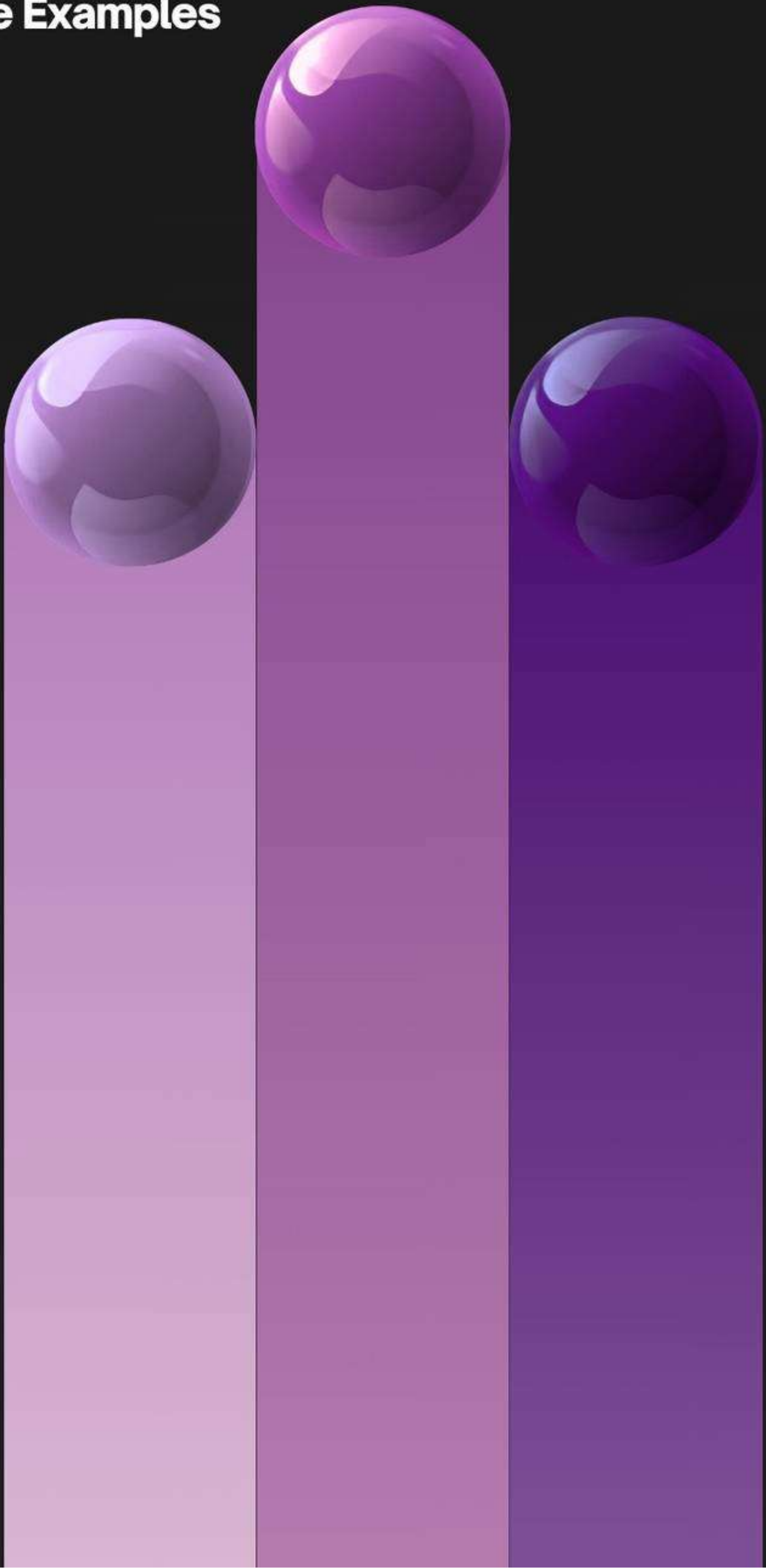
Transitioning from SQL to Pandas DataFrames Using Python

