Module 7: Merging, Joining and Concatenating

In this module, we will learn how to join, merge and concatenate multiple DataFrame using different methods. This is just like working with SQL where we combine different sources based on unique values.

In [1]:

```
import pandas as pd
```

- **Customer ID** : unique number give to each customer
- **Food ID** : unique number for each food This dataset shows food which the customers bought in Week 1.

Week 1 Dataset

In [2]:

```
week1 = pd.read_csv("data/Restaurant - Week 1 Sales.csv")
week1.head(3)
```

Out[2]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1

Week 2 Dataset

The same structure as the above dataFrame. This is data for 2nd week.

In [3]:

```
week2 = pd.read_csv("data/Restaurant - Week 2 Sales.csv")
week2.head(3)
```

Out[3]:

	Customer ID	Food ID
0	688	10
1	813	7
2	495	10

Foods Dataset

This dataset is storing information about each food. It includes food names and prices.

In [4]:

```
foods = pd.read_csv("data/Restaurant - Foods.csv")
foods.head(3)
```

Out[4]:

	Food ID	Food Item	Price
0	1	Sushi	3.99
1	2	Burrito	9.99
2	3	Taco	2.99

Customer Dataset

This dataset stores information about customers. The ID in this dataset will be used as a key to link with other datasets.

In [5]:

```
customers = pd.read_csv("data/Restaurant - Customers.csv")
customers.head(3)
```

Out[5]:

	ID	First Name	Last Name	Gender	Company	Occupation
0	1	Joseph	Perkins	Male	Dynazzy	Community Outreach Specialist
1	2	Jennifer	Alvarez	Female	DabZ	Senior Quality Engineer
2	3	Roger	Black	Male	Tagfeed	Account Executive

1. pd.concat() method

Since week1 comes before week2, then week2 dataset will be appended to week1. After applying the concat method, notice that the last index number is 249, even though we have 500 rows. This is because Pandas use the original index number. We can solve this by setting the **ignore_index parameter** to true.

In [6]:

```
len(pd.concat([week1,week2]))
```

Out[6]:

```
500
```

In [7]:

```
pd.concat([week1,week2])
```

Out[7]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1
3	202	2
4	155	9
...	...	...
245	783	10
246	556	10
247	547	9
248	252	9
249	249	6

500 rows × 2 columns

In [8]:

```
df = pd.concat([week1,week2], ignore_index=True)
df
```

Out[8]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1
3	202	2
4	155	9
...	...	...
495	783	10
496	556	10
497	547	9
498	252	9
499	249	6

500 rows × 2 columns

In [9]:

```
pd.concat([week1,week2], ignore_index=True)
```

Out[9]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1
3	202	2
4	155	9
...	...	...
495	783	10
496	556	10
497	547	9
498	252	9
499	249	6

500 rows × 2 columns

keys parameter enables us to label the dataset that we concat /combine. It creates a MultiIndex DataFrame in which the first index is the keys and the second index is the original index.

In [10]:

```
sales = pd.concat([week1,week2], keys=["Week 1","Week 2"])
sales
```

Out[10]:

		Customer ID	Food ID
Week 1	0	537	9
	1	97	4
	2	658	1
	3	202	2
	4	155	9
...	...	...	...
Week 2	245	783	10
	246	556	10
	247	547	9
	248	252	9
	249	249	6

500 rows × 2 columns

Since it is multi-index, we can access it with tuple.

In [11]:

```
sales.loc[("Week 2" , 249)]
```

Out[11]:

```
Customer ID    249
Food ID          6
Name: (Week 2, 249), dtype: int64
```

2. Append() method

Appends rows of other DataFrame to the end of the given DataFrame, returning a new DataFrame object

It produces the same output as concat() method. **.append()** method also has **ignore_index parameters**.

