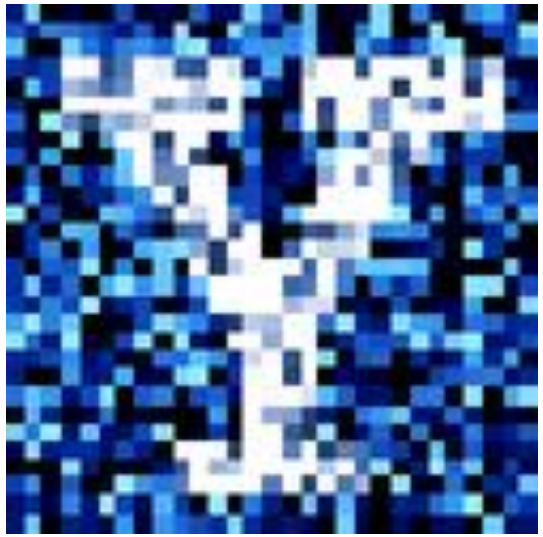
YData: Introduction to Data Science



Class 08: Pandas Series and DataFrames

Overview

Quick review of Boolean masking

Tuples and dictionaries

pandas

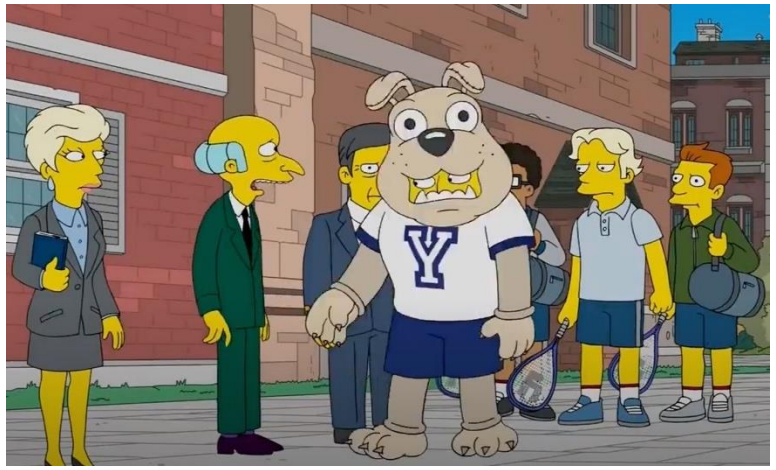
- Series
- DataFrames
- Selecting columns and rows from DataFrames
- Sorting values and adding new columns
- Calculating aggregate statistics for separate groups
- If there is time: joining DataFrames

Announcement: Homework 4

Homework 4 is due on Gradescope on Sunday September 29th at 11pm

- **Be sure to mark each question on Gradescope!**

How was homework 3?



Quick review of Boolean masking

We can also use Boolean arrays to return values in another array

- This is called "Boolean masking" or "Boolean indexing"

```
my_array = np.array([12, 4, 6, 3, 1])
boolean_mask = np.array([False, True, False, True, True])

smaller_array = my_array[boolean_mask]
```

This can be useful for calculating statistics on data that meet particular criteria:

```
np.mean(my_array[my_array < 5])    # what does this do?


boolean_mask = my_array < 5       # breaking it down into steps…
values_less_than_5  = my_array[boolean_mask ]
np.mean(values_less_than_5)
```

Let’s do a warm-up exercise in Jupyter!

Tuples and Dictionaries

Tuples

Tuples are like lists but they are ***immutable***

- i.e., once they are created we can't change the values in a tuple.

We can create a tuple using:

```
my_tuple = (10, 20, 30)
```

Like lists, we can access elements of tuples using square brackets

```
my_tuple[1]
```

We can't change values in tuples:

```
my_tuple[1] = 50    # Error!!!
```

Tuples

We can assign values in tuples into regular names using “tuple unpacking”

```
my_tuple = (10, 20, 30)

val1, val2, val3 = my_tuple

val3
```

Let's explore this in Jupyter!

Dictionaries

Dictionaries allow you to look up ***values*** based on a ***key***

- i.e., you supply a “key” and the dictionary returns the stored value

We can create dictionaries using the syntax:

```
my_dict = { 'key1': 5, 'key2':  20}
```

We can retrieve dictionary values by supplying a key using square brackets []

```
my_dict['key2']
```

Let's explore this in Jupyter!