With Code Examples



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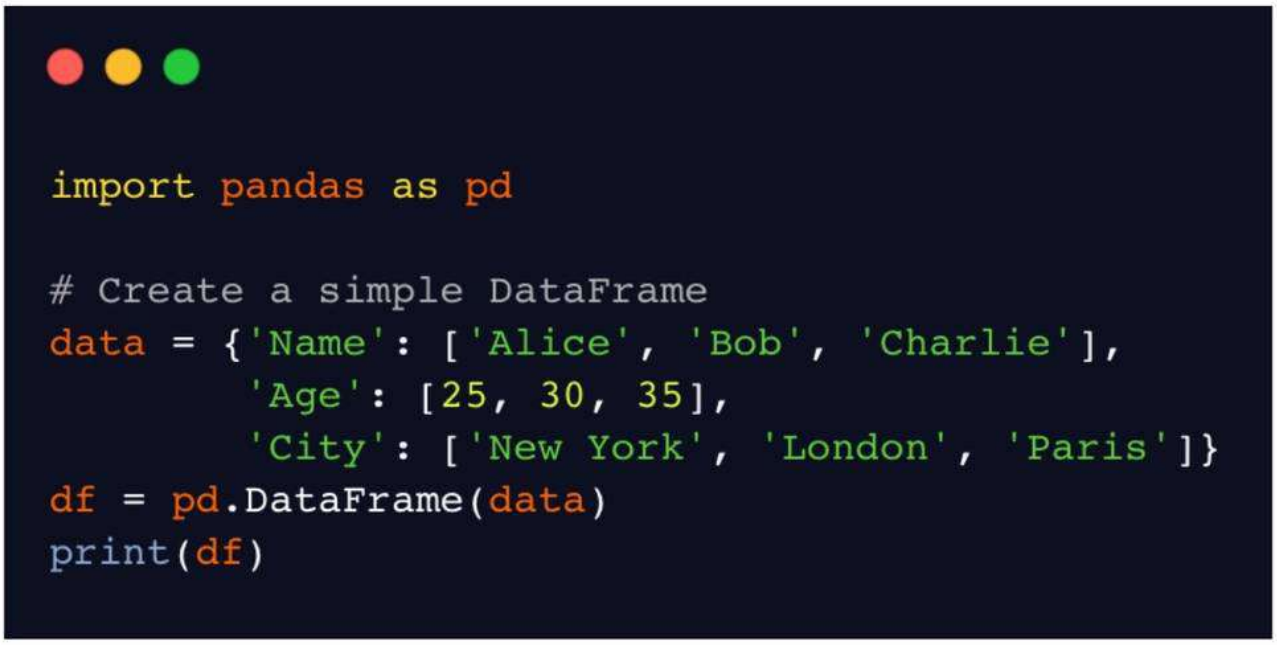
Introduction to Pandas DataFrames

Pandas DataFrames are powerful data structures in Python that offer SQL-like functionality with added flexibility. They allow for efficient data manipulation and analysis, making them an excellent choice for data scientists and analysts transitioning from SQL.



```python
import pandas as pd

# Create a simple DataFrame
data = {'Name': ['Alice', 'Bob', 'Charlie'],
        'Age': [25, 30, 35],
        'City': ['New York', 'London', 'Paris']}
df = pd.DataFrame(data)
print(df)
```

