Programming with Python
Part 5: Pandas

Introduction

Pandas is used for data manipulation and analysis

It has powerful data structures

Pandas First Steps: install and import

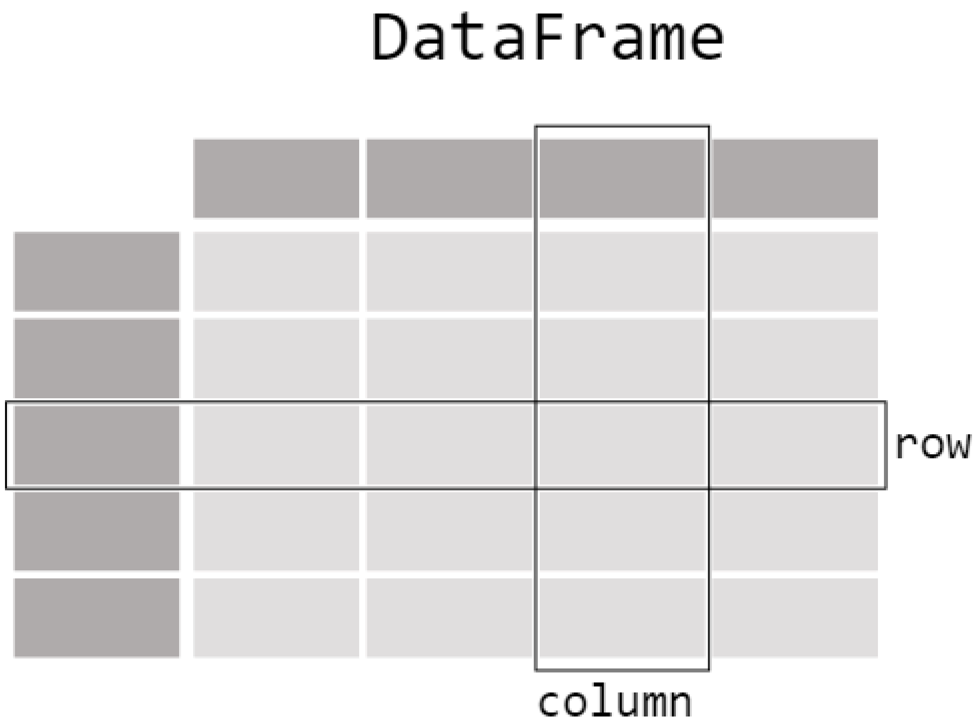
- Pandas is an easy package to install. Open up your terminal program (shell or cmd) and install it using either of the following commands:

```
$ conda install pandas
           OR
$ pip  install  pandas
```

- To import pandas we usually import it with a shorter name since it's used so much:

```
import pandas as pd
```