Series and Tables

Pandas: Series and DataFrames

"pandas is an open source, BSD-licensed library providing high-performance, easy-to-use data structures and data analysis tools for the Python programming language."

There are two main data structures in pandas:

- **Series**: represent one-dimensional data
- **DataFrames**: represent data tables
  - i.e., relational data

pandas Series

pandas Series are: One-dimensional ndarray with axis labels

- (including time series)

Example: egg _prices

DATE	
1980-01-01	0.879
1980-02-01	0.774
1980-03-01	0.812

Index

values

pandas Series

We can access elements by Index ***name*** using **.loc**

```
egg_prices.loc["1980-01-01"]
```

We can access elements by Index ***number*** using **.iloc**

```
egg_prices.iloc[0]
```

Since pandas Series are just ndarrays with an Index, all the numpy functions will work on Series

Let's explore this in Jupyter!

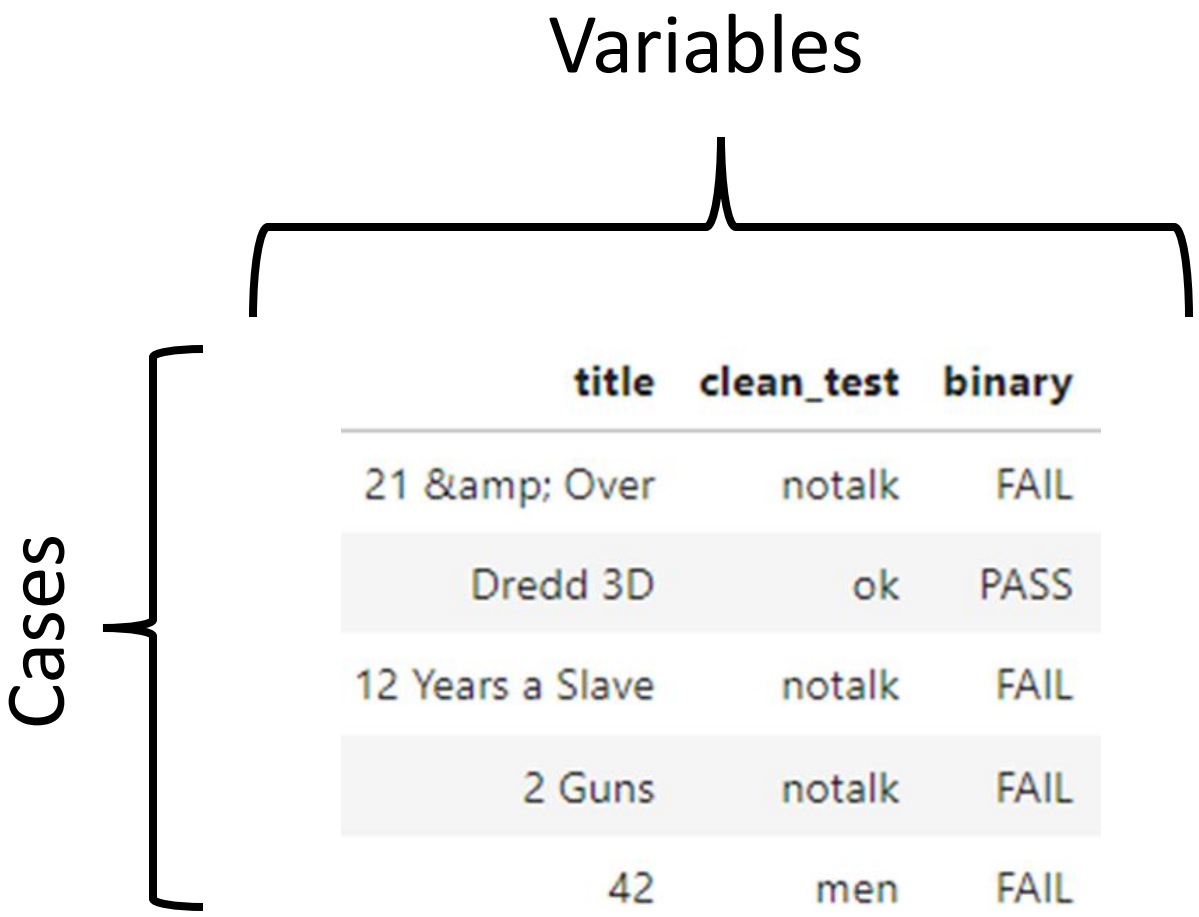
pandas DataFrames

Pandas DataFrame hold Table data

This is one of the most useful formats to extract insights from datasets

Often we read data into a DataFrame using:

```
pd.read_csv("file.csv")
```



	title	clean_test	binary
21 & Over	notalk	FAIL
Dredd 3D	ok	PASS
12 Years a Slave	notalk	FAIL
2 Guns	notalk	FAIL
42	men	FAIL

Motivation: flight information

Questions:

- Is anyone traveling by airplane for Thanksgiving?
- Is anyone flying out of New York City?
- Has anyone bought plane tickets?

