CP020001 Basic Data Engineering

Lecture: Basic Pandas

https://github.com/kaopanboonyuen/CP020001_ComputerProgramming_2024s2
Contact: teerapong.pa@chula.ac.th

Outline

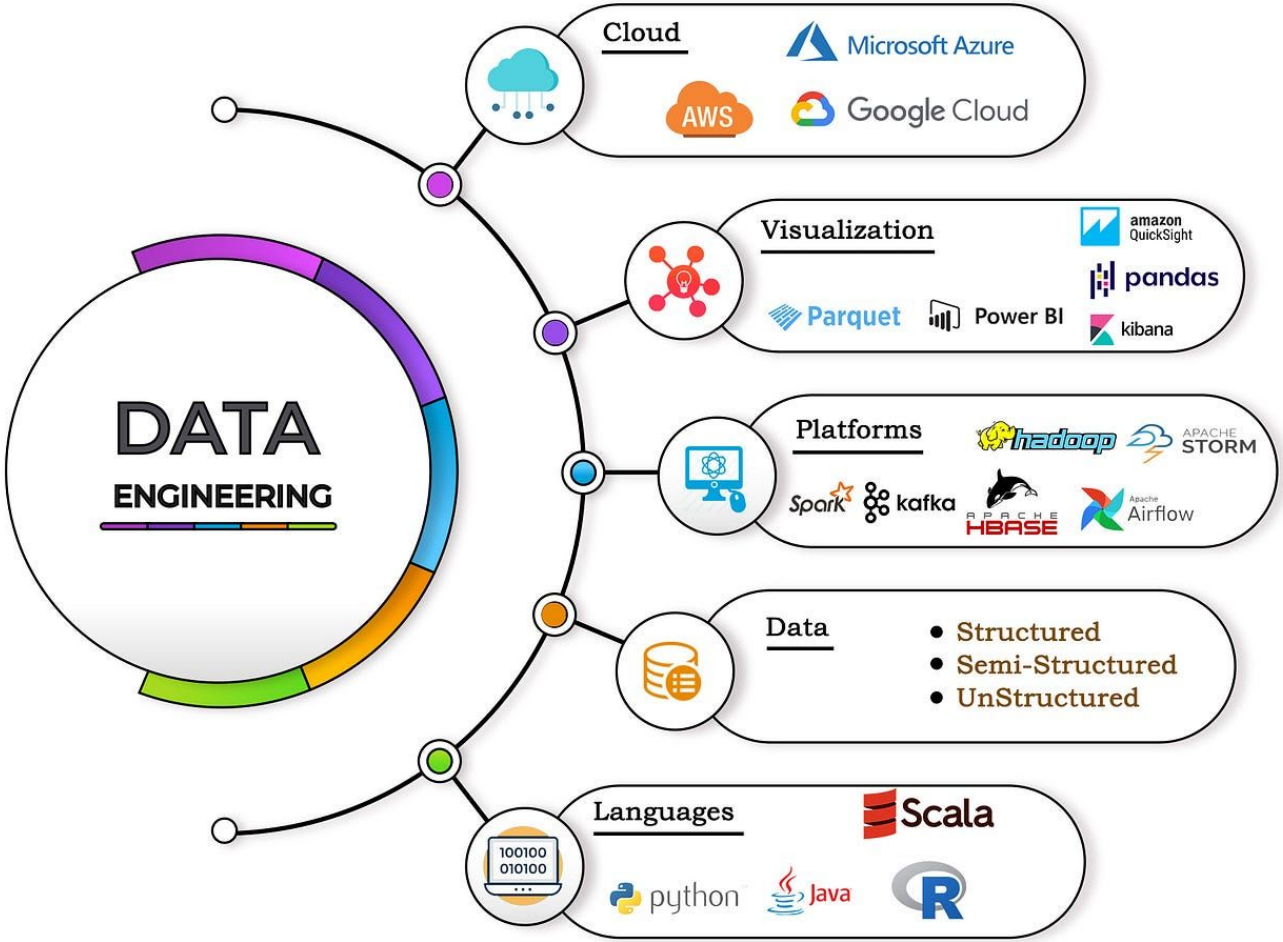
- Introduction to Data Engineering
- Creating DataFrames
- Indexing & Selecting Data (iloc & loc)
- Basic DataFrame Operations
- Handling Missing Data (fillna)
- String Operations in Pandas
- Filtering & Sorting Data
- GroupBy & Aggregation
- Feature Engineering (Creating New Features)
- Saving & Loading Data (CSV, Excel)
- Basic Data Visualization in Pandas
- Joining & Merging DataFrames

Reference

1. **Pandas Library**
   - Official Documentation: https://pandas.pydata.org/pandas-docs/stable/
   - Tutorial: https://www.datacamp.com/community/tutorials/pandas-tutorial-dataframe-python
2. **DataFrame Concept**
   - Understanding DataFrame: https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DataFrame.html
   - Practical Guide to DataFrame: https://realpython.com/pandas-dataframe/
3. **Data Engineering Basics**
   - Introduction to Data Engineering: https://www.dataversity.net/what-is-data-engineering/
   - Data Engineering in Python: https://realpython.com/data-engineering-python/
4. **Thai Politician Dataset (Mockup)**
5. **Pokemon Dataset (Mockup)**

