**1. Introduction to Pandas DataFrames**

**Description:**

A DataFrame is a two-dimensional, labeled data structure in Pandas, similar to a spreadsheet or SQL table. It consists of rows and columns, where each column can have a different data type. DataFrames are one of the most commonly used structures for data manipulation in Pandas.

**Examples:**

* **Example 1: Creating a DataFrame from a Dictionary**

*import pandas as pd # Import the pandas library*

*# Create a dictionary with data*

*data = {*

*'Employee Name': ['Alice', 'Bob', 'Charlie'], # List of employee names*

*'Age': [28, 34, 25], # List of ages*

*'Department': ['HR', 'IT', 'Finance'] # List of departments*

*}*

*# Convert the dictionary into a DataFrame*

*df = pd.DataFrame(data)*

*# Display the DataFrame*

*print(df)*

**Explanation:** We created a DataFrame by passing a dictionary where keys are column names, and values are lists of column data. Each key-value pair in the dictionary represents a column and its corresponding data.

* **Example 2: Creating a DataFrame from a List of Lists**

*# Create a list of lists, where each inner list represents a row*

*data = [*

*['Alice', 28, 'HR'],*

*['Bob', 34, 'IT'],*

*['Charlie', 25, 'Finance']*

*]*

*# Convert the list of lists into a DataFrame and specify column names*

*df = pd.DataFrame(data, columns=['Employee Name', 'Age', 'Department'])*

*# Display the DataFrame*

*print(df)*

**Explanation:** Each sublist in the list of lists represents a row in the DataFrame. We also specified column names to clearly identify each column of data.

* **Example 3: Creating a DataFrame from a List of Dictionaries**

*# Create a list of dictionaries, where each dictionary represents a row*

*data = [*

*{'Employee Name': 'Alice', 'Age': 28, 'Department': 'HR'},*

*{'Employee Name': 'Bob', 'Age': 34, 'Department': 'IT'},*

*{'Employee Name': 'Charlie', 'Age': 25, 'Department': 'Finance'}*

*]*

*# Convert the list of dictionaries into a DataFrame*

*df = pd.DataFrame(data)*

*# Display the DataFrame*

*print(df)*

**Explanation:** Each dictionary represents a row in the DataFrame, with keys as column names and values as the row's data.

* **Example 4: Creating an Empty DataFrame and Adding Rows**

*# Create an empty DataFrame with specified column names*

*df = pd.DataFrame(columns=['Employee Name', 'Age', 'Department'])*

*# Add rows one by one using the append method*

*df = df.append({'Employee Name': 'Alice', 'Age': 28, 'Department': 'HR'}, ignore\_index=True)*

*df = df.append({'Employee Name': 'Bob', 'Age': 34, 'Department': 'IT'}, ignore\_index=True)*

*df = df.append({'Employee Name': 'Charlie', 'Age': 25, 'Department': 'Finance'}, ignore\_index=True)*

*# Display the DataFrame*

*print(df)*

**Explanation:** We created an empty DataFrame with specified column names and added rows to it using the append method. The ignore\_index=True parameter ensures that the index is reset for each new row.

**2. Understanding Pandas Series**

**Description:**

A Series in Pandas is a one-dimensional labeled array that can hold data of any type (integers, strings, floats, etc.). It's similar to a single column in a DataFrame. Series are useful for representing and manipulating a single column of data.

**Examples:**

* **Example 1: Creating a Series from a List**

*# Create a Series from a list of employee names*

*employee\_names = pd.Series(['Alice', 'Bob', 'Charlie'])*

*# Display the Series*

*print(employee\_names)*

This Series contains a list of employee names, with the default index starting from 0. A Series can be thought of as a single column of data.

* **Example 2: Accessing a Column from a DataFrame as a Series**

*# Create a DataFrame*

*df = pd.DataFrame({*

*'Employee Name': ['Alice', 'Bob', 'Charlie'],*

*'Age': [28, 34, 25],*

*'Department': ['HR', 'IT', 'Finance']*

*})*

*# Access the 'Age' column as a Series*

*ages = df['Age']*

*# Display the Series*

*print(ages)*

**Explanation:** We extracted the 'Age' column from the DataFrame as a Series. This allows for operations and analysis on a single column of data.

* **Example 3: Creating a Series with Custom Index**

*# Create a Series with custom index labels*

*departments = pd.Series(['HR', 'IT', 'Finance'], index=['Alice', 'Bob', 'Charlie'])*

*# Display the Series*

*print(departments)*

**Explanation:** We created a Series with custom index labels, which makes it easier to access data based on meaningful labels rather than default numerical indices.

* **Example 4: Performing Operations on a Series**

*# Create a Series of ages*

*ages = pd.Series([28, 34, 25])*

*# Add 1 to each age in the Series*

*ages\_plus\_one = ages + 1*

*# Display the modified Series*

*print(ages\_plus\_one)*

**Explanation:** We performed a simple arithmetic operation (adding 1) on each element of the Series, demonstrating how Series support vectorized operations.

**3. Reading Data with Pandas**

**Description:**

Pandas can read data from a variety of formats such as CSV, Excel, JSON, and SQL databases. This functionality allows you to easily load and work with external datasets in a DataFrame.