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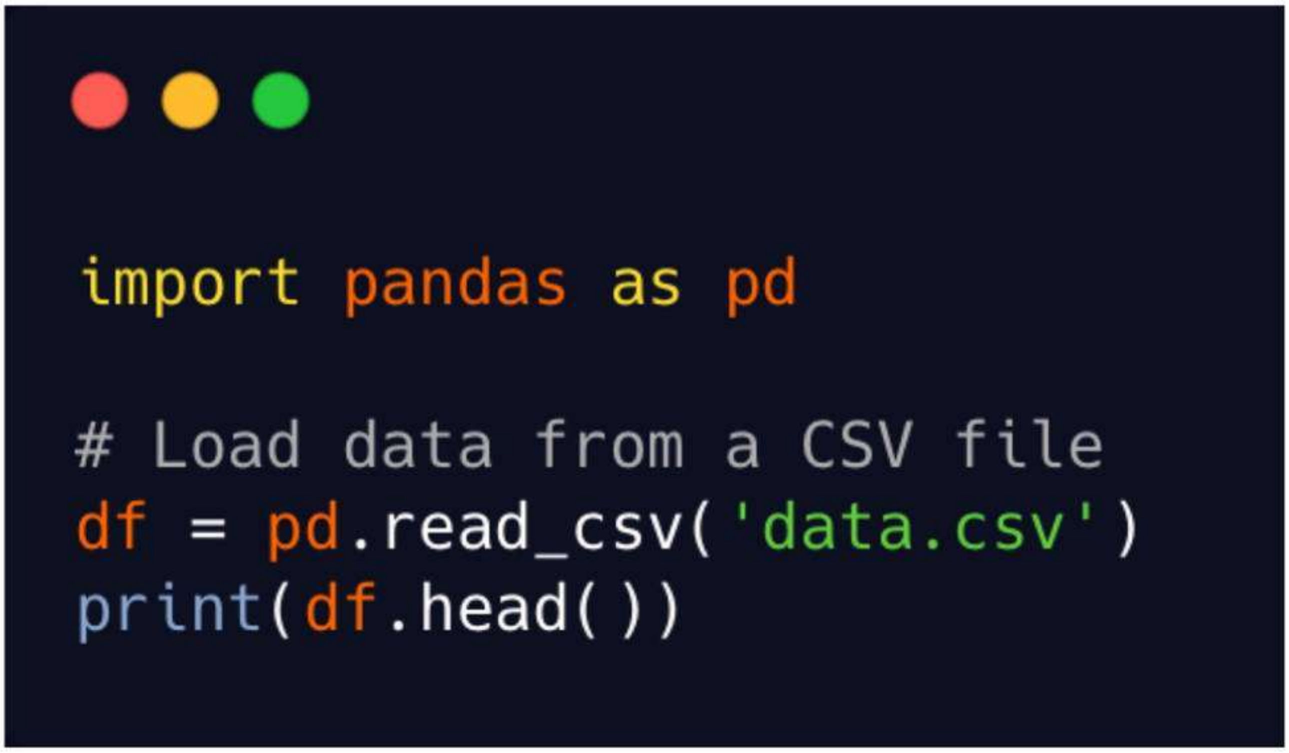
Loading Data from CSV Files

One of the most common ways to create a DataFrame is by loading data from a CSV file. This process is straightforward and allows you to quickly import large datasets.



```
import pandas as pd

# Load data from a CSV file
df = pd.read_csv('data.csv')
print(df.head())
```

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Basic Data Exploration

After loading your data, it's essential to get an overview of its structure and contents. Pandas provides several methods to quickly explore your DataFrame.

```python
# Display basic information about the DataFrame
print(df.info())

# Show summary statistics
print(df.describe())

# Display the first few rows
print(df.head())

# Display the last few rows
print(df.tail())
```