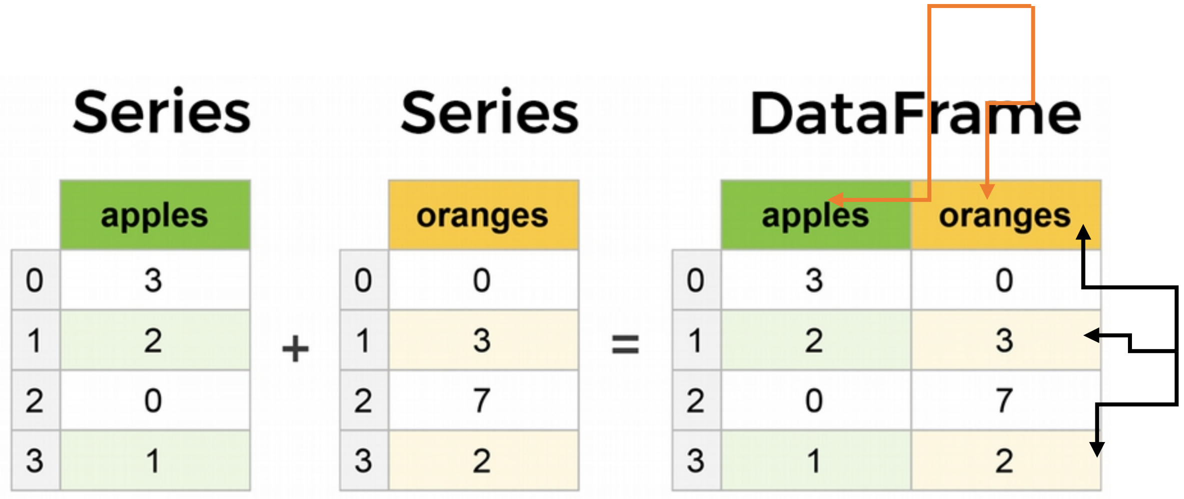
pandas: Data Table Representation



Core components of pandas: Series & DataFrames

- The primary two components of pandas are the Series and DataFrame.
    - Series is essentially a column, and
    - DataFrame is a multi-dimensional table made up of a collection of Series.
- DataFrames and Series are quite similar in that many operations that you can do with one you can do with the other, such as filling in null values and calculating the mean.
    - A Data frame is a two-dimensional data structure, i.e., data is aligned in a tabular fashion in rows and columns.

- Features of DataFrame
    - Potentially columns are of different types
    - Size – Mutable
    - Labeled axes (*rows* and *columns*)
    - Can Perform Arithmetic operations on rows and columns



Series

	apples
0	3
1	2
2	0
3	1

+

Series

	oranges
0	0
1	3
2	7
3	2

=

DataFrame

	apples	oranges
0	3	0
1	2	3
2	0	7
3	1	2

Types of Data Structure in Pandas

Series	1	1D labeled homogeneous array with immutable size
Data Frames	2	General 2D labeled, size mutable tabular structure with potentially heterogeneously typed columns.

- **Series & DataFrame**
  - Series is a one-dimensional array (1D Array) like structure with homogeneous data.
  - DataFrame is a two-dimensional array (2D Array) with heterogeneous data.

pandas.DataFrame

```
pandas.DataFrame(data, index , columns , dtype , copy )
```

- data: data takes various forms like `ndarray`, `series`, `map`, `lists`, `dict`, constants and also another `DataFrame`.
- index: For the **row labels**, that are to be used for the resulting frame, Optional, Default is `np.arrange(n)` if no index is passed.
- columns: For **column labels**, the optional default syntax is - `np.arrange(n)`. This is only true if no index is passed.
- dtype: Data type of each column.
- copy: This command (or whatever it is) is used for copying of data, if the default is False.
- **Create DataFrame**
  - A pandas DataFrame can be created using various inputs like –
    - Lists
    - dict
    - Series
    - Numpy ndarrays
    - Another DataFrame

Creating a DataFrame from scratch

Creating a DataFrame from scratch

- There are many ways to create a DataFrame from scratch, but a great option is to just use a simple dict. But first you must import pandas.

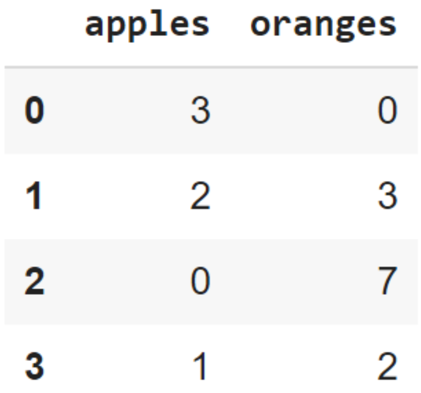
```
import pandas as pd
```

- Let's say we have a fruit stand that sells apples and oranges. We want to have a column for each fruit and a row for each customer purchase. To organize this as a dictionary for pandas we could do something like:

```
data = { 'apples':[3, 2, 0, 1] , 'oranges':[0, 3, 7, 2] }
```

- And then pass it to the pandas DataFrame constructor:

```
df = pd.DataFrame(data)
```

