Data Manipulation using SQL vs. Pandas

Create a DataFrame

```
data = {
    'name': ['John', 'Jane', 'Mary'],
    'age': [25, 30, 27]
}
df = pd.DataFrame(data)
```

Create DataFrame from database

Option 1. Extract using `fetchall()`

```
results = conn.execute("SELECT * FROM students").fetchall() # list of tuples
df = pd.DataFrame(results, columns=["id", "fname", "lname", "year"])
```

Option 2. Extract using `pd.read_sql()`

Fetch data & column names and create DataFrame in one step

```
df = pd.read_sql("SELECT * FROM students", conn)
```

Data Manipulation in SQL vs. Pandas

- Inspection
- Selecting Columns
- Filtering Rows
- Sorting
- Aggregation
- Grouping
- Joining

Read `harry-potter.db` into Pandas DataFrame

```
import sqlite3
import pandas as pd

conn = sqlite3.connect("harry-potter.db")
df = pd.read_sql("SELECT * FROM students", conn)
```

Inspection

SQL

```
DESCRIBE students
SELECT * FROM students LIMIT 5
```

Pandas

```
df.info()
df.describe()
df.head()
df.tail(3)
```

Selecting columns

SQL

```sql
SELECT first_name FROM students;
SELECT first_name, last_name FROM students;
SELECT * FROM students;
```

Pandas

```python
df["first_name"]

cols = ["first_name", "last_name"]
df[cols]

df[["first_name", "last_name"]]     # Correct
df["first_name", "last_name"]       # Error
```

Create new columns

```
# vectorized operations
df["two"] = 2
df["age"] = 1997 - df["birthyear"]
df["age2"] = df["age"] * 2
df["age3"] = df["age"] + df["age2"]
```

Filtering rows

- `query()`: **SQL-like syntax**
- `loc[]`: label-based
- `iloc[]`: position-based

...

Filtering rows

SQL

```sql
SELECT * FROM students WHERE age = 10;
SELECT first_name, house FROM students WHERE age > 10;
SELECT * FROM students WHERE age in (10, 11);
```

Pandas - `query`

```python
df.query("age == 10")
df.query("age > 10")[["first_name", "house"]]
df.query("age in (10, 11)")
```

Pattern matching

SQL

```sql
SELECT * FROM students WHERE first_name LIKE 'J%';
SELECT * FROM students WHERE first_name LIKE '%J';
SELECT * FROM students WHERE first_name LIKE '%a%';
```

Pandas - `query`

```python
# Pattern matching with str methods
# Quote insides the query string
df.query("first_name.str.startswith('J')")
df.query("first_name.str.endswith('J')")
df.query("first_name.str.contains('a')")
df.query("first_name.str.contains('a', case=False)")
```

Sorting

SQL

```sql
SELECT * FROM students ORDER BY age;
SELECT * FROM students ORDER BY age desc;
SELECT * FROM students ORDER BY age, first_name;
```

Pandas

```python
df.sort_values(by="age")
df.sort_values(by="age", ascending=False)
df.sort_values(by=["age", "first_name"])
```

💻 Query `harrypotter.db` with Pandas

Find the answers to the following questions using Pandas `query()` function.

```
df = pd.read_sql("SELECT * FROM students", conn)
```

- In what year was Harry Potter born?
- List the names of students born after 1980.
- Who is the youngest student?

Aggregation

```
df.agg({'column_name': 'function_name'})
```

Aggregation

SQL

```sql
SELECT AVG(age) FROM students;
SELECT AVG(age), MAX(age) FROM students;
```