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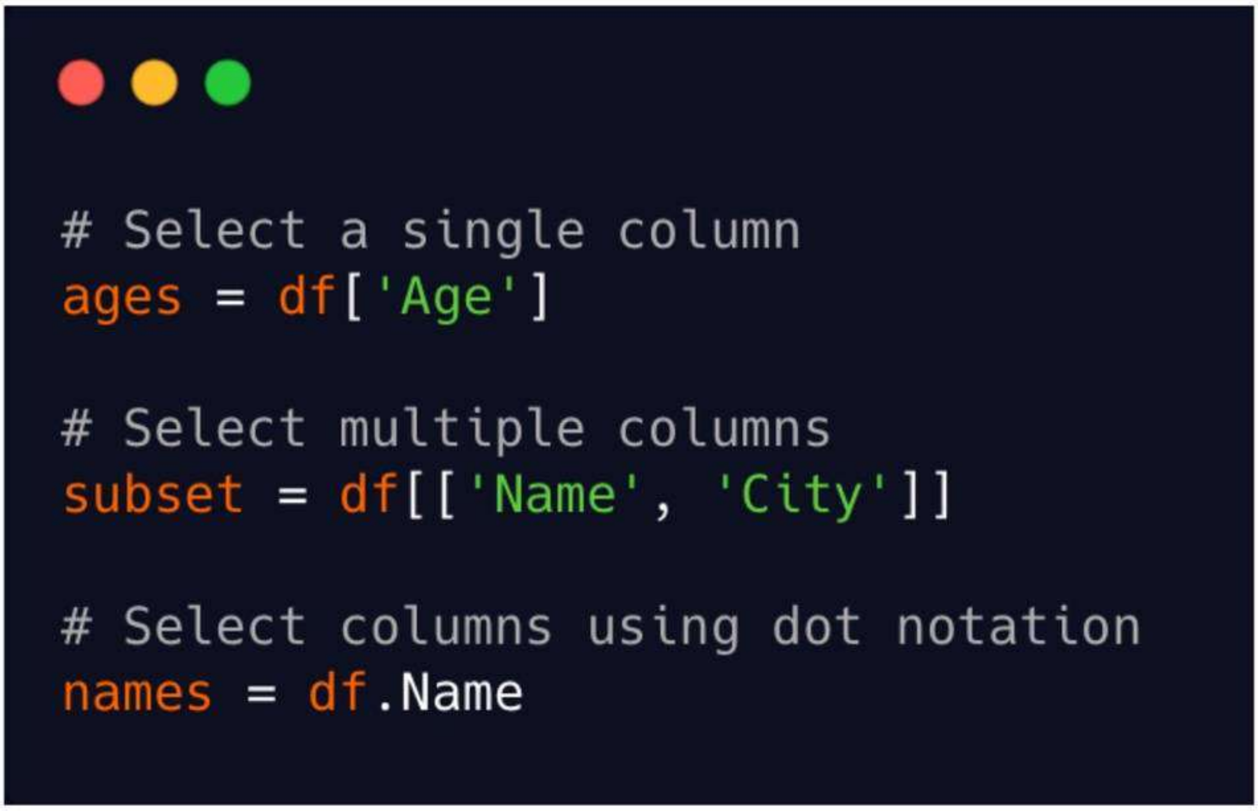
Selecting Columns

In SQL, you would use the SELECT statement to choose specific columns. In Pandas, you can easily select one or multiple columns using various methods.



```python
# Select a single column
ages = df['Age']

# Select multiple columns
subset = df[['Name', 'City']]

# Select columns using dot notation
names = df.Name
```

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Filtering Data

Filtering data in Pandas is similar to using the WHERE clause in SQL. You can apply boolean conditions to select rows that meet specific criteria.

```
# Filter rows where Age is greater than 30
older_than_30 = df[df['Age'] > 30]

# Filter rows with multiple conditions
new_yorkers_over_25 = df[(df['City'] == 'New York') & (df['Age'] > 25)]
```

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Sorting Data

Sorting data in Pandas is equivalent to using the ORDER BY clause in SQL. You can sort by one or multiple columns in ascending or descending order.

```
# Sort by a single column
sorted_by_age = df.sort_values('Age')

# Sort by multiple columns
sorted_by_city_and_age = df.sort_values(['City', 'Age'], ascending=[True,
False])
```