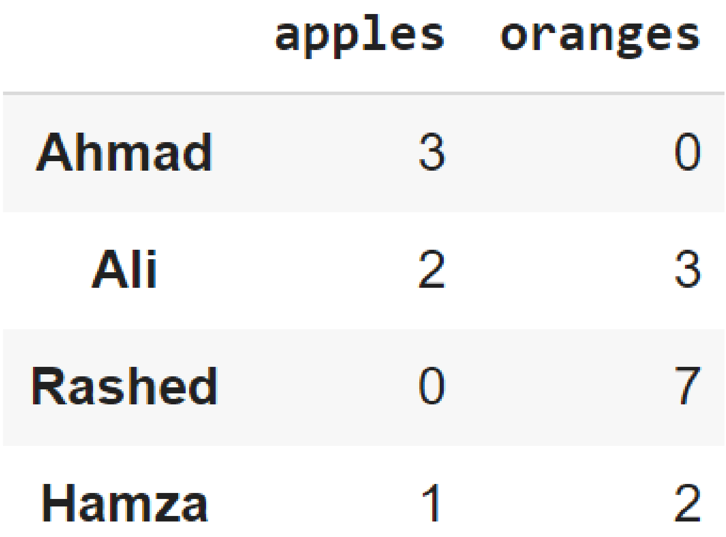


	apples	oranges
0	3	0
1	2	3
2	0	7
3	1	2

How did that work?

- Each (key, value) item in data corresponds to a column in the resulting DataFrame.
- The Index of this DataFrame was given to us on creation as the numbers **`0-3`**, but we could also create our own when we initialize the DataFrame.
- E.g. if you want to have customer names as the index:

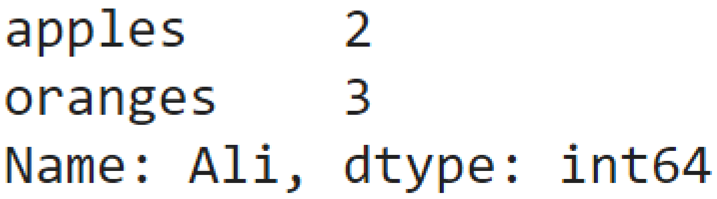
```
df = pd.DataFrame(data, index=['Ahmad', 'Ali', 'Rashed', 'Hamza'])
```



	apples	oranges
Ahmad	3	0
Ali	2	3
Rashed	0	7
Hamza	1	2

- So now we could locate a customer's order by using their names:

```
df.loc['Ali']
```



```
apples     2
oranges    3
Name: Ali, dtype: int64
```

pandas.DataFrame.from_dict

```
pandas.DataFrame.from_dict(data, orient='columns', dtype=None, columns=None)
```

- **data** : dict
  - Of the form `{field:array-like}` or `{field:dict}`.

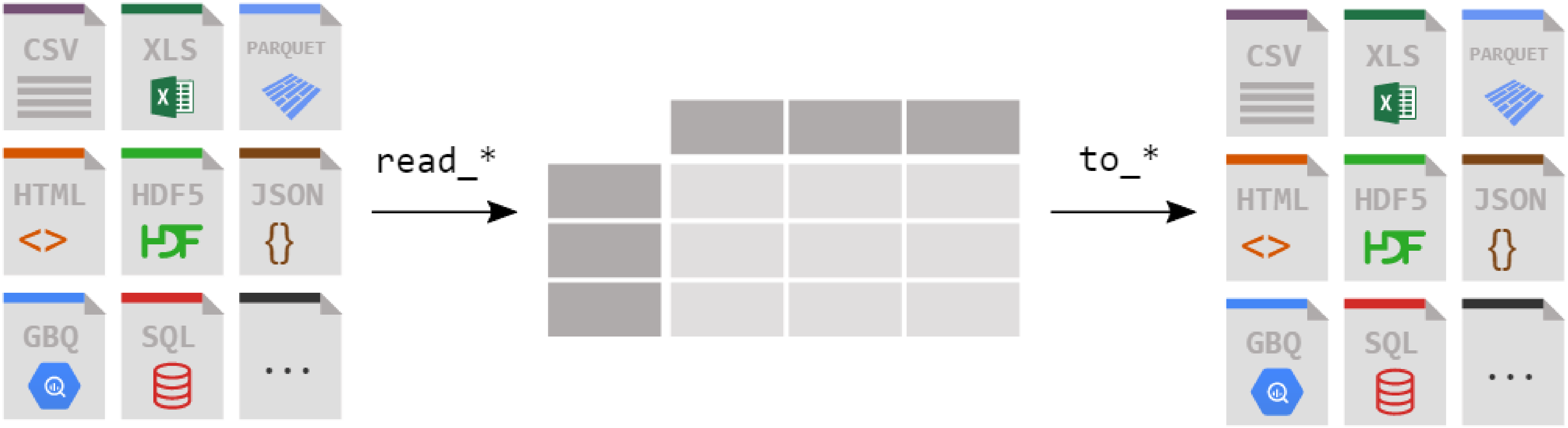
- **orient** : `{‘columns’, ‘index’}`, default ‘`columns`’
  - The “orientation” of the data.
  - If the keys of the passed dict should be the columns of the resulting DataFrame, pass ‘columns’ (default).
  - Otherwise if the keys should be rows, pass ‘index’.