Let’s look at flight delay data from NYC airports!

Selecting columns from a DataFrame

We can select a column from a DataFrame using square brackets:

```
my_df["my_col"]       # returns a Series!
```

We can select multiple columns from a DataFrame by passing a list into the square brackets

```
my_df[["col1", "col2"]]
```

Let's explore this in Jupyter!

Extracting rows from a DataFrame

We can extract rows from a DataFrame by:

1. The position they appear in the DataFrame
2. The Index values

We use the .iloc[] property to extract values by ***position***

```
my_df.iloc[0]
```

We use the .loc[] property to extract values by ***Index value***

```
my_df.loc["index_name"]
```

Extracting rows from a DataFrame

We can also extract rows through using Boolean masking

For example:

```
bool_mask = my_df["col_name"] == 7
my_df.loc[bool_mask]
```

Or in one step: `my_df [my_df["col_name"] == 7]`

Let's explore this in Jupyter!

Sorting rows from a DataFrame

We can sort values in a DataFrame using .sort_values("col_name")

- my_df.sort_values("col_name")

We can sort from highest to lowest by setting the argument ascending = False

- my_df.sort_values("col_name", ascending = False)

Let's explore this in Jupyter!

Adding new columns and renaming columns

We can add a column to a data frame using square backets. For example:

```
my_df["new_col"] = values_array
my_df["new col"] = my_df["col1"] + my_df["col2"]
```

We can rename columns by passing a dictionary to the .rename() method.

```
rename_dictionary = {"old_col_name": "new_col_name"}
my_df.rename(columns = rename_dictionary )
```

Let's explore this in Jupyter!

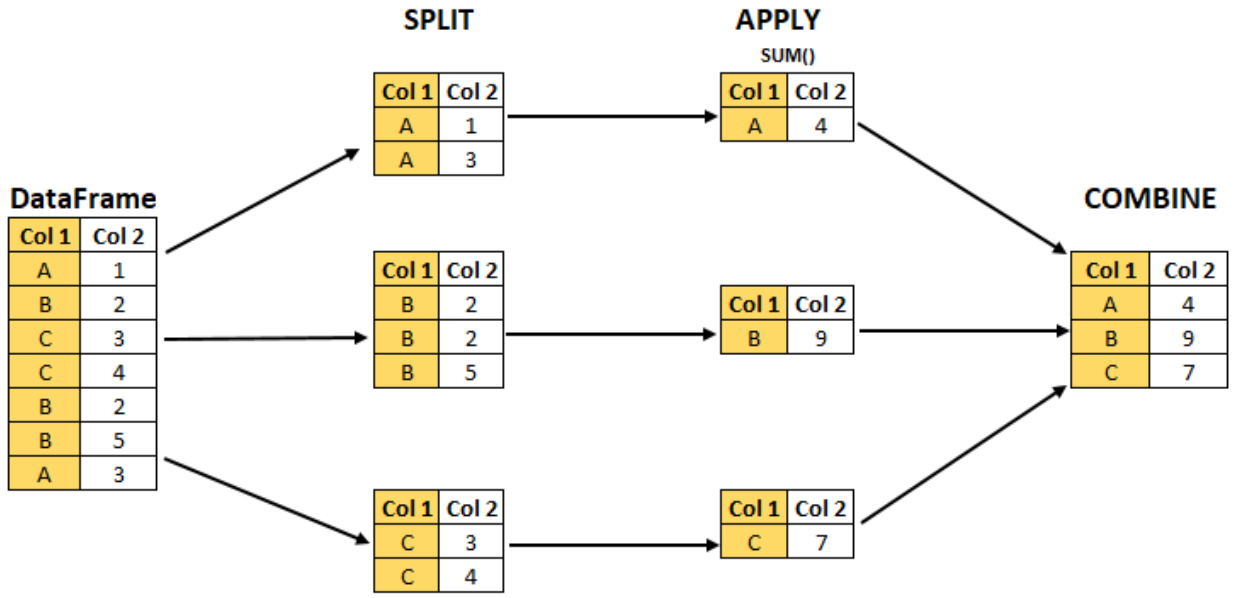
Creating aggregate statistics by group

We can get statistics separately by group using the .groupby() and .agg() methods