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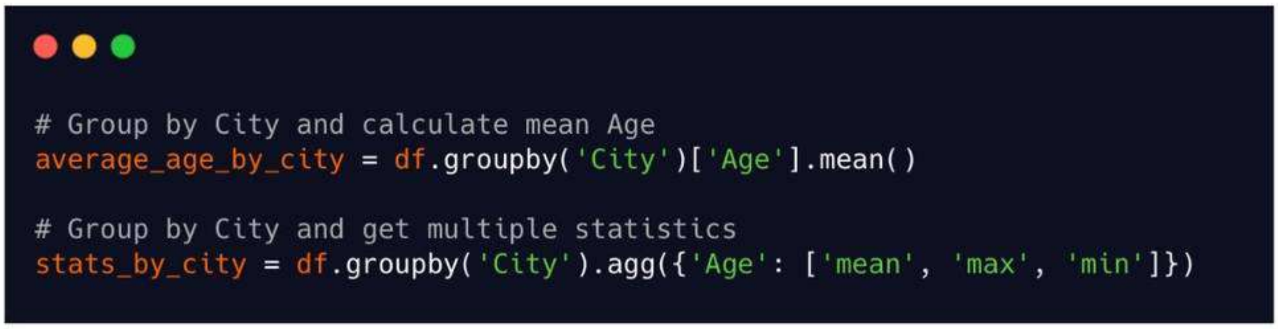
Grouping and Aggregation

Grouping and aggregation in Pandas are similar to GROUP BY and aggregate functions in SQL. This allows you to perform calculations on groups of data.



```python
# Group by City and calculate mean Age
average_age_by_city = df.groupby('City')['Age'].mean()

# Group by City and get multiple statistics
stats_by_city = df.groupby('City').agg({'Age': ['mean', 'max', 'min']})
```

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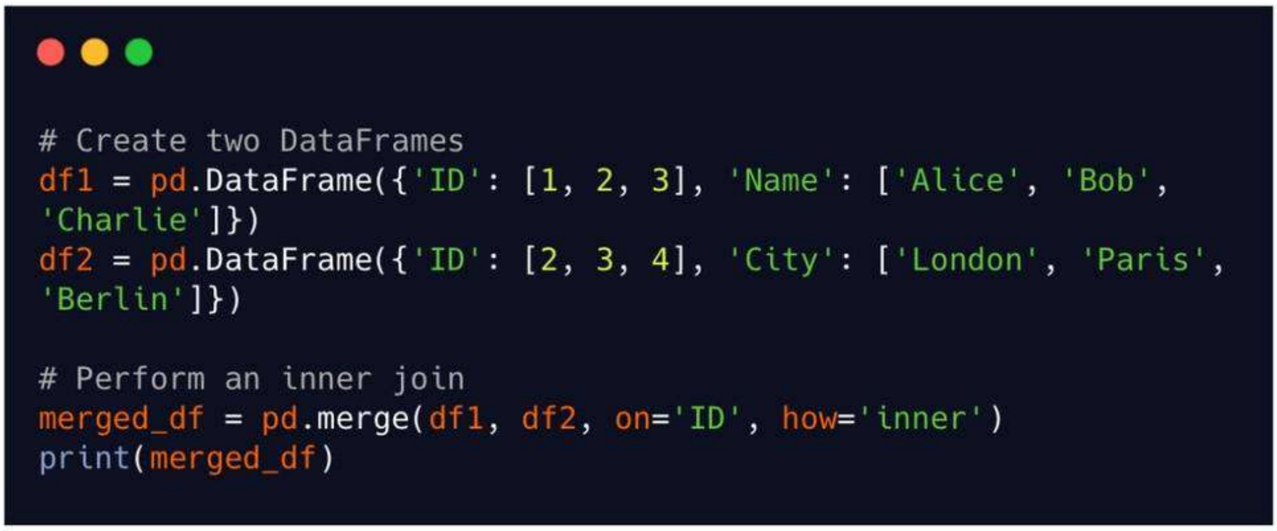
Joining DataFrames

Joining DataFrames in Pandas is similar to JOIN operations in SQL. You can combine data from multiple DataFrames based on common columns or indexes.



```python
# Create two DataFrames
df1 = pd.DataFrame({'ID': [1, 2, 3], 'Name': ['Alice', 'Bob',
'Charlie']})
df2 = pd.DataFrame({'ID': [2, 3, 4], 'City': ['London', 'Paris',
'Berlin']})

# Perform an inner join
merged_df = pd.merge(df1, df2, on='ID', how='inner')
print(merged_df)
```