**Examples:**

* **Example 1: Reading Data from a CSV File**

*# Read data from a CSV file into a DataFrame*

*df = pd.read\_csv('employees.csv')*

*# Display the first 5 rows of the DataFrame*

*print(df.head())*

**Explanation:** We used read\_csv to load data from a CSV file into a DataFrame. The head() method is used to display the first 5 rows of the DataFrame, giving a quick preview of the data.

* **Example 2: Reading Data from an Excel File**

*# Read data from an Excel file into a DataFrame*

*df = pd.read\_excel('employees.xlsx')*

*# Display the first 5 rows of the DataFrame*

*print(df.head())*

**Explanation:** We used read\_excel to load data from an Excel file into a DataFrame. This is useful when working with data stored in spreadsheets.

* **Example 3: Reading Data from a JSON File**

*# Read data from a JSON file into a DataFrame*

*df = pd.read\_json('employees.json')*

*# Display the first 5 rows of the DataFrame*

*print(df.head())*

**Explanation:** JSON files are commonly used for data interchange, and we used read\_json to load this data into a DataFrame for analysis.

* **Example 4: Reading Data from a SQL Database**

*import sqlite3 # Import SQLite3 to connect to the database*

*# Establish a connection to the database*

*conn = sqlite3.connect('employees.db')*

*# Read data from a SQL table into a DataFrame*

*df = pd.read\_sql\_query('SELECT \* FROM employees\_table', conn)*

*# Display the first 5 rows of the DataFrame*

*print(df.head())*

**Explanation:** Pandas can read data directly from SQL databases using the read\_sql\_query function, allowing for easy integration of database data into DataFrames.

**4. Data Manipulation with Pandas**

**Description:**

Data manipulation in Pandas involves modifying, adding, removing, or organizing data within a DataFrame. This is a crucial step in data analysis as it allows for the cleaning and preparation of data for further analysis.

**Examples:**

* **Example 1: Filtering Data Based on a Condition**

*# Create a DataFrame*

*df = pd.DataFrame({*

*'Employee Name': ['Alice', 'Bob', 'Charlie', 'David'],*

*'Age': [28, 34, 25, 29],*

*'Department': ['HR', 'IT', 'Finance', 'HR']*

*})*

*# Filter the DataFrame to include only employees in the HR department*

*hr\_employees = df[df['Department'] == 'HR']*

*# Display the filtered DataFrame*

*print(hr\_employees)*

**Explanation:** We filtered the DataFrame to include only rows where the 'Department' column has a value of 'HR'. Filtering is commonly used to focus on specific subsets of data.

* **Example 2: Adding a New Column Based on a Calculation**

*# Add a new column 'Years Until Retirement' calculated from the 'Age' column*

*df['Years Until Retirement'] = 65 - df['Age']*

*# Display the DataFrame with the new column*

*print(df)*

**Explanation:** We added a new column 'Years Until Retirement' to the DataFrame by performing a calculation based on the 'Age' column. This shows how you can derive new information from existing data.

* **Example 3: Removing a Column**

*# Remove the 'Department' column from the DataFrame*

*df = df.drop(columns=['Department'])*

*# Display the DataFrame after removing the column*

*print(df)*

**Explanation:** We removed the 'Department' column using the drop method, which is useful when you want to clean up unnecessary data from your DataFrame.

* **Example 4: Renaming Columns**

*# Rename the columns of the DataFrame*

*df = df.rename(columns={'Employee Name': 'Name', 'Age': 'Employee Age'})*

*# Display the DataFrame with renamed columns*

*print(df)*

**Explanation:** We renamed the columns to more descriptive names using the rename method. Renaming columns can make the DataFrame more readable and understandable.

**5. Basic Operations in Pandas**

**Description:**

Pandas provides various basic operations for sorting, grouping, and summarizing data. These operations are essential for exploring and understanding the data before performing more complex analyses.

**Examples:**

* **Example 1: Sorting Data by a Single Column**

*# Sort the DataFrame by the 'Age' column*

*sorted\_df = df.sort\_values(by='Age')*

*# Display the sorted DataFrame*

*print(sorted\_df)*

**Explanation:** We sorted the DataFrame by the 'Age' column in ascending order. Sorting is often used to organize data in a specific order for better analysis.

* **Example 2: Sorting Data by Multiple Columns**

*# Sort the DataFrame by 'Department' and then by 'Age'*

*sorted\_df = df.sort\_values(by=['Department', 'Age'])*

*# Display the sorted DataFrame*

*print(sorted\_df)*

**Explanation:** We first sorted the DataFrame by 'Department', and within each department, we sorted by 'Age'. Sorting by multiple columns helps in organizing data hierarchically.

* **Example 3: Grouping Data and Calculating Aggregate Statistics**

*# Group data by 'Department' and calculate the average age for each department*

*average\_age\_by\_department = df.groupby('Department')['Age'].mean()*

*# Display the result*

*print(average\_age\_by\_department)*

**Explanation:** We grouped the data by 'Department' and calculated the average age for each group. Grouping is commonly used for summarizing and analyzing data across different categories.

* **Example 4: Counting Unique Values**

*# Count the number of employees in each department*

*department\_counts = df['Department'].value\_counts()*

*# Display the result*

*print(department\_counts)*

**Explanation:** We used the value\_counts method to count the number of occurrences of each unique value in the 'Department' column. This is useful for understanding the distribution of categorical data.