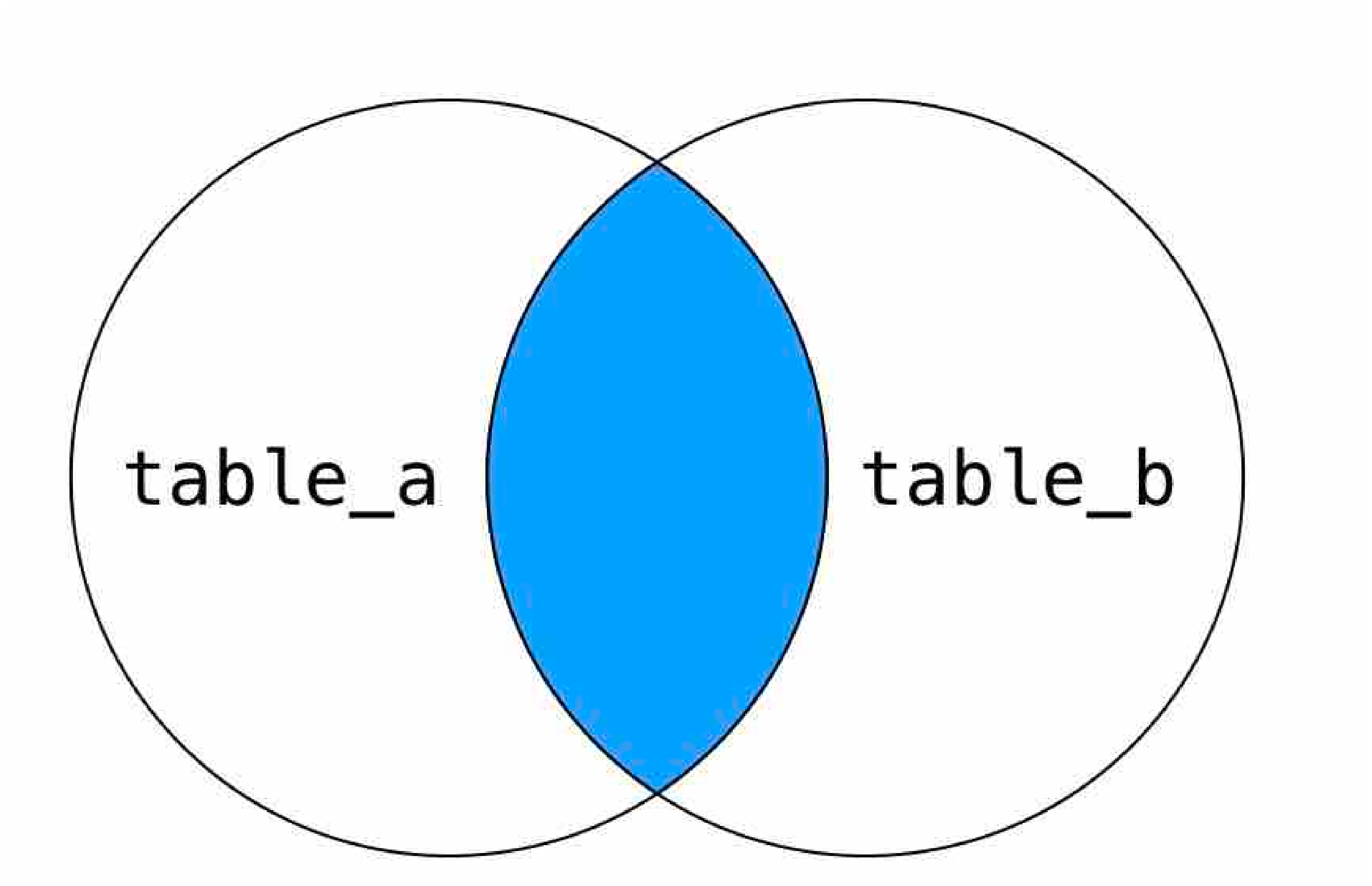
In [12]:

```
week1.append(week2, ignore_index=True).head(15)
```

Out[12]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1
3	202	2
4	155	9
5	213	8
6	600	1
7	503	5
8	71	3
9	174	3
10	961	9
11	966	5
12	641	4
13	288	2
14	149	4

3. Inner join



As shown in the image above, inner join returns the intersection of two datasets. The intersection is the universal reference point(s) or key that is shared by the two datasets.