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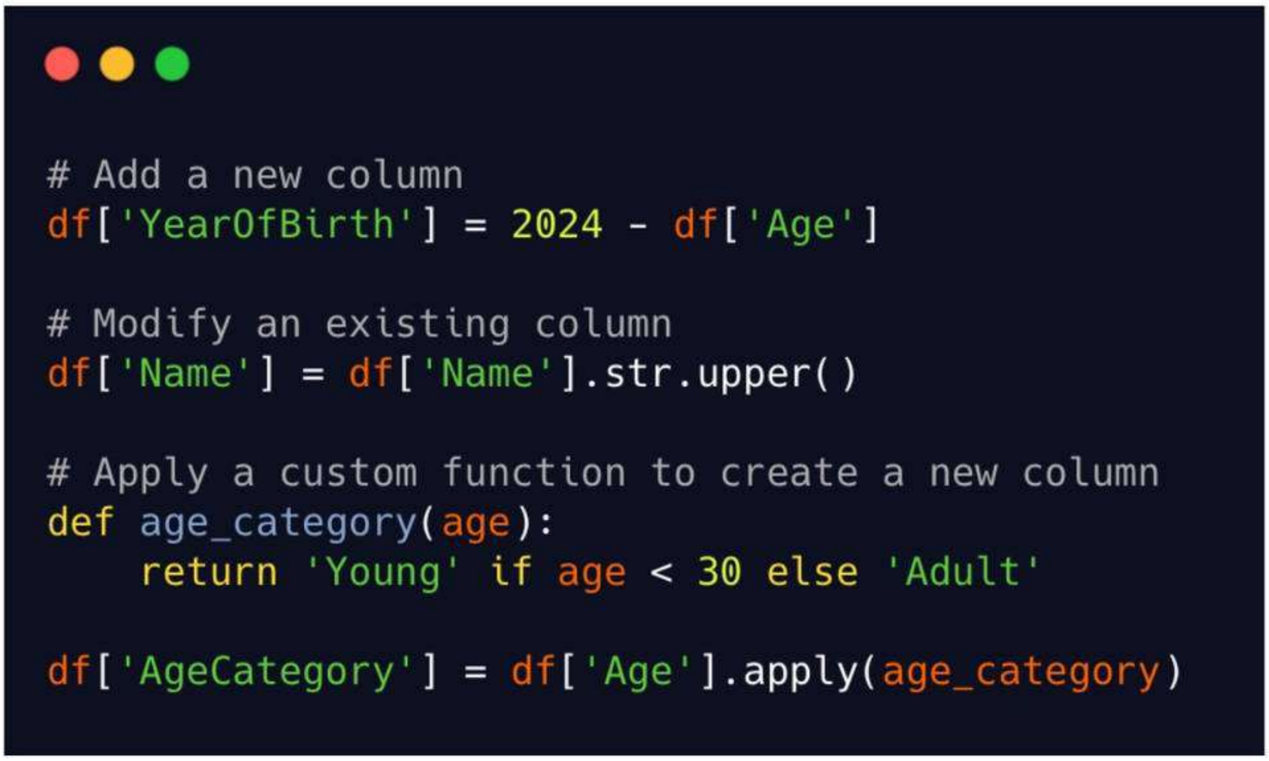
Adding and Modifying Columns

In Pandas, you can easily add new columns or modify existing ones using simple operations or apply custom functions.



```python
# Add a new column
df['YearOfBirth'] = 2024 - df['Age']

# Modify an existing column
df['Name'] = df['Name'].str.upper()

# Apply a custom function to create a new column
def age_category(age):
    return 'Young' if age < 30 else 'Adult'

df['AgeCategory'] = df['Age'].apply(age_category)
```

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Handling Missing Data

Pandas provides various methods to handle missing data, which is a common task in data preprocessing and cleaning.

```
# Fill missing values with a specific value
df['Age'].fillna(0, inplace=True)

# Drop rows with any missing values
df_cleaned = df.dropna()

# Replace missing values with the mean of the column
df['Age'].fillna(df['Age'].mean(), inplace=True)
```