- E.g. dow.groupby("Year").agg("max")

This implements:

"Split-apply-combine"



Creating aggregate statistics by group

There are several ways to get multiple statistics by group

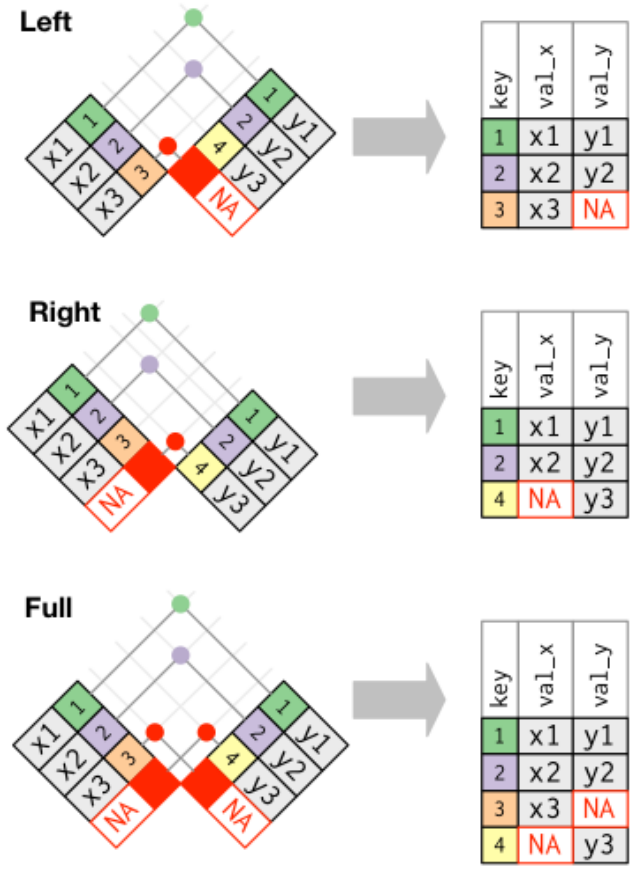
Perhaps the most useful way is to use the syntax:

```
my_df.groupby("group_col_name").agg(
      new_col1 = ('col_name1', 'statistic_name1’),
      new_col2 = ('col_name2', 'statistic_name2’),
      new_col3 = ('col_name3', 'statistic_name3')
)
```

```
nba_salaries.groupby("TEAM").agg(
    max_salary = ("SALARY", "max"),
    min_salary = ("SALARY", "min"),
    first_player = ("PLAYER", "min")
)
```

Let's explore this in Jupyter!