This join can be created by using the **merge()** method.

- **left** parameter : the first table
- **right** parameter : the second table
- **on** : the reference point or key
- **how** parameter : the method. Here, we specify inner. (We will learn about outer, left and right soon)
- **suffixes** parameter : Suffix to apply to overlapping column names in the left and right side, respectively

In [13]:

```
df= pd.merge(left=week1, right=week2, how="inner", on="Customer ID", suffixes=[" - Week 1",
df
```

Out[13]:

	Customer ID	Food ID - Week 1	Food ID - Week 2
0	537	9	5
1	155	9	3
2	155	1	3
3	503	5	8
4	503	5	9
...	...	...	...
57	945	5	4
58	343	3	5
59	343	3	2
60	343	3	7
61	621	9	6

62 rows × 3 columns

If you notice, there are two rows with Customer ID of 155 in the new DataFrame. This is because these rows existed in Week 1 dataset which means Customer 155 came twice in week 1. Hence, when we do inner join, it will duplicate the value.

In [14]:

```
df.head()
```

Out[14]:

	Customer ID	Food ID - Week 1	Food ID - Week 2
0	537	9	5
1	155	9	3
2	155	1	3
3	503	5	8
4	503	5	9

In [15]:

```
week1[week1["Customer ID"] == 155]
```

Out[15]:

	Customer ID	Food ID
4	155	9
17	155	1

In [16]:

```
week2[week2["Customer ID"] == 155]
```

Out[16]:

	Customer ID	Food ID
208	155	3

Extract customers who came on both weeks and bought the same food

In [17]:

```
pd.merge(left=week1, right=week2, how="inner" , on=["Customer ID" , "Food ID"])
```

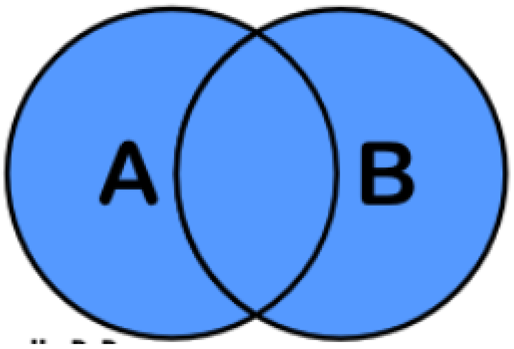
Out[17]:

	Customer ID	Food ID
0	304	3
1	540	3
2	937	10
3	233	3
4	21	4
5	21	4
6	922	1
7	578	5
8	578	5

However, we can still see some duplicates in the DataFrame (Customer 21 and 578). Why?

Answer: These customers came twice either in Week 1 or Week 2. Try to extract the data from weeks 1 and 2 and compare them. You will understand more!

4. Outer Joins



Combine both datasets at one reference point

- **how** : outer, because we want to do outer join.
- **indicator** : represents which table the data belongs to.

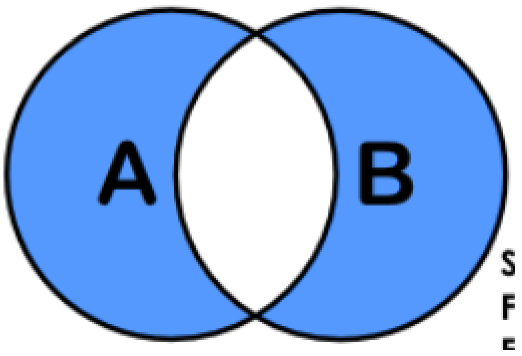
In [18]:

```
merged = pd.merge(left=week1, right=week2, how="outer",on="Customer ID", suffixes=[" - Week
merged.head(15)
```

Out[18]:

	Customer ID	Food ID - Week 1	Food ID - Week 2	_merge
0	537	9.0	5.0	both
1	97	4.0	NaN	left_only
2	658	1.0	NaN	left_only
3	202	2.0	NaN	left_only
4	155	9.0	3.0	both
5	155	1.0	3.0	both
6	213	8.0	NaN	left_only
7	600	1.0	NaN	left_only
8	503	5.0	8.0	both
9	503	5.0	9.0	both
10	71	3.0	NaN	left_only
11	71	8.0	NaN	left_only
12	174	3.0	NaN	left_only
13	961	9.0	NaN	left_only
14	966	5.0	NaN	left_only

Outer Joins with exception



As shown in the diagram, it combines the datasets except the middle part (intersection part).

In [19]:

```
mask = merged["_merge"].isin(["right_only" , "left_only"])
merged[mask]
```

Out[19]:

	Customer ID	Food ID - Week 1	Food ID - Week 2	_merge
1	97	4.0	NaN	left_only
2	658	1.0	NaN	left_only
3	202	2.0	NaN	left_only
6	213	8.0	NaN	left_only
7	600	1.0	NaN	left_only
...	...	...	...	...
449	855	NaN	4.0	right_only
450	559	NaN	10.0	right_only
451	276	NaN	4.0	right_only
452	556	NaN	10.0	right_only
453	252	NaN	9.0	right_only

392 rows × 4 columns

Another technique to do Outer Join without taking intersection :

In [20]:

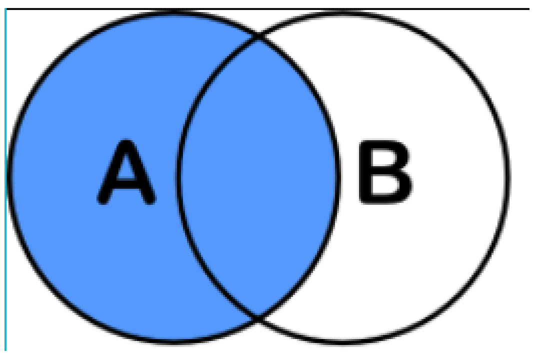
```
mask = merged["_merge"] != "both"
merged[mask]
```

Out[20]:

	Customer ID	Food ID - Week 1	Food ID - Week 2	_merge
1	97	4.0	NaN	left_only
2	658	1.0	NaN	left_only
3	202	2.0	NaN	left_only
6	213	8.0	NaN	left_only
7	600	1.0	NaN	left_only
...	...	...	...	...
449	855	NaN	4.0	right_only
450	559	NaN	10.0	right_only
451	276	NaN	4.0	right_only
452	556	NaN	10.0	right_only
453	252	NaN	9.0	right_only

392 rows × 4 columns

5. Left Joins



Focus on one DataFrame and include the intersection of the second DataFrame.

In [21]:

```
week1.head(3)
```

Out[21]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1

In [22]:

```
foods.head(3)
```

Out[22]:

	Food ID	Food Item	Price
0	1	Sushi	3.99
1	2	Burrito	9.99
2	3	Taco	2.99

Let's combine both of the tables.

Now, we can identify the name of the food the customers ate.

In [23]:

```
df = pd.merge(left=week1, right=foods, how="left", on="Food ID")
df
```

Out[23]:

	Customer ID	Food ID	Food Item	Price
0	537	9	Donut	0.99
1	97	4	Quesadilla	4.25
2	658	1	Sushi	3.99
3	202	2	Burrito	9.99
4	155	9	Donut	0.99
...	...	...	...	...
245	413	9	Donut	0.99
246	926	6	Pasta	13.99
247	134	3	Taco	2.99
248	396	6	Pasta	13.99
249	535	10	Drink	1.75

250 rows × 4 columns

In the **merge() method,** we have additional parameter which is called **sort**. By default it is set to False. If it is True, it will sort the keys in ascending order.