- **dtype** : `dtype`, default `None`
  - Data type to force, otherwise infer.

- **columns** : `list`, default `None`
  - Column labels to use when `orient='index'`. Raises a `ValueError` if used with `orient='columns'`.

https://pandas.pydata.org/pandas-docs/version/0.23/generated/pandas.DataFrame.from_dict.html

Loading a DataFrame from files



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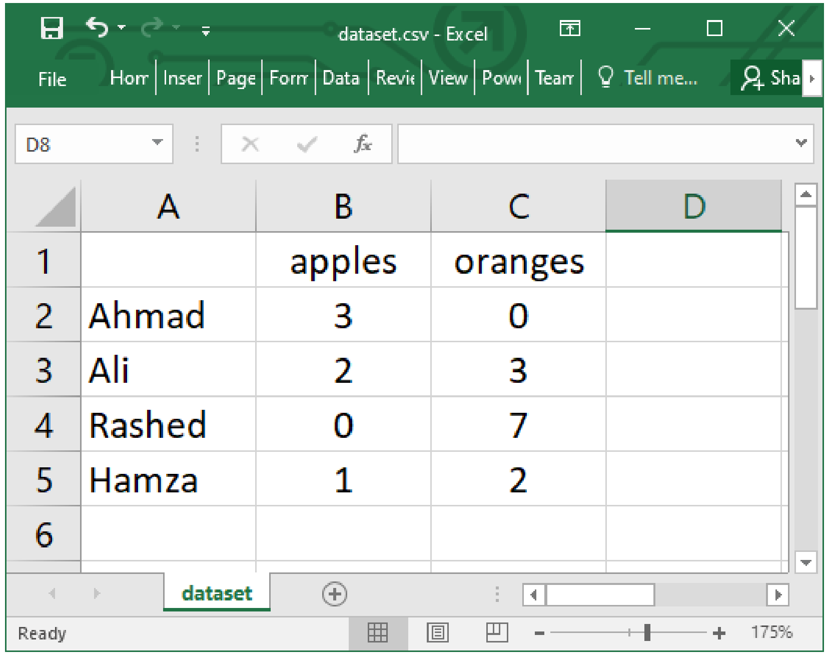
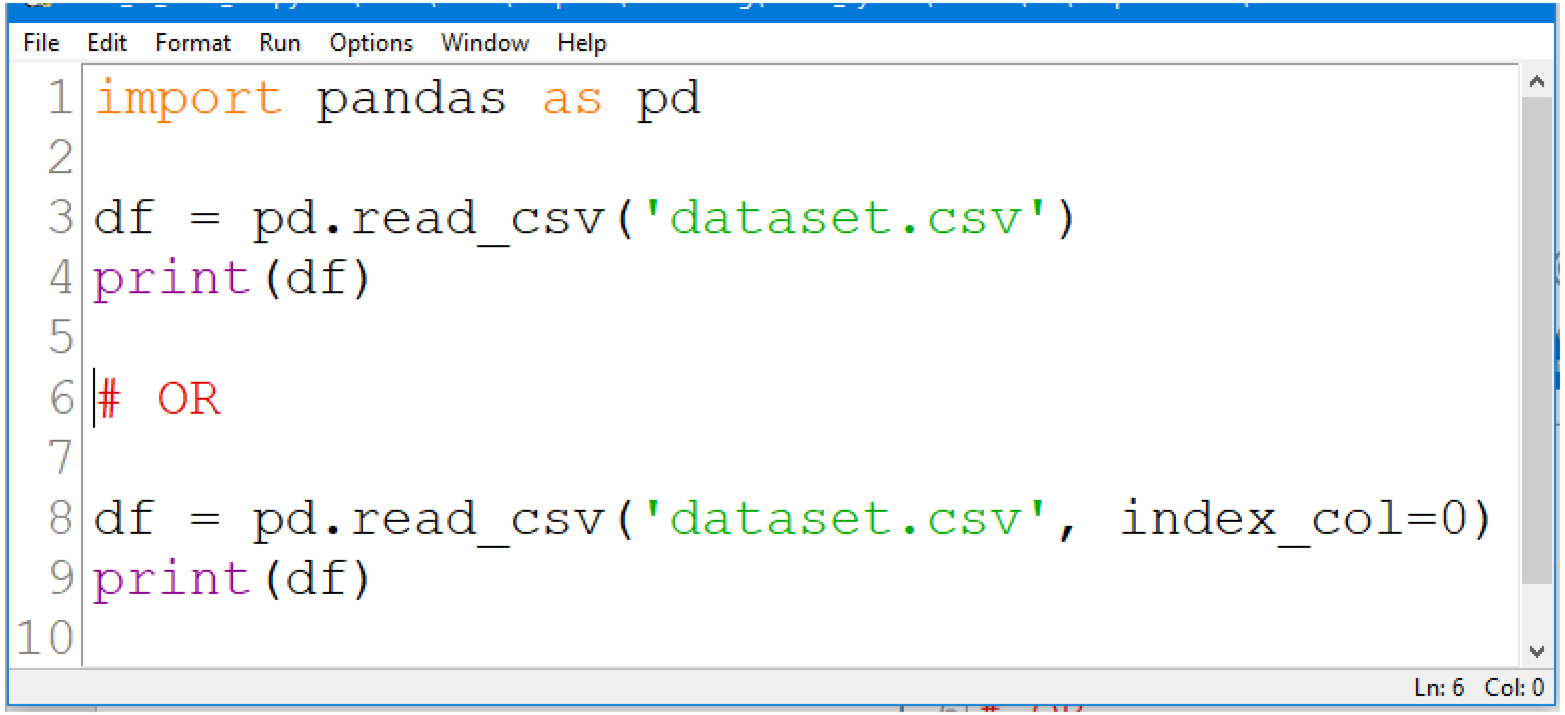
Reading data from a CSV file