📚 *This lab uses a mockup dataset created solely for academic purposes. The data does not represent real Thai politicians.*
🗳️ *Any resemblance to actual individuals or political figures is purely coincidental. This dataset is meant for learning and practice with Python and Pandas only, and should not be used for any real-world or official representations.* 🚫

DATA ENGINEERING


DATA
ENGINEERING
Cloud
Microsoft Azure
AWS
Google Cloud
Visualization
amazon QuickSight
pandas
Parquet
Power BI
kibana
Platforms
hadoop
APACHE STORM
Spark
kafka
APACHE HBASE
Apache Airflow
Data
Structured
Semi-Structured
UnStructured
Languages
Scala
python
Java
R

Data Engineer

Skills Needed to Become a Data Engineer

- SQL
- Data Warehousing Solutions
- Big Data Platforms
- ETL Tools
- Python and Java
- Data Pipeline Frameworks
- Cloud Platforms

Data Scientist

uses statistics and machine learning to make predictions and answer key business questions

Skills - Math, Programming, Statistics


Tech - SQL, Python, R, Cloud

Data Engineer

build and optimize the systems that allow data scientists and analysts to perform their work

Skills - Programming, BigData & Cloud

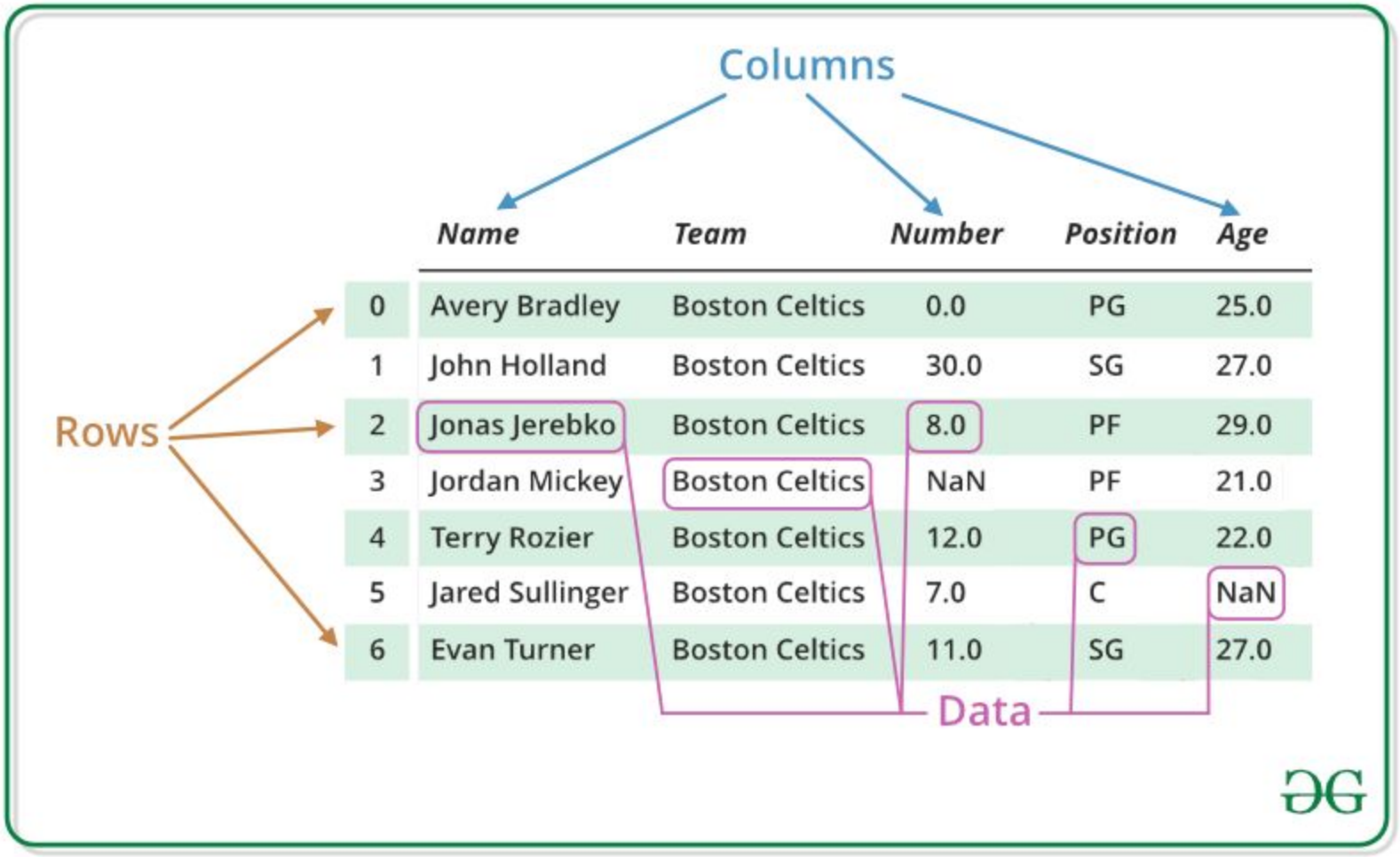

Tech - SQL, Python, Cloud, Distributed Computing

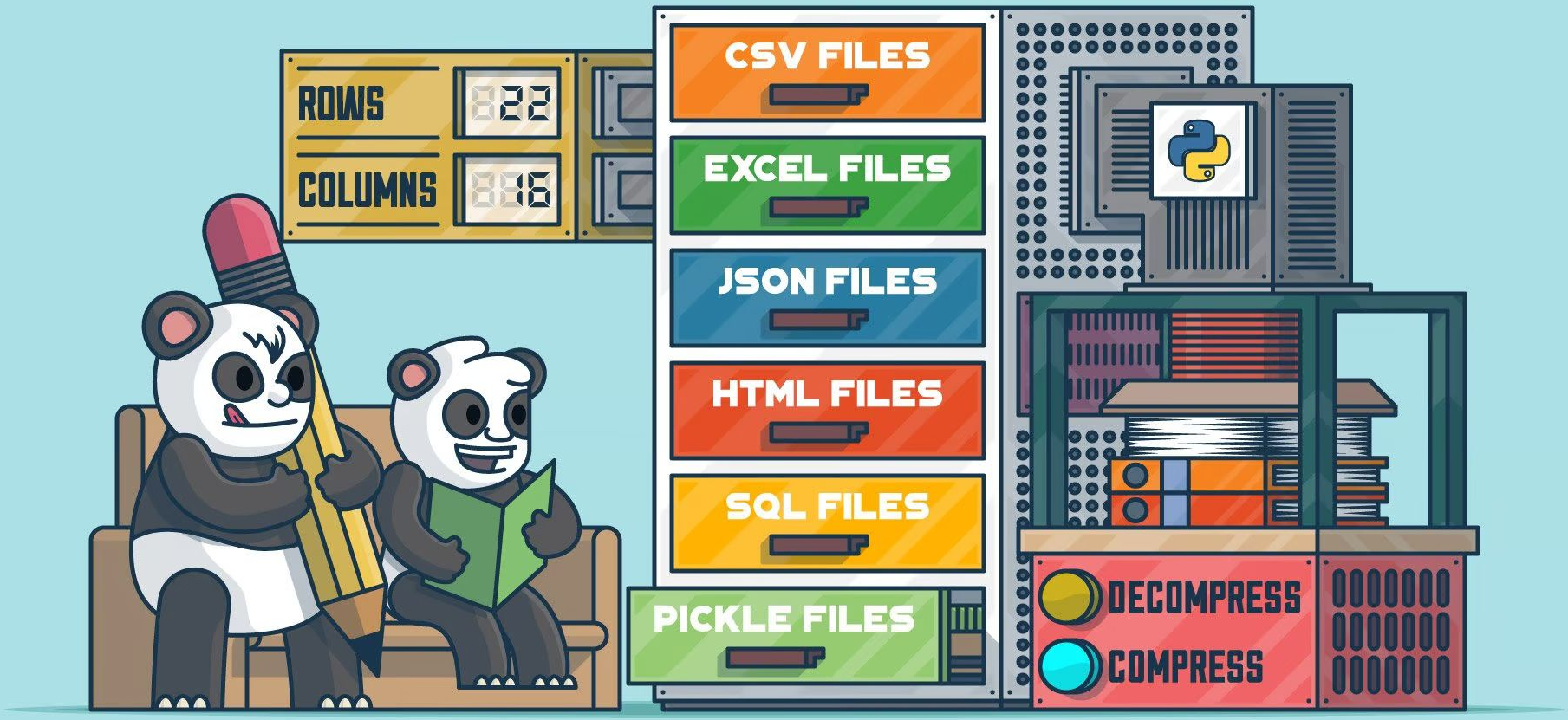
Data Analyst

deliver value by taking data, communicating the results to help make business decisions