In [24]:

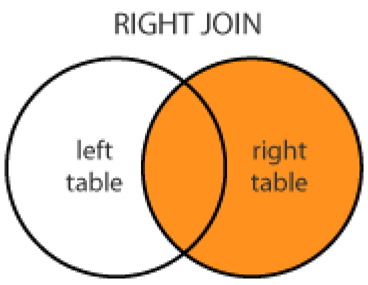
```
pd.merge(left=week1, right=foods,how="left", on="Food ID", sort=True)
```

Out[24]:

	Customer ID	Food ID	Food Item	Price
0	658	1	Sushi	3.99
1	600	1	Sushi	3.99
2	155	1	Sushi	3.99
3	341	1	Sushi	3.99
4	20	1	Sushi	3.99
...	...	...	...	...
245	809	10	Drink	1.75
246	584	10	Drink	1.75
247	274	10	Drink	1.75
248	151	10	Drink	1.75
249	535	10	Drink	1.75

250 rows × 4 columns

6. Right Join



Combine the two tables on a specific key. Only data on the intersection and right table will be taken. It is the same as Left Join, but in a different direction.

Let's use the right join to get the customers' information.

First, we have to rename the key column because in Customers dataset, its name is ID while in our new DataFrame, the key column name is Customer ID.

In [25]:

```
customers.head(3)
```

Out[25]:

	ID	First Name	Last Name	Gender	Company	Occupation
0	1	Joseph	Perkins	Male	Dynazzy	Community Outreach Specialist
1	2	Jennifer	Alvarez	Female	DabZ	Senior Quality Engineer
2	3	Roger	Black	Male	Tagfeed	Account Executive

In [26]:

```
df.head(3)
```

Out[26]:

	Customer ID	Food ID	Food Item	Price
0	537	9	Donut	0.99
1	97	4	Quesadilla	4.25
2	658	1	Sushi	3.99

In [27]:

```
df.columns = ['ID', 'Food ID', 'Food Item', 'Price']
```

In [28]:

```
pd.merge(left=customers, right=df, on="ID", how="right").head()
```

Out[28]:

	ID	First Name	Last Name	Gender	Company	Occupation	Food ID	Food Item	Price
0	3	Roger	Black	Male	Tagfeed	Account Executive	2	Burrito	9.99
1	10	Steven	Ryan	Male	Twinder	Community Outreach Specialist	2	Burrito	9.99
2	20	Lisa	Rice	Female	Oloo	Programmer IV	1	Sushi	3.99
3	21	Albert	Burns	Male	Rhynoodle	Junior Executive	4	Quesadilla	4.25
4	21	Albert	Burns	Male	Rhynoodle	Junior Executive	4	Quesadilla	4.25

7. left_on and right_on Parameters

In the previous technique, we have to rename the column first before combining which is a tedious process. Without renaming the column, we can still combine them by specifying the column names on both left and right.

- **right_on** : Column or index level names to join on in the right DataFrame.
- **left_on** : Use the index from the left DataFrame as the join key(s).

In [29]:

```
week1.head(3)
```

Out[29]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1

In [30]:

```
customers.head(3)
```

Out[30]:

	ID	First Name	Last Name	Gender	Company	Occupation
0	1	Joseph	Perkins	Male	Dynazzy	Community Outreach Specialist
1	2	Jennifer	Alvarez	Female	DabZ	Senior Quality Engineer
2	3	Roger	Black	Male	Tagfeed	Account Executive

In [31]:

```
pd.merge(left=customers, right=week1, left_on="ID", right_on="Customer ID", sort=True).heac
```

Out[31]:

	ID	First Name	Last Name	Gender	Company	Occupation	Customer ID	Food ID
0	3	Roger	Black	Male	Tagfeed	Account Executive	3	2
1	10	Steven	Ryan	Male	Twinder	Community Outreach Specialist	10	2
2	20	Lisa	Rice	Female	Oloo	Programmer IV	20	1
3	21	Albert	Burns	Male	Rhynoodle	Junior Executive	21	4
4	21	Albert	Burns	Male	Rhynoodle	Junior Executive	21	4

ID column and Customer ID column are the same thing. After merging, Pandas will include both of them in the new DataFrame. We do not need to keep both as they are similar hence, we should drop any one of them.