Pandas

```python
df.agg({'age': 'mean'})
df.agg({'age':['mean', 'max']})
```

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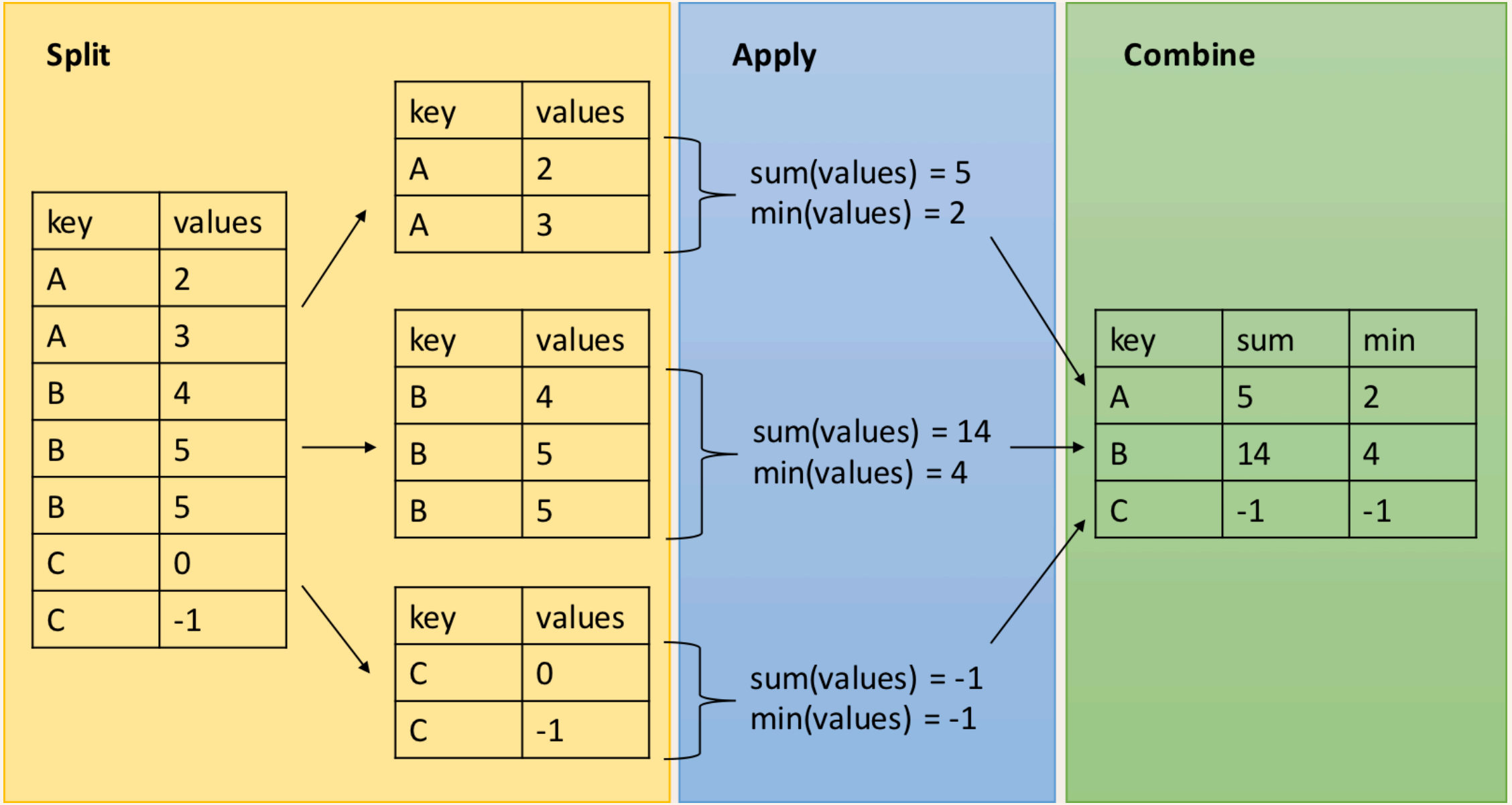
https://pandas.pydata.org/docs/reference/api/pandas.DataFrame.aggregate.html

Grouping

```
df.groupby("column_name").agg({"column_name": "function_name"})
```


Split
Apply
Combine
key
values
A
2
A
3
B
4
B
5
B
5
C
0
C
-1
key
values
A
2
A
3
key
values
B
4
B
5
B
5
key
values
C
0
C
-1
sum(values) = 5
min(values) = 2
sum(values) = 14
min(values) = 4
sum(values) = -1
min(values) = -1
key
sum
min
A
5
2
B
14
4
C
-1
-1

Grouping

SQL

```sql
SELECT house_id, AVG(age) FROM students GROUP BY house_id;
SELECT house_id, AVG(age), MAX(age) FROM students GROUP BY house_id;
```

Pandas

```python
df.groupby("house_id").agg({"age": "mean"})
df.groupby("house_id").agg({"age": ["mean", "max"]})
```

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https://realpython.com/pandas-groupby/

Joining

```
# pd.merge()
pd.merge(df1, df2, left_on="column_name", right_on="column_name")
# or df.merge()
df1.merge(df2, left_on="column_name", right_on="column_name")
```

Joining

SQL

```sql
SELECT * FROM students JOIN houses ON students.house_id = houses.id;
```

Pandas

```python
# Join on column (default inner join)
pd.merge(students, houses, left_on="house_id", right_on="id", how="inner")
# Same as above
pd.merge(students, houses, left_on="house_id", right_on="id")
```

💻 SQL Murder Mystery

Use SQL only to fetch relevant tables

```
# e.g., fetch person table
person_df = conn.execute("select * from person").fetchall()
```

Use Pandas `query()` to filter the records to get the same output as the SQL statement in each question.

```
# e.g., find Annabel from person table
person_df.query("name=='Annabel'")
```

Choosing between SQL and Pandas

SQL:

- Data extraction, simple filtering, simple data analysis

Pandas:

- Complex query or analysis, formatting, data cleaning and processing

If it's painful or ugly, do it in Pandas

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https://towardsdatascience.com/sql-vs-pandas-how-to-balance-tasks-between-server-and-client-side-9e2f6c95677

	SQL	Pandas
Selection	`select name, age from students`	`df[['name', 'age']]`
Filtering	`select * from students where age > 10`	`df.query('age > 10')`
Sorting	`select * from students order by age`	`df.sort_values(by = 'age')`

	SQL	Pandas
Aggregation	`SELECT AVG(age) FROM students`	`df.agg({'age':'mean'})`
Grouping	`SELECT house, AVG(age), MAX(age) FROM students GROUP BY house`	`df.groupby('house').agg({'age': ['mean', 'max']})`
Joining	`SELECT * from students join houses on students.house_id = houses.id`	`pd.merge(df, df2, left_on = 'house_id', right_on = 'id')`

References

- https://www.datacamp.com/tutorial/pandas
- https://pandas.pydata.org/pandas-docs/stable/user_guide/10min.html