	A	B	C	D
1		apples	oranges	
2	Ahmad	3	0	
3	Ali	2	3	
4	Rashed	0	7	
5	Hamza	1	2	
6				

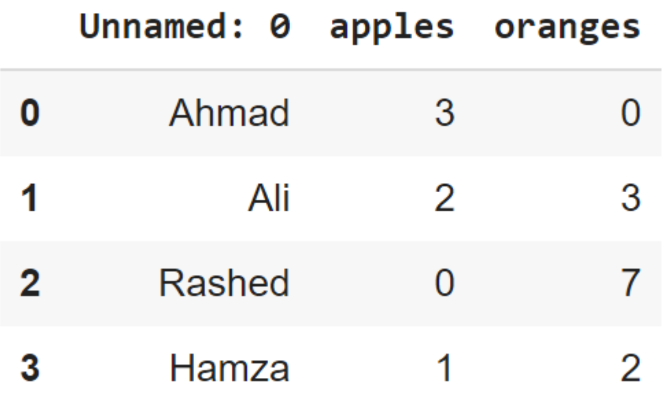


```
import pandas as pd

df = pd.read_csv('dataset.csv')
print(df)

# OR

df = pd.read_csv('dataset.csv', index_col=0)
print(df)

```

Reading data from CSVs

- With CSV files, all you need is a single line to load in the data:

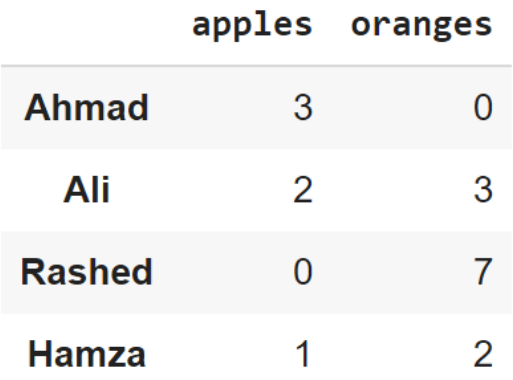
```
df = pd.read_csv('dataset.csv')
```



	Unnamed: 0	apples	oranges
0	Ahmad	3	0
1	Ali	2	3
2	Rashed	0	7
3	Hamza	1	2

- CSVs don't have indexes like our DataFrames, so all we need to do is just designate the **`index_col`** when reading:

```
df = pd.read_csv('dataset.csv', index_col=0)
```



	apples	oranges
Ahmad	3	0
Ali	2	3
Rashed	0	7
Hamza	1	2

  - *Note: here we're setting the index to be column zero.*

Most important DataFrame operations

- DataFrames possess hundreds of methods and other operations that are crucial to any analysis.
- As a beginner, you should know the operations that:
  - that perform simple transformations of your data and those
  - that provide fundamental statistical analysis on your data.

Loading dataset

- We're loading this dataset from a CSV and designating the movie titles to be our index.

```
iris_df = pd.read_csv("iris.csv")
```

Viewing your data

- The first thing to do when opening a new dataset is print out a few rows to keep as a visual reference. We accomplish this with **`.head()`**:

```
iris_df.head()
```

- .head() outputs the first five rows of your DataFrame by default, but we could also pass a number as well: **iris`_df.head(10)`** would output the top ten rows, for example.

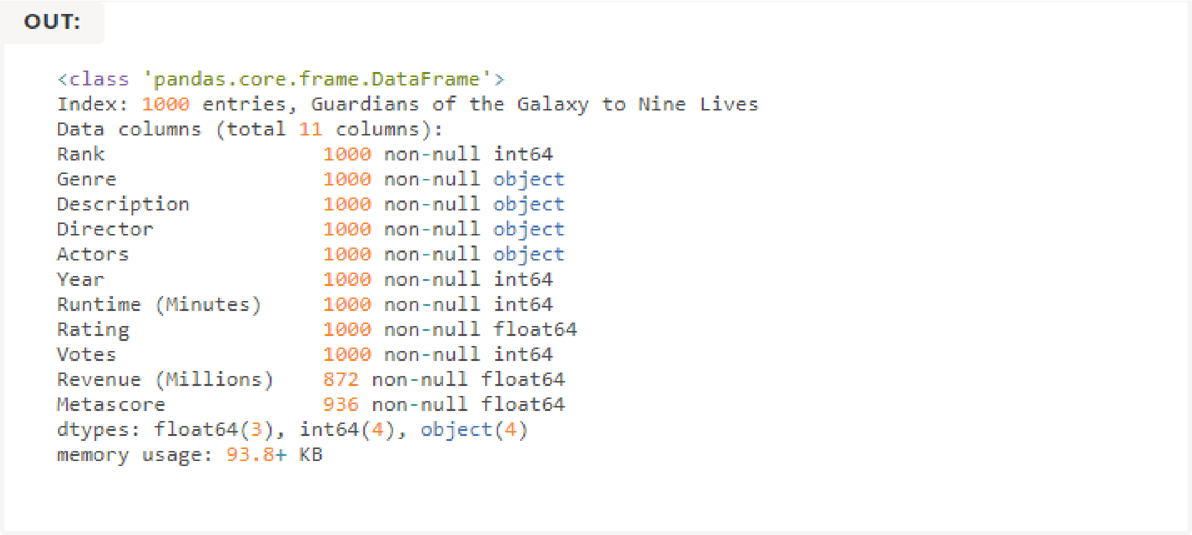
- To see the last five rows use **`.tail()`** that also accepts a number, and in this case we printing the bottom two rows.:

```
iris_df.tail(2)
```

Getting info about your data

- `.info()` should be one of the very first commands you run after loading your data
- `.info()` provides the essential details about your dataset, such as the number of rows and columns, the number of non-null values, what type of data is in each column, and how much memory your DataFrame is using.