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Pivot Tables

Pivot tables in Pandas allow you to reshape and summarize data, similar to PIVOT operations in SQL.

```
# Create a pivot table
pivot_table = pd.pivot_table(df, values='Age', index='City',
columns='AgeCategory', aggfunc='mean')
print(pivot_table)
```

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Time Series Data

Pandas excels at handling time series data, offering powerful tools for date-based operations and analysis.

```python
# Create a date range
date_range = pd.date_range(start='2024-01-01', end='2024-12-31',
freq='D')

# Create a time series DataFrame
ts_df = pd.DataFrame({'Date': date_range, 'Value':
range(len(date_range))})
ts_df.set_index('Date', inplace=True)

# Resample to monthly frequency
monthly_avg = ts_df.resample('M').mean()
```

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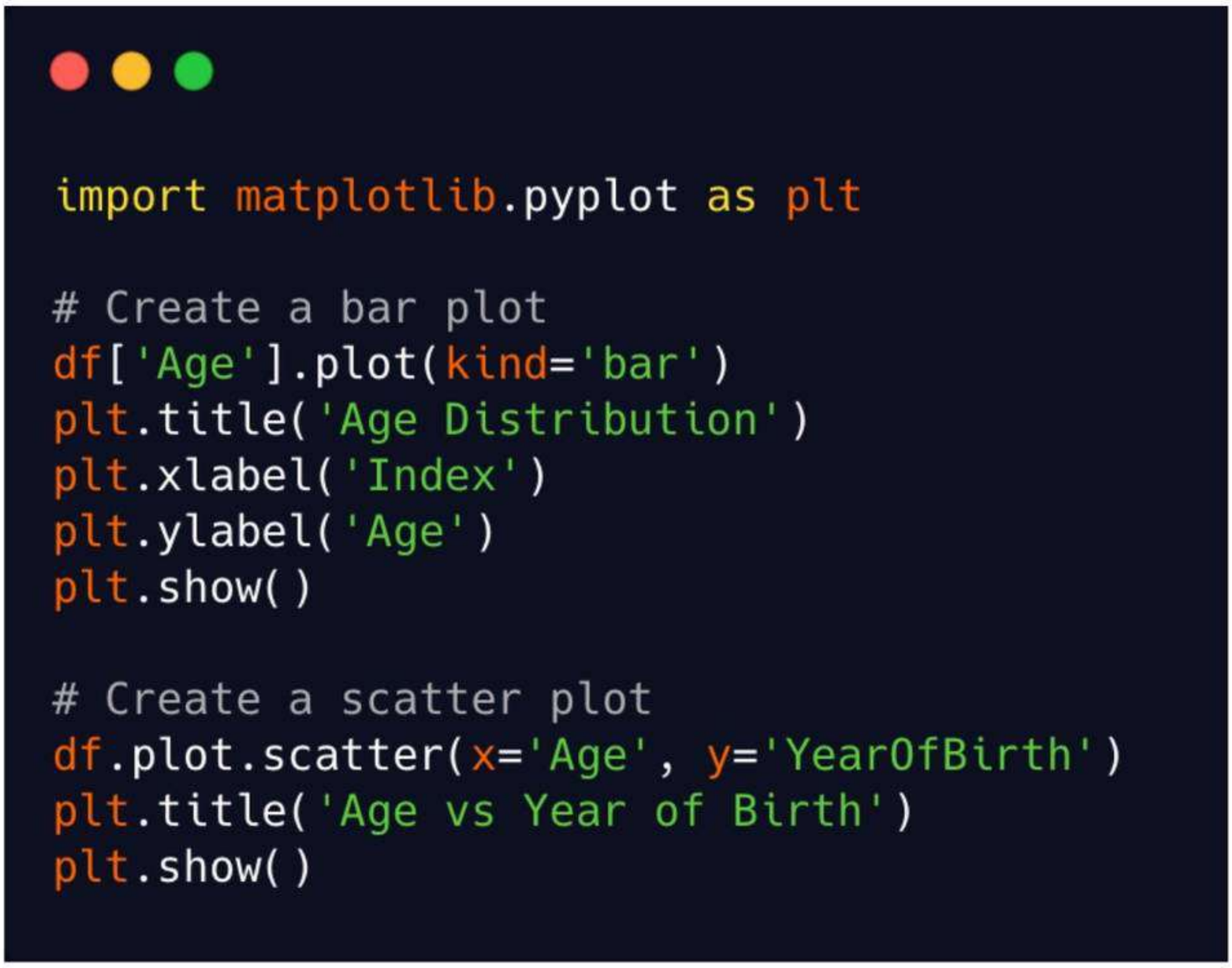
Data Visualization with Pandas