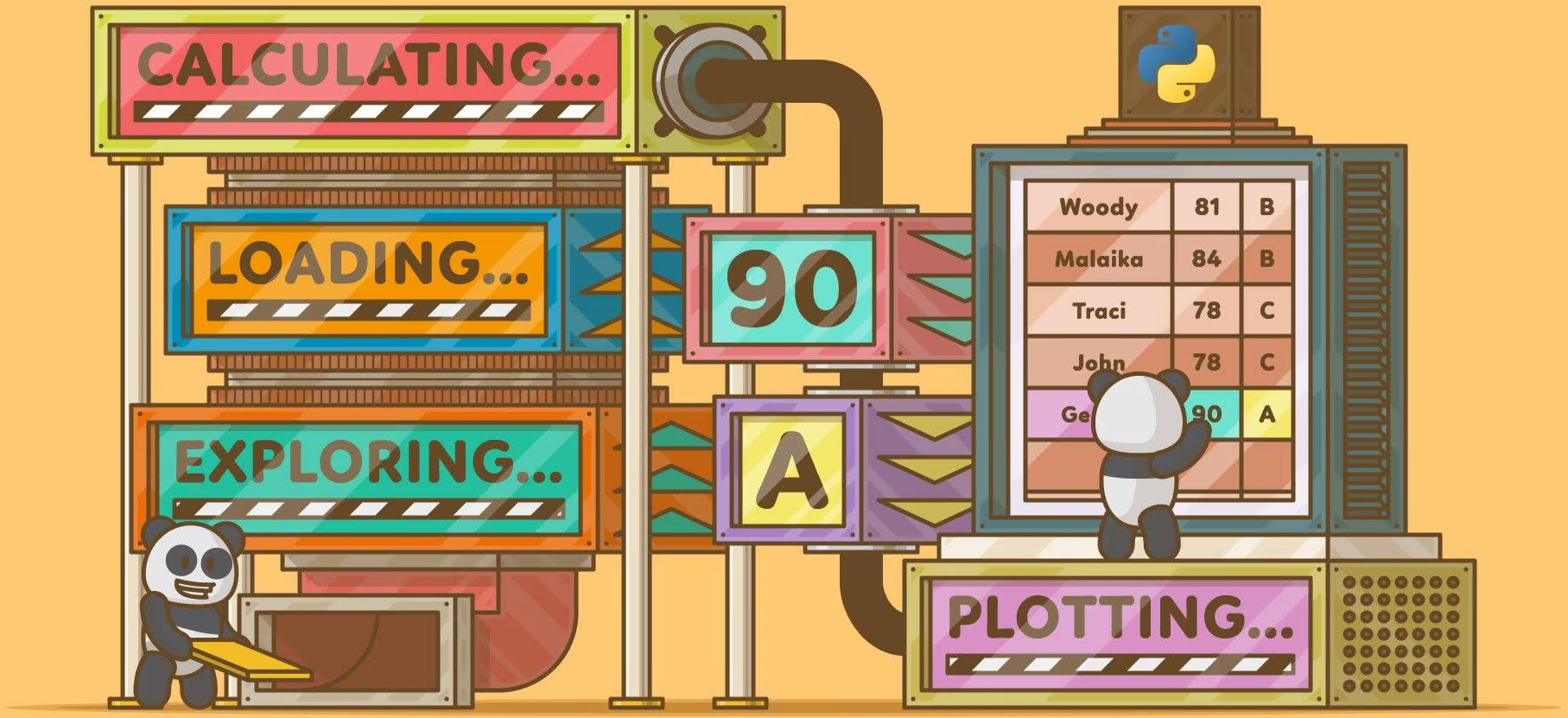
Skills - Communication, Business Knowledge


