

# Python Summer Course

## Course 5: Pandas

Théophile Gentilhomme

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Pandas

Downloading package: micropip

# Introduction

Pandas is a Python library for **data analysis and manipulation**.

It provides two main data structures:

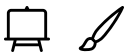
- **Series** → 1D labeled array
- **DataFrame** → 2D labeled table (like Excel or a database)



Pandas

Pandas

Downloading package: ipython





# Why Use Pandas?

- Built on top of NumPy
- Makes it easy to:
  - Load and clean data
  - Filter, transform, and group data
  - Perform statistics and summaries
- Works well with CSV, Excel, SQL, and more

# Example

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 import pandas as pd
2
3 # A simple DataFrame example
4 data = {
5     "Name": ["Alice", "Bob", "Charlie"],
6     "Age": [25, 30, 35],
7     "IsStudent": [True, False, False]
8 }
9
10 df = pd.DataFrame(data)
11 print(df)
```

- ✓ Each **key** becomes a column name
- ✓ Each **value** must be a list or array of the **same length**

Pandas is the perfect tool for **data science**, **bioinformatics**, and any task involving **structured data**.



# DataFrame = 2D Table

A DataFrame is like a table with **rows** and **columns**.

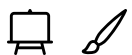
Python Code

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▶ Run Code

```
1 import pandas as pd
2
3 data = {
4     "Name": ["Alice", "Bob", "Charlie"],
5     "Age": [25, 30, 35]
6 }
7
8 df = pd.DataFrame(data)
9 print(df)
```

- Rows are automatically indexed (0, 1, 2...)
- Columns are labeled (like a dict of Series)



# Series = 1D Column or Row

A Series is like a **single column** with an index:

Python Code

↺ Start Over

▶ Run Code

```
1 # Column access
2 ages = df["Age"]
3 print(ages)
```

- Has both values **and** an index
- Acts like a NumPy array + labels

# Access by Label `.loc[row_label, column_label]`

You can access specific element of the table using row/column label with `.loc[]`.

Python Code

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▶ Run Code

```
1 # Access one element
2 print(df.loc[0, "Age"])    # Age of Alice
```

# Modify an element

Python Code

↺ Start Over

▶ Run Code

```
1 df.loc[2, "Age"] = 31
2 print(df)
```





# Row/column access

Python Code

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```
1 print(df.loc[1])          # Entire row (Series)
2 print(df.loc[:, "Name"])  # Entire column (Series)
```

# Access by Index

`.iloc[row_index, column_index]`

Python Code

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▶ Run Code

```
1 print(df.iloc[0, 1])      # Same as above (row 0, column 1)
```

Same as `.loc[]` but with indexes

Python Code

↺ Start Over

▶ Run Code

```
1 # Slicing
2 print(df.iloc[0:2, 0:2])  # First 2 rows and 2 columns
3
4 # Can be done with .loc[] too
```

# Add a Column / Filter Rows

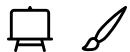
You can add columns just like a dictionary

Python Code

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▶ Run Code

```
1 df["HES"] = [True, False, False]
```



# Filter with conditions (Boolean mask)

You can filter the row using boolean mask with the same length as the columns.

Usually, you filter using value in one or several columns

Python Code

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▶ Run Code

```
1 print(df.loc[df["Age"] > 30]) # Rows where Age > 30
2
3 # Combine conditions with `&` (and) `|` (or)
```



# Loading CSV and Excel Files

Pandas makes it easy to import real-world data from common formats.

This is usually what your are going to do.

Examples for CSV and Excel files

# Loading files

```
1 import pandas as pd
2 # Load a CSV file from a URL or local path
3 df = pd.read_csv("my_data.csv") # or from a URL
4 print(df.head()) # Show first 5 rows
```

- Use `sep=";"` if using semicolon separator
- Use `encoding="utf-8"` if needed
- Can use a column as row indexes `index_col="thisCol"`

```
1 # Load an Excel File
2 df = pd.read_excel("my_data.xlsx", sheet_name="Sheet1")
```

# Compute Stats and Explore Data

Pandas offers many built-in tools to summarize and analyze your data quickly.

Python Code

↺ Start Over

▶ Run Code

```
1 import pandas as pd
2
3 df = pd.DataFrame({
4     "Age": [25, 30, 35, 28],
5     "Score": [80, 90, 88, 75],
6     "Something": ["A", "B", "C", "D"]
7 })
```



# Quick Exploration

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 print(df.head())      # First 5 rows
2 print(df.tail(2))     # Last 2 rows
3 print(df.columns)     # List of column names
4 print(df.index)       # Row index
```



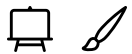


# Basic Statistics

Python Code

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```
1 print(df.mean())      # Column-wise average
2 print(df["Age"].max()) # Max value in a column
```



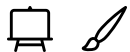
# Data Overview

Python Code

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▶ Run Code

```
1 print(df.info())      # Structure and types
2 print(df.describe()) # Summary stats for numeric columns
```



# Handling Missing Values in Pandas

Missing values are common in real-world data. Pandas uses `NaN` (Not a Number) to represent them.