In [32]:

```
pd.merge(left=customers, right=week1, left_on="ID", right_on="Customer ID", sort=True).drop
```

Out[32]:

	First Name	Last Name	Gender	Company	Occupation	Customer ID	Food ID
0	Roger	Black	Male	Tagfeed	Account Executive	3	2
1	Steven	Ryan	Male	Twinder	Community Outreach Specialist	10	2
2	Lisa	Rice	Female	Oloo	Programmer IV	20	1
3	Albert	Burns	Male	Rhynoodle	Junior Executive	21	4
4	Albert	Burns	Male	Rhynoodle	Junior Executive	21	4
...	...	...	...	...	...	...	...
245	Robert	Ford	Male	Jabbertype	Account Representative IV	966	5
246	Teresa	Reynolds	Female	Flashdog	Budget/Accounting Analyst IV	968	1
247	Julia	Ortiz	Female	Kwideo	Structural Analysis Engineer	985	5
248	Melissa	Wells	Female	Lazzy	Senior Sales Associate	991	2
249	Brian	Daniels	Male	Tazzy	Physical Therapy Assistant	1000	2

250 rows × 7 columns

8. Merging two dataFrame base on Index

In merge() method, there are right_index and left_index parameters. Set them to True to do merging using the particular index as the reference point.

In [33]:

```
week1.head()
```

Out[33]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1
3	202	2
4	155	9

In [34]:

```
foods = pd.read_csv("data/Restaurant - Foods.csv", index_col="Food ID")
foods.head(3)
```

Out[34]:

	Food Item	Price
Food ID		
1	Sushi	3.99
2	Burrito	9.99
3	Taco	2.99

Here, we are not using the on parameter. Instead, I specify the **left_on** parameter and set the **right_index** parameter to True.

In [35]:

```
pd.merge(left=week1, right=foods, how="left", left_on="Food ID", right_index=True)
```

Out[35]:

	Customer ID	Food ID	Food Item	Price
0	537	9	Donut	0.99
1	97	4	Quesadilla	4.25
2	658	1	Sushi	3.99
3	202	2	Burrito	9.99
4	155	9	Donut	0.99
...	...	...	...	...
245	413	9	Donut	0.99
246	926	6	Pasta	13.99
247	134	3	Taco	2.99
248	396	6	Pasta	13.99
249	535	10	Drink	1.75

250 rows × 4 columns

9 .join() method

It works the same as merge() method. We can join the table on the reference point(s).

In [36]:

```
satisfaction = pd.read_csv("data/Restaurant - Week 1 Satisfaction.csv")
satisfaction.head()
```

Out[36]:

	Satisfaction Rating
0	2
1	7
2	3
3	7
4	10

In [37]:

```
week1.head(3)
```

Out[37]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1

In [38]:

```
week1.join(satisfaction).head()
```

Out[38]:

	Customer ID	Food ID	Satisfaction Rating
0	537	9	2
1	97	4	7
2	658	1	3
3	202	2	7
4	155	9	10

Using the merge() method, we can also get the same output. However, merge() method **requires more parameters.**

In [39]:

```
pd.merge(left=week1, right=satisfaction, left_index=True, right_index=True)
```

Out[39]:

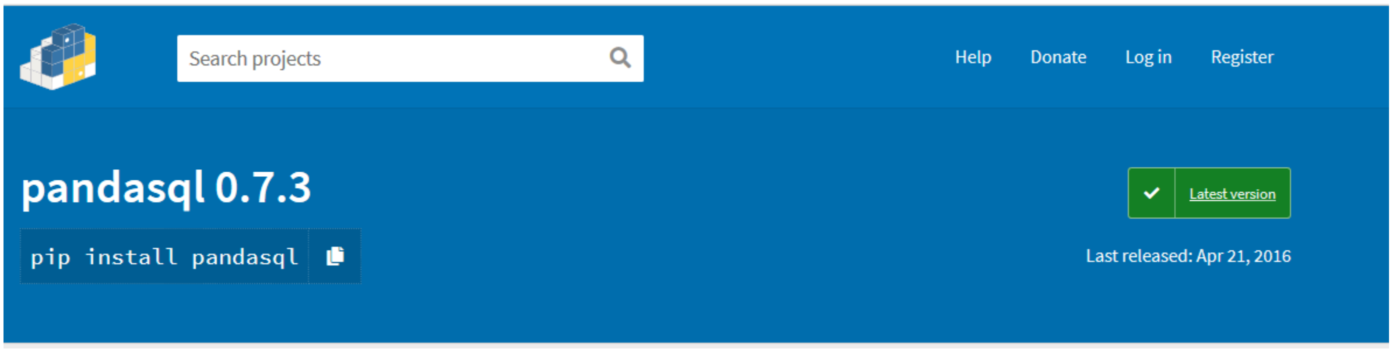
	Customer ID	Food ID	Satisfaction Rating
0	537	9	2
1	97	4	7
2	658	1	3
3	202	2	7
4	155	9	10
...	...	...	...
245	413	9	1
246	926	6	2
247	134	3	8
248	396	6	10
249	535	10	3

250 rows × 3 columns

10. SQL command in Pandas

To use the SQL command in Pandas, we need additional library called **PandasSQL**.
https://pypi.org/project/pandasql/ (https://pypi.org/project/pandasql/)

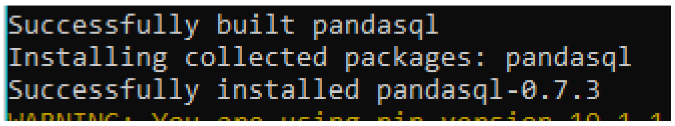
You can install it using this command: *pip install pandasql*



pandasql 0.7.3

```
pip install pandasql
```

Last released: Apr 21, 2016



```
Successfully built pandasql
Installing collected packages: pandasql
Successfully installed pandasql-0.7.3
WARNING: You are using pip version 19.1.1
```

Once the library installation is completed, you can import the library inside Jupyter Notebook.

In [40]:

```
import pandasql as ps
```

We use **sqldf() function** to do query by passing SQL Query in string format. For example, we want to select all columns in the food table. The query is as follows:

SELECT * from foods

In [41]:

```
ps.sqldf("SELECT * from foods").head(5)
```

Out[41]:

	Food ID	Food Item	Price
0	1	Sushi	3.99
1	2	Burrito	9.99
2	3	Taco	2.99
3	4	Quesadilla	4.25
4	5	Pizza	2.49

Inner Join with SQL Query.

Let's join Week1 and Week2 table using Customer ID as the primary key.

In [42]:

```
week1.head(3)
```

Out[42]:

	Customer ID	Food ID
0	537	9
1	97	4
2	658	1

In [43]:

```
week2.head(3)
```

Out[43]:

	Customer ID	Food ID
0	688	10
1	813	7
2	495	10

We can combine the table using Customer ID as the key. However, the key name contains space which we need to replace with underscore (_).

In [44]:

```
week1.columns = ["Customer_ID" , "Food_ID"]
week2.columns = ["Customer_ID" , "Food_ID"]
```

If we want to do the Inner join using SQL Command, the query is as follows:

SELECT * FROM week1 INNER JOIN week2 ON week1.Customer_ID = week2.Customer_ID

The query yields the same result as using Pandas Merge() function. If you are familiar with SQL commands, this library will help you a lot.

In [45]:

```
ps.sqldf("SELECT * FROM week1  INNER JOIN week2 ON week1.Customer_ID = week2.Customer_ID").
```

Out[45]:

	Customer_ID	Food_ID	Customer_ID	Food_ID
0	537	9	537	5
1	155	9	155	3
2	503	5	503	8
3	503	5	503	9
4	155	1	155	3