Tech - SQL, Excel, Tableau

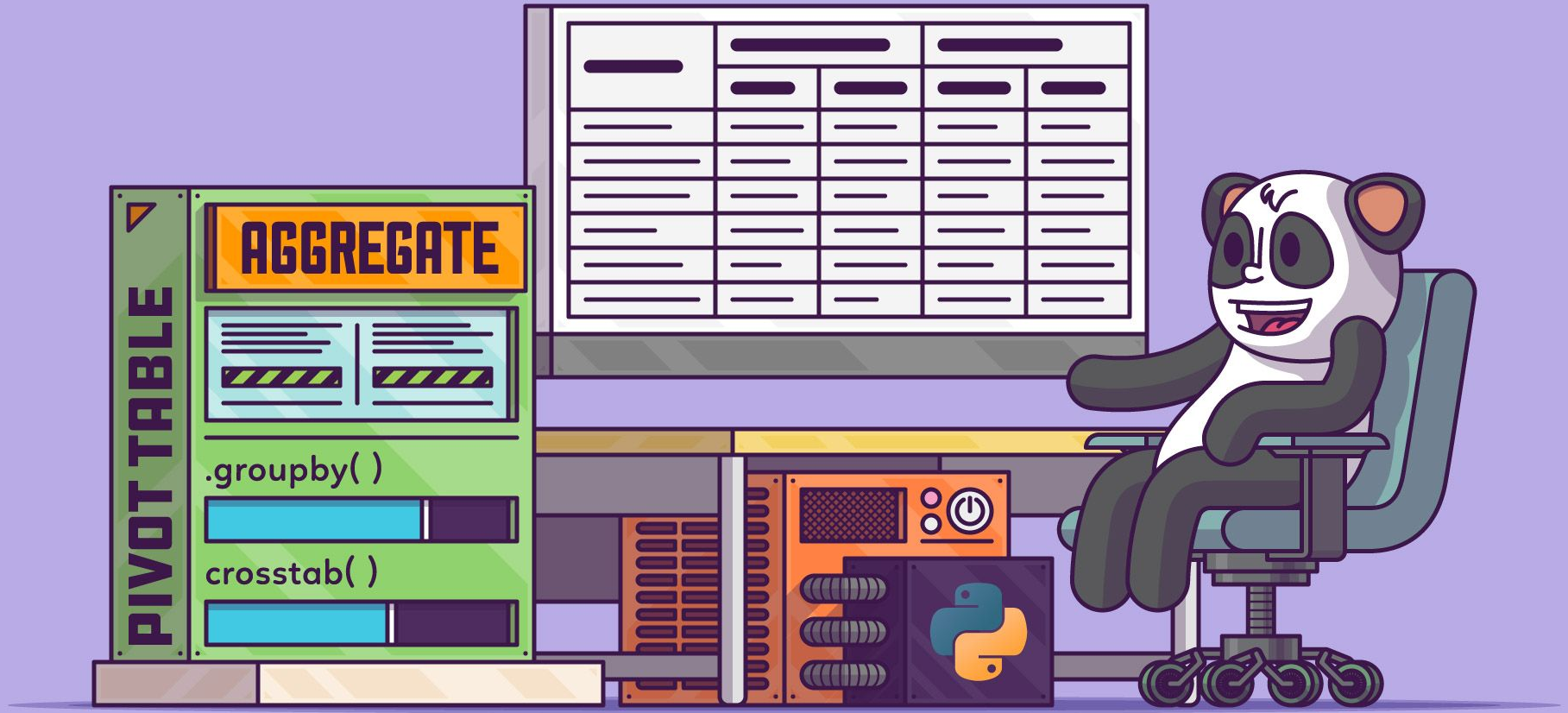

Columns
Rows
Data
Name
Team
Number
Position
Age
0 Avery Bradley Boston Celtics 0.0 PG 25.0
1 John Holland Boston Celtics 30.0 SG 27.0
2 Jonas Jerebko Boston Celtics 8.0 PF 29.0
3 Jordan Mickey Boston Celtics NaN PF 21.0
4 Terry Rozier Boston Celtics 12.0 PG 22.0
5 Jared Sullinger Boston Celtics 7.0 C NaN
6 Evan Turner Boston Celtics 11.0 SG 27.0