Python Code

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▶ Run Code

```
1 import pandas as pd
2 import numpy as np
3
4 df = pd.DataFrame({
5     "Name": ["Alice", "Bob", "Charlie"],
6     "Age": [25, np.nan, 35]
7 })
8
9 ### Detect Missing Data
10 print(df.isna())      # True where values are missing
11 print(df.isna().sum()) # Count missing per column
```



# Drop or Fill

Python Code

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```
1 df.dropna()          # Remove rows with missing values
2 df.fillna(0)          # Replace missing with 0
3 df["Age"].fillna(df["Age"].mean(), inplace=True) # Replace with column mean
```



# Simple Plots with Pandas

Pandas makes it easy to plot data directly from a DataFrame.

It uses [Matplotlib](#), which is a Python library commonly used for plots.

You can customize the plots using Matplotlib functionalities.

# Line Plot

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 # You do not need this code: just for the presentation
2 import micropip
3 await micropip.install("matplotlib") # One-time install
```

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 import pandas as pd
2 import matplotlib.pyplot as plt
3
4 df = pd.DataFrame({
5     "Year": [2020, 2021, 2022, 2023],
6     "Revenue": [100, 150, 200, 250]
7 })
8
9 df.plot(x="Year", y="Revenue", kind="line", title="Revenue Over Time")
10
11 # Call pyplot show
12 plt.show() # You normally do need this (only for the presentation)
```



# Other Plot Types

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 df.plot(kind="bar")           # Bar chart
2 plt.show()
```

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 df.plot(kind="hist")         # Histogram
2 plt.show()
```

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 df.plot(kind="box")          # Boxplot
2 plt.show()
```

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 df.plot(kind="scatter", x="Year", y="Revenue") # Scatter plot
2 plt.show()
```

# And many more to cover on Pandas!

- `group_by()`
- Time series
- interpolation
- ...



# Your turn!

You are given a dataset `gene_expression_data.csv`. There is no descriptions, but you need to explore and make some analyses.

1. Load the file using Pandas
2. Explore it using the functions seen in this course
3. Check how many treated vs healthy samples there are using `value_counts()` on the column or using boolean condition

4. Compute the mean expression for `Tissue_B` (optional: all tissues)
5. Calculate the difference between Tissue A and B and store it in a new column
6. Filter the genes where Tissue C expression is greater than 9 and Biomarker is True (i.e. two boolean expression combined with `&`)

7. Plot a scatter plot of Tissue A vs Tissue B, colored with biomarker. Tip: use `scatter` with

```
colors = ["red" if b else "blue" for b in df["Biomarker"]]
```

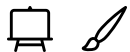
# More references

[Python course for data analysis](#)

[PANDAS-TUTORIAL](#)

[Pandas](#)

# Solution



# 1. Load the CSV

Python Code

↺ Start Over

▶ Run Code

```
1 import pandas as pd
2
3 df = pd.read_csv("gene_expression_data.csv")
```



## 2. Explore the Data

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 print(df.info())
2 print(df.describe())
3 print(df.head())
4 print(df.columns)
5 print(df.shape)
```



# 3. Count Conditions

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 print(df["Condition"].value_counts())  
2 # OR using boolean:  
3 print((df["Condition"] == "Treated").sum())
```





## 4. Mean Expression per Tissue

Python Code

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▶ Run Code

```
1 tissue_cols = [col for col in df.columns if "Tissue" in col]
2 print(df[tissue_cols].mean())
```

## 5. Add Difference Column (Tissue A – B)

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 df["Diff_AB"] = df["Tissue_A"] - df["Tissue_B"]  
2 print(df[["Gene", "Diff_AB"]].head())
```



## 6. Filter: Tissue C > 9 and Biomarker = True

Python Code

[↺ Start Over](#)[▶ Run Code](#)

```
1 filtered = df[(df["Tissue_C"] > 9) & (df["Biomarker"] == True)]  
2 print(filtered)
```



# 7. Scatter Plot (Tissue A vs B, colored by Biomarker)

Python Code

↺ Start Over

▶ Run Code

```
1 import matplotlib.pyplot as plt
2
3 colors = df["Biomarker"].map({True: "red", False: "blue"})
4
5 df.plot.scatter(x="Tissue_A", y="Tissue_B", c=colors)
6 plt.title("Tissue A vs B (Biomarker Color)")
7 plt.show()
```

