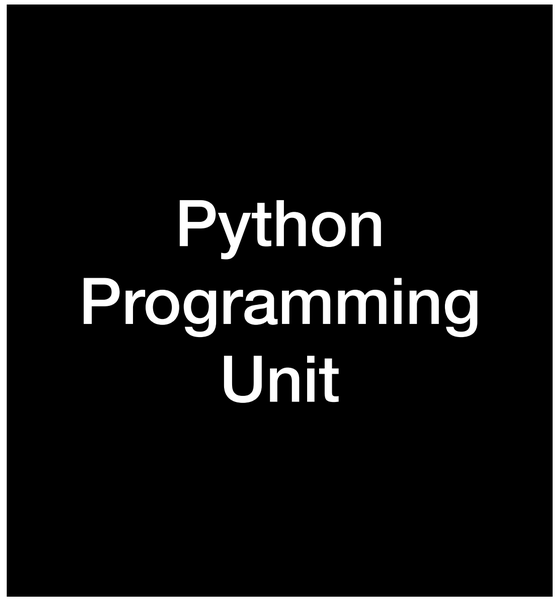
Topic 4: Python Basics Recap

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
```

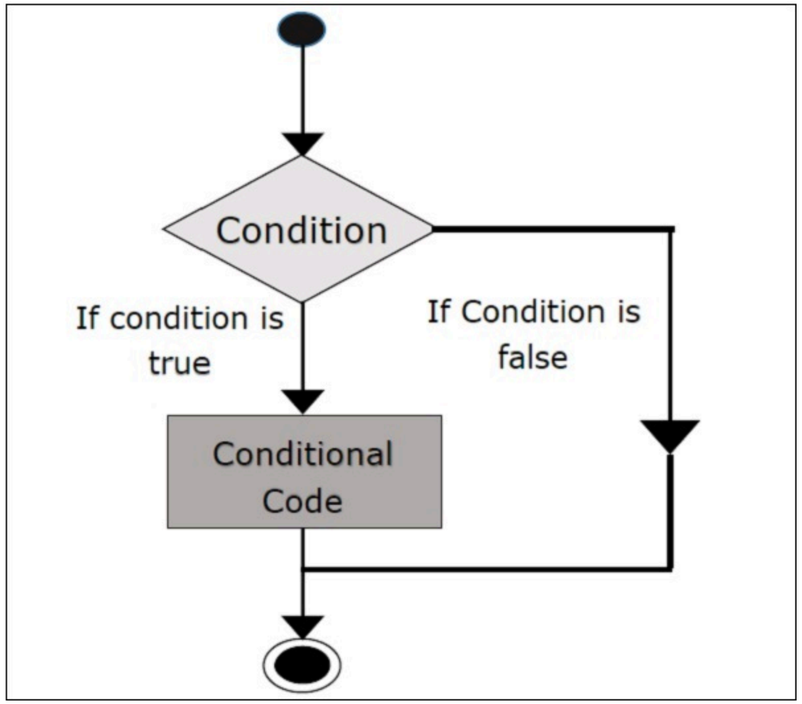
```
{'Players': ['Messi', 'Ronaldo', 'Maradona'],
 'Goals': [10, 8, 6],
 'Assists': [12, 3, 5]}
```

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 <= b, a >= 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. (Do examples first)

Exercise

- Create a function:
    - That has 2 inputs
    - Where both inputs are numbers
    - Where you check whether the first input is larger than 3
        - If it is: Return the sum of both numbers
        - If it is lower than 3: Return the subtraction of both
        - Else (When it is equal to 3): return the multiplication of both numbers

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Topic 5: Jupyter Notebook & Clean Code

Work on your code! You are not the only one reading it!

Comment your code

```python
# Create a list of numbers
numbers = [1, 2, 3, 4, 5]

# Create a new list to store the results
results = []

# Iterate over the numbers in the list
for number in numbers:
    # Subtract 2 from each number and append the result to the results list
    results.append(number - 2)
```

1. Use clear and descriptive variable and function names. Instead of x (or y, z, l, j) put a proper name, i.e., results, number
2. Comment explaining what the code is meant to do
3. Explain complex or obscure code
4. Update comments as you make changes to your code

Which option do you prefer?

1

```python
def calculate_discounted_price(price, discount_rate):
    """
    Calculates the discounted price of an item given its original price and discount rate.
    :param price: The original price of the item
    :param discount_rate: The discount rate as a percentage
    :return: The discounted price of the item
    """
    discount_amount = price * (discount_rate / 100)
    discounted_price = price - discount_amount
    return discounted_price
```

2

```python
def fn(a,b):
    return a - a*(b/100)
```

Also on your JN! It has to be read by other people (me)

Break up the JN into sections
Use bold levels

```
# Hello
## I
### am
#### Pepe
```

Hello

I

am

Pepe

Class 1.2. Intermediate Python & AI

Pandas

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esade

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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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?

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Topic 6: Documentation

Datacamp Courses

Python Fundamentals

Are you ready to gain the foundational skills you need to become a Python programmer? In this track, you'll learn the Python basics you need to start on your programming journey, including how to clean real-world data ready for analysis, use data visualization libraries, and even how to write your own Python functions.

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.

Switch Track

Python 15 hours 4 Courses 1 Skill Assessment

Data Scientist with Python

Gain the career-building Python skills you need to succeed as a data scientist. No prior coding experience required.

In this track, you'll learn how this versatile language allows you to import, clean, manipulate, and visualize data—all integral skills for any aspiring data professional or researcher. Through interactive exercises, you'll get hands-on with some of the most popular Python libraries, including pandas, NumPy, Matplotlib, and many more. You'll then work with real-world datasets to learn the statistical and machine learning techniques you need to train decision trees and use natural language processing (NLP). Start this track, grow your Python skills, and begin your journey to becoming a confident data scientist.

Resume Track

Python 88 hours 23 Courses 6 Projects 3 Skill Assessments

Free Books to learn Python & data analytics