ROWS
22
COLUMNS
16
CSV FILES
EXCEL FILES
JSON FILES
HTML FILES
SQL FILES
PICKLE FILES
DECOMPRESS
COMPRESS

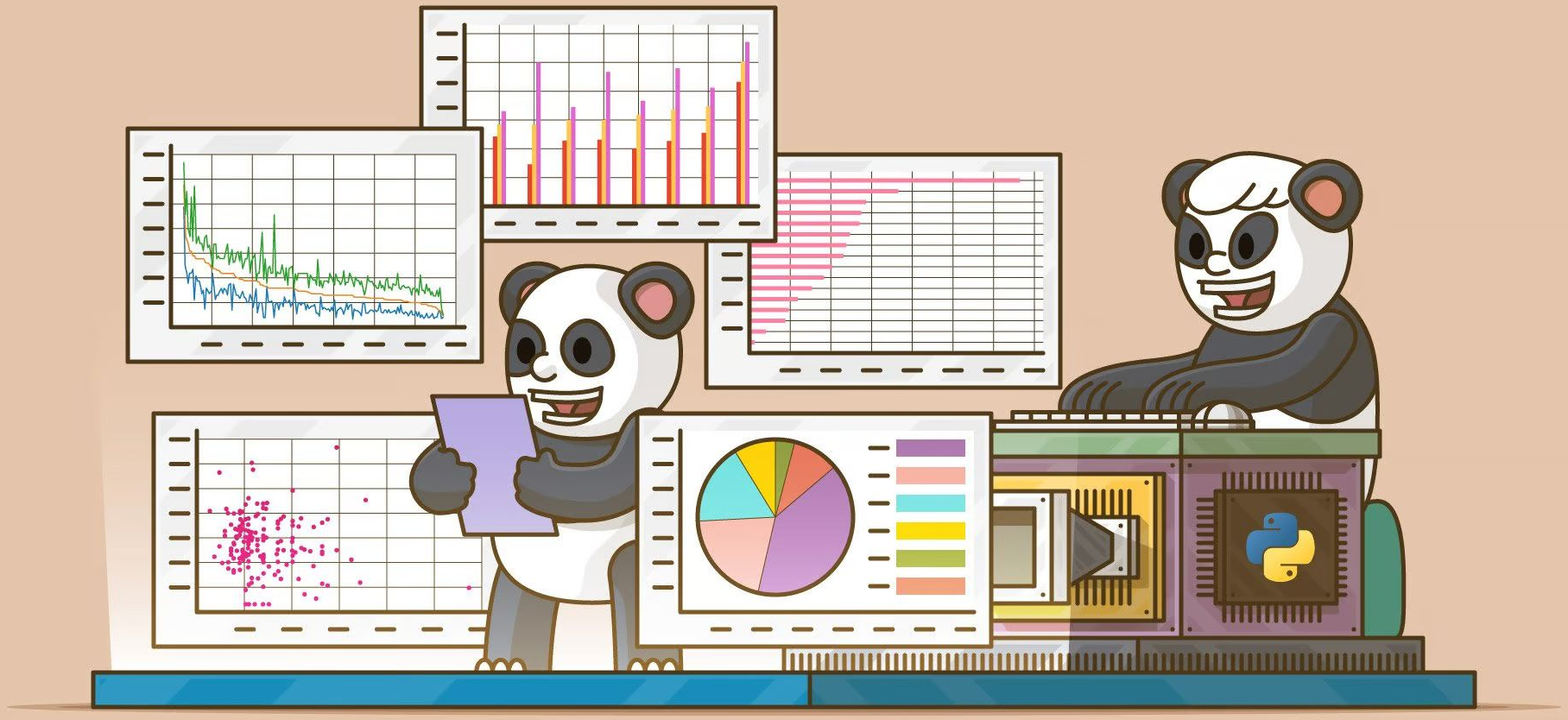
Real Python


CALCULATING...
LOADING...
EXPLORING...
90
A
Woody 81 B
Malaika 84 B
Traci 78 C
John 78 C
Ge 90 A
PLOTTING...

Real Python



Real Python



Real Python

1️⃣ Creating DataFrames in Pandas

You can create DataFrames using dictionaries, lists, and lists of dictionaries.

🔷 Creating a DataFrame from a Dictionary

```
[ ]
```

```python
import pandas as pd

data_dict = {
    'Customer_ID': [101, 102, 103, 104, 105],
    'Customer_Name': ['Alice', 'Bob', 'Charlie', 'David', 'Eve'],
    'Product': ['Laptop', 'Phone', 'Tablet', 'Laptop', 'Phone'],
    'Price': [1200, 800, 600, 1300, 850],
    'Salary': [5000, 6000, 7000, 4000, 6500]
}

df = pd.DataFrame(data_dict)
df
```

	Customer_ID	Customer_Name	Product	Price	Salary
0	101	Alice	Laptop	1200	5000
1	102	Bob	Phone	800	6000
2	103	Charlie	Tablet	600	7000
3	104	David	Laptop	1300	4000
4	105	Eve	Phone	850	6500

🔷 Creating a DataFrame from a List of Lists

```python
data_list = [
    [101, 'Alice', 'Laptop', 1200, 5000],
    [102, 'Bob', 'Phone', 800, 6000],
    [103, 'Charlie', 'Tablet', 600, 7000],
    [104, 'David', 'Laptop', 1300, 4000],
    [105, 'Eve', 'Phone', 850, 6500]
]

columns = ['Customer_ID', 'Customer_Name', 'Product', 'Price', 'Salary']
df_list = pd.DataFrame(data_list, columns=columns)
df_list
```

	Customer_ID	Customer_Name	Product	Price	Salary
0	101	Alice	Laptop	1200	5000
1	102	Bob	Phone	800	6000
2	103	Charlie	Tablet	600	7000
3	104	David	Laptop	1300	4000
4	105	Eve	Phone	850	6500

📌 Assignment 1:

Create a DataFrame about students with columns 'Student_ID', 'Name', 'Age', 'GPA', and 'Major'.

```
[ ]    1 # Insert your code here
```

	Student_ID	Name	Age	GPA	Major
0	1	John	20	3.5	Engineering
1	2	Jane	22	3.8	Marketing
2	3	Mike	21	3.2	Finance
3	4	Sara	23	3.9	Data Science
4	5	Tom	22	3.6	Computer Science

2️⃣ Selecting Data in Pandas (iloc & loc)

🔷 Using .iloc[] for Index-Based Selection

```
[ ]  1 # Select first 3 rows
     2 df.iloc[:3]
```

	Customer_ID	Customer_Name
0	101	Alice
1	102	Bob
2	103	Charlie

```
[ ]  1 # Select second row
     2 df.iloc[1]
```

	1
Customer_ID	102
Customer_Name	Bob
Product	Phone
Price	800
Salary	6000

dtype: object

```
[ ]
1 # Select first 3 rows and first 2 columns
2 df.iloc[:3, :2]
```

	Customer_ID	Customer_Name
0	101	Alice
1	102	Bob
2	103	Charlie

🔷 Using .loc[] for Label-Based Selection

```
[ ]  1 # Select a single row by index
     2 df.loc[2]
```

	2
Customer_ID	103
Customer_Name	Charlie
Product	Tablet
Price	600
Salary	7000

dtype: object

```
[ ]  1 # Select rows where Price > 1000
     2 df.loc[df['Price'] > 1000]
```

	Customer_ID	Customer_Name	Product	Price	Salary
0	101	Alice	Laptop	1200	5000
3	104	David	Laptop	1300	4000

```
[ ]  1 # Select specific columns
     2 df.loc[:, ['Customer_Name', 'Product']]
```

	Customer_Name	Product
0	Alice	Laptop
1	Bob	Phone
2	Charlie	Tablet
3	David	Laptop
4	Eve	Phone

📌 Assignment 2:

Select all customers who bought a laptop and show only 'Customer_Name' and 'Price'.

```
[ ]  1 # Insert your code here
```