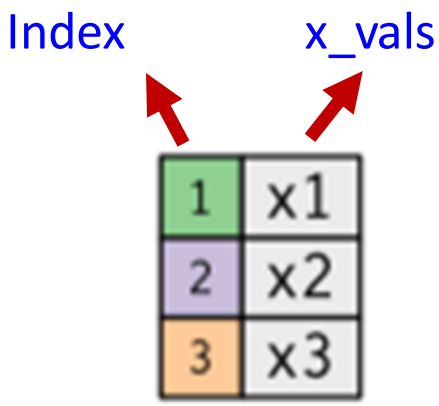
Joining data frames



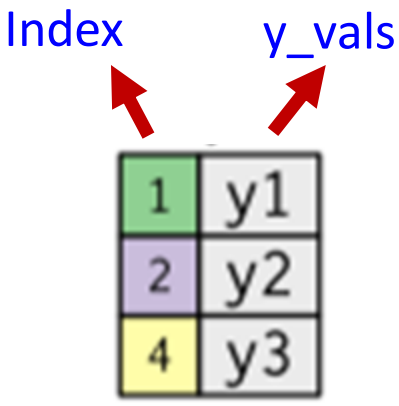
Left and right tables

Suppose we have two DataFrames (or Series) called **x_df** and **y_df**

- x_df have one column called x_vals
- y_df has one column called y_vals



DataFame: x_df



DataFrame: y_df

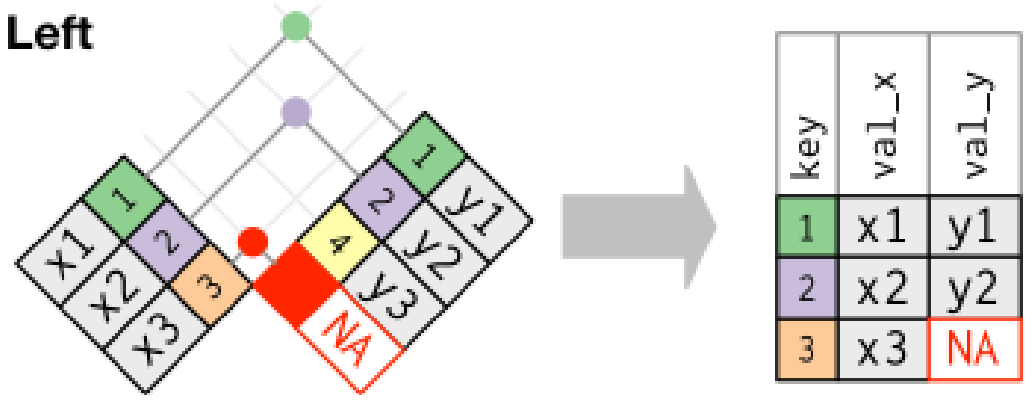
We can join these two DataFrames into a single DataFrame by aligning rows with the same Index value using the general syntax: x_df.join(y_df)

- i.e., the new joined data frame will have two columns: x_vals, and y_vals

Left joins

Left joins keep all rows in the left table.

Data from right table is added when there is a matching Index value, otherwise NA as added

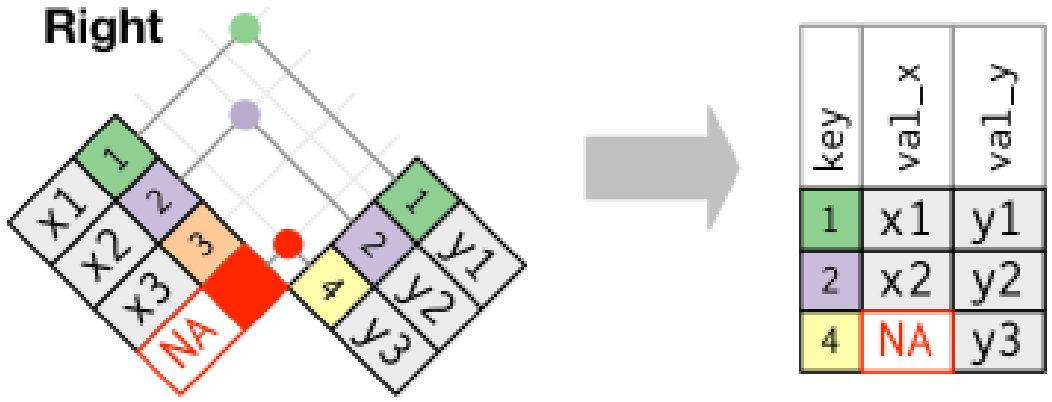



```
x_df.join(y_df, how = "left”)
```

Right joins

Right joins keep all rows in the right table.

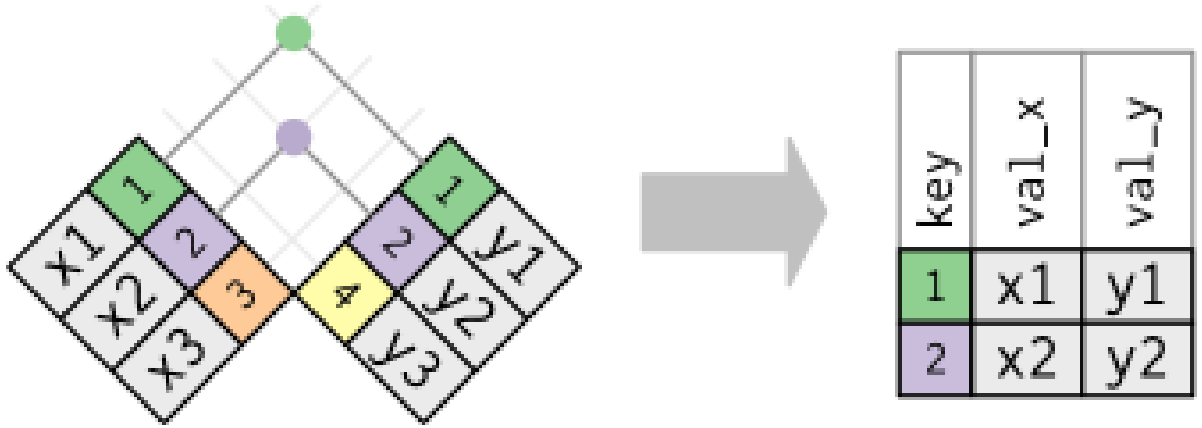
Data from left table added when there is a matching Index value otherwise NA as added




```
x_df.join(y_df, how = "right")
```