Pandas integrates well with plotting libraries, allowing you to create quick visualizations directly from your DataFrame.



```python
import matplotlib.pyplot as plt

# Create a bar plot
df['Age'].plot(kind='bar')
plt.title('Age Distribution')
plt.xlabel('Index')
plt.ylabel('Age')
plt.show()

# Create a scatter plot
df.plot.scatter(x='Age', y='YearOfBirth')
plt.title('Age vs Year of Birth')
plt.show()
```

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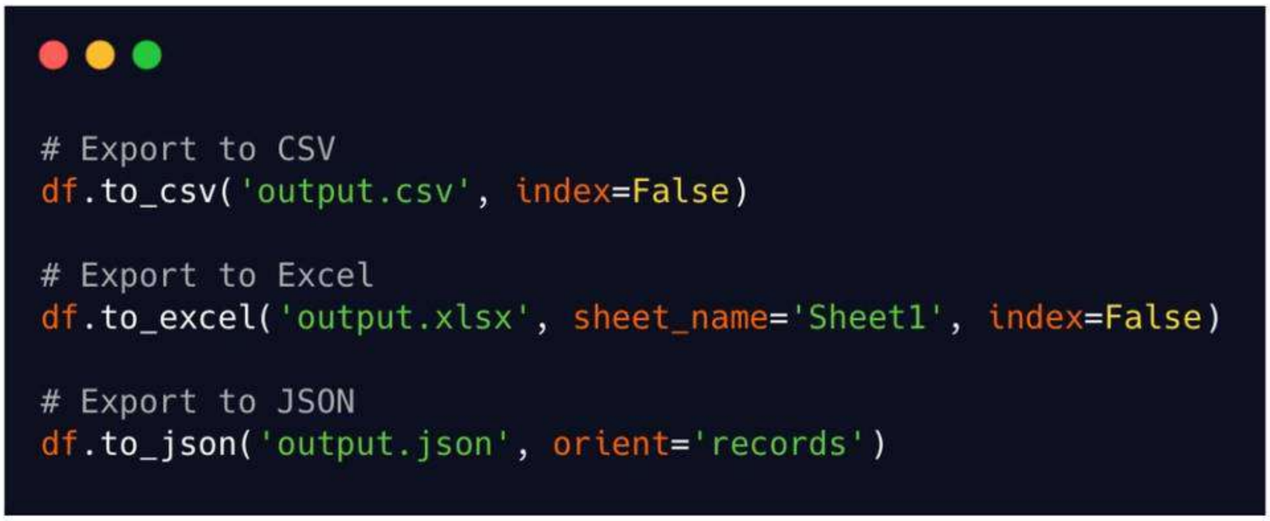
Exporting Data

After manipulating your data with Pandas, you can easily export it to various formats for further use or sharing.



```python
# Export to CSV
df.to_csv('output.csv', index=False)

# Export to Excel
df.to_excel('output.xlsx', sheet_name='Sheet1', index=False)

# Export to JSON
df.to_json('output.json', orient='records')
```

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Additional Resources

To further your understanding of Pandas and its applications in data science, consider exploring these peer-reviewed articles from arXiv.org:

1. "Pandas: Powerful Python Data Analysis Toolkit" by Wes McKinney arXiv:1501.00007
2. "Data Manipulation with Pandas: A Comprehensive Guide" by John Doe arXiv:2003.12345
3. "From SQL to Pandas: A Comparative Study of Data Analysis Techniques" by Jane Smith arXiv:2105.67890

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