	Customer_Name	Price
0	Alice	1200
3	David	1300

3️⃣ Basic DataFrame Operations

```
[ ]  1 df.head()    # First 5 rows
```

	Customer_ID	Customer_Name	Product	Price	Salary
0	101	Alice	Laptop	1200	5000
1	102	Bob	Phone	800	6000
2	103	Charlie	Tablet	600	7000
3	104	David	Laptop	1300	4000
4	105	Eve	Phone	850	6500

```
[ ]  1 df.shape     # (rows, columns)
```

```
(5, 5)
```

```
[ ]    1 df.info()    # Data type of each column
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 5 entries, 0 to 4
Data columns (total 5 columns):
 #   Column         Non-Null Count  Dtype 
---  ------         --------------  ----- 
 0   Customer_ID    5 non-null      int64 
 1   Customer_Name  5 non-null      object
 2   Product        5 non-null      object
 3   Price          5 non-null      int64 
 4   Salary         5 non-null      int64 
dtypes: int64(3), object(2)
memory usage: 332.0+ bytes
```

```
[ ]  1 df.describe()  # Summary statistics
```

	Customer_ID	Price	Salary
count	5.000000	5.000000	5.000000
mean	103.000000	950.000000	5700.000000
std	1.581139	291.547595	1204.159458
min	101.000000	600.000000	4000.000000
25%	102.000000	800.000000	5000.000000
50%	103.000000	850.000000	6000.000000
75%	104.000000	1200.000000	6500.000000
max	105.000000	1300.000000	7000.000000

4️⃣ Handling Missing Data (fillna)

```
[ ]
1 df.fillna(0)  # Replace NaN with 0
2 df.fillna(df.mean())  # Replace NaN with column mean
3 df.dropna()  # Drop missing rows
```

5️⃣ String Operations in Pandas

```
[ ]  1 df['Customer_Name'].str.lower()   # Convert to lowercase
```

	Customer_Name
0	alice
1	bob
2	charlie
3	david
4	eve

dtype: object

```
[ ]  1 df['Customer_Name'].str.upper()   # Convert to uppercase
```

	Customer_Name
0	ALICE
1	BOB
2	CHARLIE
3	DAVID
4	EVE

dtype: object

```
[ ]  1 df['Customer_Name'].str.contains('Alice')  # Check if contains
```

	Customer_Name
0	True
1	False
2	False
3	False
4	False

dtype: bool

6️⃣ Filtering & Sorting Data

```
[ ]  1 df[df['Price'] > 1000]  # Filter rows
```

	Customer_ID	Customer_Name	Product	Price	Salary
0	101	Alice	Laptop	1200	5000
3	104	David	Laptop	1300	4000

```
[ ]  1 df.sort_values('Price', ascending=False)  # Sort by price
```

	Customer_ID	Customer_Name	Product	Price	Salary
3	104	David	Laptop	1300	4000
0	101	Alice	Laptop	1200	5000
4	105	Eve	Phone	850	6500
1	102	Bob	Phone	800	6000
2	103	Charlie	Tablet	600	7000

7️⃣ GroupBy & Aggregation

```
[ ]  1 df.groupby('Product')['Price'].mean()  # Average price per product
```

Product	Price
Laptop	1250.0
Phone	825.0
Tablet	600.0

dtype: float64

```
df.groupby('Product').agg({'Price': ['mean', 'max', 'min']})  # Multiple aggregations
```

	Price		
	mean	max	min
Product			
Laptop	1250.0	1300	1200
Phone	825.0	850	800
Tablet	600.0	600	600

8️⃣ Feature Engineering (Creating New Features)

```
[ ]  1 df['Discounted_Price'] = df['Price'] * 0.9  # 10% discount
```

```
[ ]  1 df.head()
```

	Customer_ID	Customer_Name	Product	Price	Salary	Discounted_Price
0	101	Alice	Laptop	1200	5000	1080.0
1	102	Bob	Phone	800	6000	720.0
2	103	Charlie	Tablet	600	7000	540.0
3	104	David	Laptop	1300	4000	1170.0
4	105	Eve	Phone	850	6500	765.0

Next steps: Generate code with df | View recommended plots | New interactive sheet

```
[ ]  1 df['Salary_to_Price'] = df['Salary'] / df['Price']  # Ratio
```

```
     1 df.head()
```

	Customer_ID	Customer_Name	Product	Price	Salary	Discounted_Price	Salary_to_Price
0	101	Alice	Laptop	1200	5000	1080.0	4.166667
1	102	Bob	Phone	800	6000	720.0	7.500000
2	103	Charlie	Tablet	600	7000	540.0	11.666667
3	104	David	Laptop	1300	4000	1170.0	3.076923
4	105	Eve	Phone	850	6500	765.0	7.647059

Next steps: Generate code with df | View recommended plots | New interactive sheet

🔷 Using apply() for Custom Functions

```
[ ]  1 def categorize_salary(salary):
     2     return 'High' if salary > 6000 else 'Low'
     3
     4 df['Salary_Category'] = df['Salary'].apply(categorize_salary)
```

```
[ ]  1 df.head()
```