Inner joins

Inner joins only keep rows in which there are matches between the Index values in <u>both</u> tables.



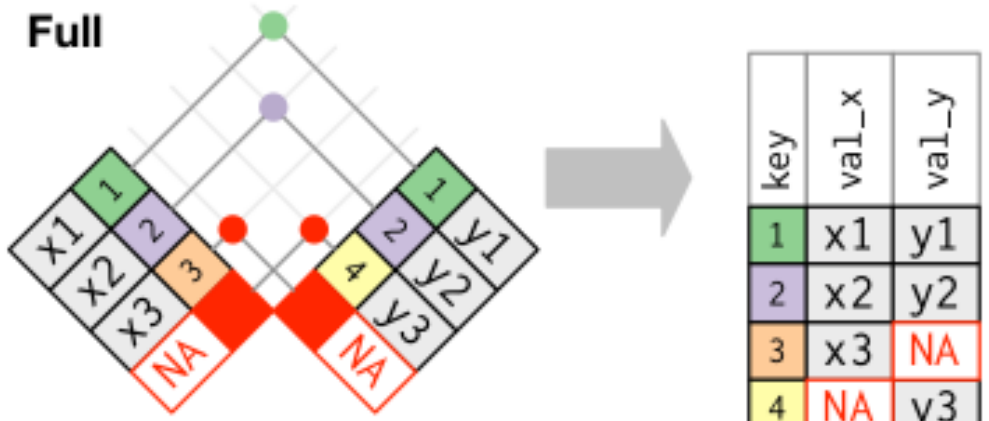
key	val_x	val_y
1	x1	y1
2	x2	y2

```
x_df.join(y_df, how = "inner")
```

Full (outer) joins

Full joins keep all rows in both table

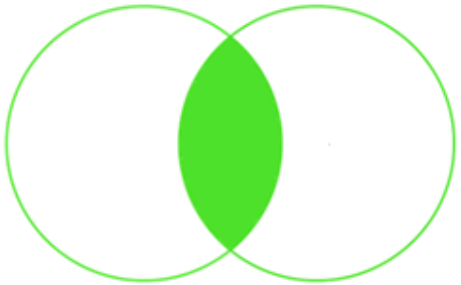
NAs are added where there are no matches



key	val_x	val_y
1	x1	y1
2	x2	y2
3	x3	NA
4	NA	y3

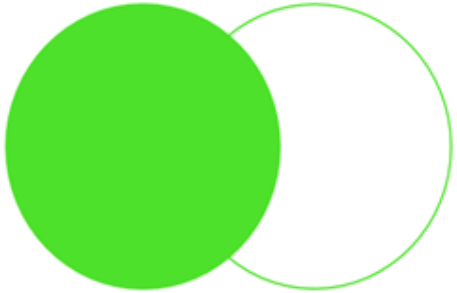
```
x_df.join(y_df, how = "outer")
```

Summary

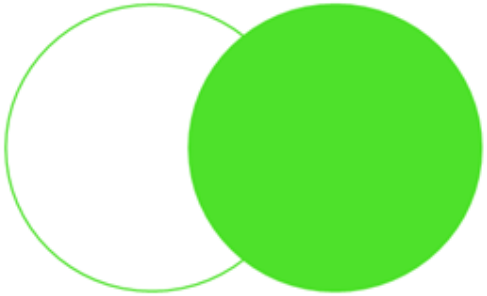


INNER JOIN

FULL OUTER JOIN



LEFT JOIN



RIGHT JOIN

“Merging” data frames

We can also join DataFrames based on values in ***columns*** rather than based on the DataFrames Index values

To do this we can use the merge method which has the form:

- x_df.merge(y_df, how = "left", left_on = "x_col", right_on = "y_col")

All the same types of joins still work

- i.e., we can do: left, right, inner and outer joins

Let's explore this in Jupyter!

Questions?