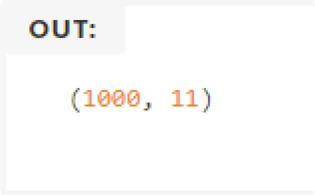
```
iris_df.info()
```



OUT:

```
<class 'pandas.core.frame.DataFrame'>
Index: 1000 entries, Guardians of the Galaxy to Nine Lives
Data columns (total 11 columns):
Rank                  1000 non-null int64
Genre                 1000 non-null object
Description           1000 non-null object
Director              1000 non-null object
Actors                1000 non-null object
Year                  1000 non-null int64
Runtime (Minutes)     1000 non-null int64
Rating                1000 non-null float64
Votes                 1000 non-null int64
Revenue (Millions)    872 non-null float64
Metascore             936 non-null float64
dtypes: float64(3), int64(4), object(4)
memory usage: 93.8+ KB
```

```
iris_df.shape
```



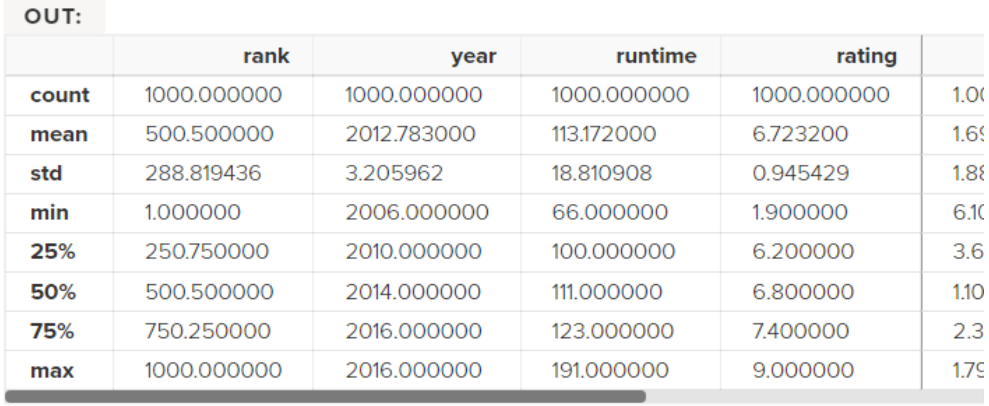
OUT:

```
(1000, 11)
```

Understanding your variables

- Using **`.describe()`** on an entire DataFrame we can get a summary of the distribution of continuous variables:

```
iris_df.describe()
```

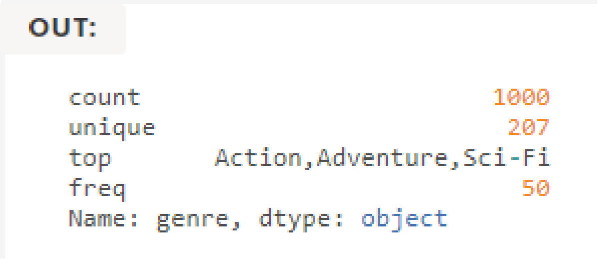


OUT:

	rank	year	runtime	rating	
count	1000.000000	1000.000000	1000.000000	1000.000000	1.00
mean	500.500000	2012.783000	113.172000	6.723200	1.6
std	288.819436	3.205962	18.810908	0.945429	1.8
min	1.000000	2006.000000	66.000000	1.900000	6.1
25%	250.750000	2010.000000	100.000000	6.200000	3.6
50%	500.500000	2014.000000	111.000000	6.800000	1.10
75%	750.250000	2016.000000	123.000000	7.400000	2.3
max	1000.000000	2016.000000	191.000000	9.000000	1.7