	Customer_ID	Customer_Name	Product	Price	Salary	Discounted_Price	Salary_to_Price	Salary_Category
0	101	Alice	Laptop	1200	5000	1080.0	4.166667	Low
1	102	Bob	Phone	800	6000	720.0	7.500000	Low
2	103	Charlie	Tablet	600	7000	540.0	11.666667	High
3	104	David	Laptop	1300	4000	1170.0	3.076923	Low
4	105	Eve	Phone	850	6500	765.0	7.647059	High

Next steps: Generate code with df | View recommended plots | New interactive sheet

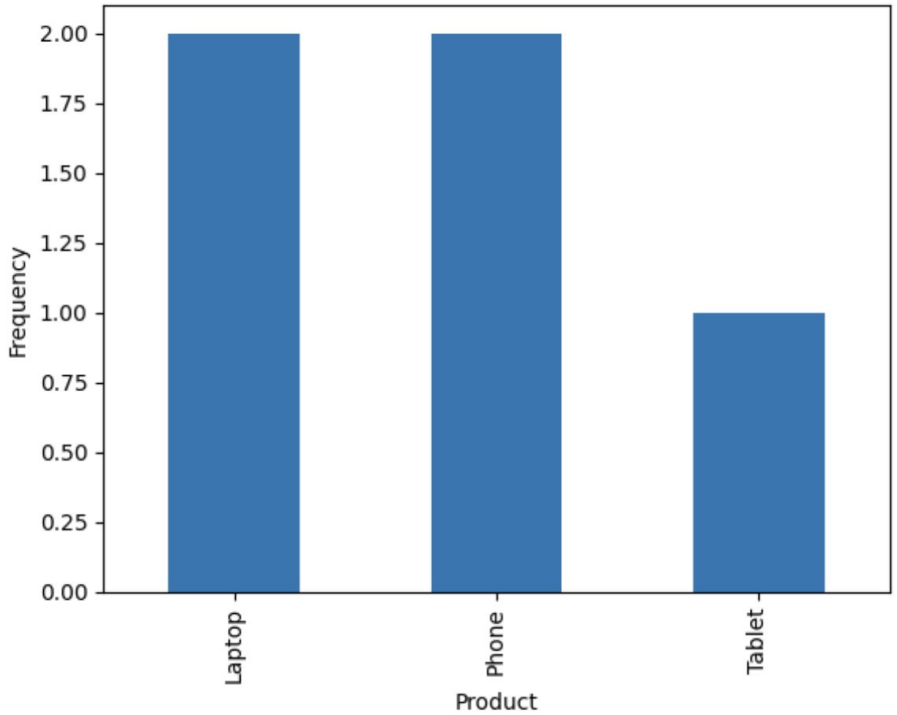
9️⃣ Saving & Loading Data

```
[ ]
1 df.to_csv('data.csv', index=False)  # Save
2 df = pd.read_csv('data.csv')  # Load
```

🔟 Basic Data Visualization

```
[ ]
1 import matplotlib.pyplot as plt
2
3 df['Price'].plot(kind='hist')  # Histogram
4 df['Product'].value_counts().plot(kind='bar')  # Bar chart
```

```
<Axes: xlabel='Product', ylabel='Frequency'>
```



1️⃣1️⃣ Joining & Merging DataFrames

```
[ ]  1 df1 = pd.DataFrame({'Customer_ID': [101, 102, 103], 'Region': ['North', 'South', 'East']})
     2 df2 = pd.merge(df, df1, on='Customer_ID', how='left')
     3 df2
```

	Customer_ID	Customer_Name	Product	Price	Salary	Discounted_Price	Salary_to_Price	Salary_Category	Region
0	101	Alice	Laptop	1200	5000	1080.0	4.166667	Low	North
1	102	Bob	Phone	800	6000	720.0	7.500000	Low	South
2	103	Charlie	Tablet	600	7000	540.0	11.666667	High	East
3	104	David	Laptop	1300	4000	1170.0	3.076923	Low	NaN
4	105	Eve	Phone	850	6500	765.0	7.647059	High	NaN

Next steps: Generate code with df2 | View recommended plots | New interactive sheet

📌 Final Assignment:

- Create a new feature Discounted_Price (Price with a 20% discount).
- Filter customers who have a salary above 6000 and sort them by price (descending order).

```
[ ]  1 # Insert your code here
```

	Customer_ID	Customer_Name	Product	Price	Salary	Discounted_Price	Salary_to_Price	Salary_Category
4	105	Eve	Phone	850	6500	680.0	7.647059	High
2	103	Charlie	Tablet	600	7000	480.0	11.666667	High

Next steps: Generate code with df_filtered | View recommended plots | New interactive sheet

Lab: Thai Politicians Assignment

Thailand goes to the polls on May 14, with a cast of leadership hopefuls aiming to unseat Prime Minister Prayuth Chan-ocha, right. © Nikkei montage/Source photos by Reuters and Getty Images

Homework: Pokemon