- **`.describe()`** can also be used on a categorical variable to get the count of rows, unique count of categories, top category, and freq of top category:

```
iris_df['genre'].describe()
```



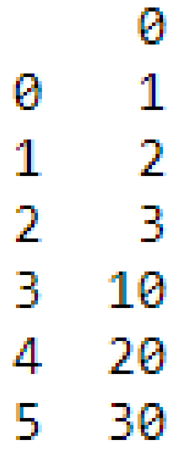
OUT:

```
count                        1000
unique                        207
top         Action,Adventure,Sci-Fi
freq                           50
Name: genre, dtype: object
```

- This tells us that the genre column has 207 unique values, the top value is Action/Adventure/Sci-Fi, which shows up 50 times (freq).

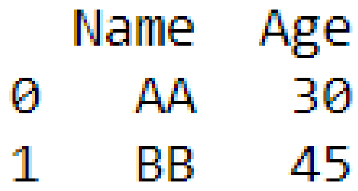
More Examples

```
import pandas as pd
data = [1,2,3,10,20,30]
df = pd.DataFrame(data)
print(df)
```



```
    0
0   1
1   2
2   3
3  10
4  20
5  30
```

```
import pandas as pd
data = {'Name' : ['AA', 'BB'], 'Age': [30,45]}
df = pd.DataFrame(data)
print(df)
```



```
  Name  Age
0   AA   30
1   BB   45
```

More Examples

```
import pandas as pd
data = [{'a': 1, 'b': 2},{'a': 5, 'b': 10, 'c': 20}]
df = pd.DataFrame(data)
print(df)
```

```
   a   b     c
0  1   2   NaN
1  5  10  20.0
```

```
import pandas as pd
data = [{'a': 1, 'b': 2},{'a': 5, 'b': 10, 'c': 20}]
df = pd.DataFrame(data, index=['first', 'second'])
print(df)
```

```
        a   b     c
first   1   2   NaN
second  5  10  20.0
```

More Examples

E.g. This shows how to create a DataFrame with a list of dictionaries, row indices, and column indices.

```
import pandas as pd
data = [{'a': 1, 'b': 2},{'a': 5, 'b': 10, 'c': 20}]

#With two column indices, values same as dictionary keys
df1 = pd.DataFrame(data,index=['first','second'],columns=['a','b'])

#With two column indices with one index with other name
df2 = pd.DataFrame(data,index=['first','second'],columns=['a','b1'])

print(df1)
print('...........')
print(df2)
```

```
        a   b
first   1   2
second  5  10
...........
        a  b1
first   1 NaN
second  5 NaN
```

More Examples:
Create a DataFrame from Dict of Series

```
import pandas as pd
d = {'one' : pd.Series([1, 2, 3]   , index=['a', 'b', 'c']),
     'two' : pd.Series([1,2, 3, 4], index=['a', 'b', 'c', 'd'])
    }
df = pd.DataFrame(d)
print(df)
```

```
   one  two

a  1.0    1

b  2.0    2

c  3.0    3

d  NaN    4
```

More Examples: Column Addition

```
import pandas as pd
d = {'one':pd.Series([1,2,3],   index=['a','b','c']),
     'two':pd.Series([1,2,3,4], index=['a','b','c','d'])
    }
df = pd.DataFrame(d)
# Adding a new column to an existing DataFrame object
# with column label by passing new series

print("Adding a new column by passing as Series:")
df['three'] = pd.Series([10,20,30],index=['a','b','c'])
print(df)

print("Adding a column using an existing columns in
DataFrame:")
df['four'] = df['one']+df['three']
print(df)
```

```
Adding a column using Series:
   one  two  three
a  1.0    1   10.0
b  2.0    2   20.0
c  3.0    3   30.0
d  NaN    4    NaN


Adding a column using columns:
   one  two  three  four
a  1.0    1   10.0  11.0
b  2.0    2   20.0  22.0
c  3.0    3   30.0  33.0
d  NaN    4    NaN   NaN
```

More Examples: Column Deletion

```
# Using the previous DataFrame, we will delete a column
# using del function
import pandas as pd
d = {'one'   : pd.Series([1, 2, 3],    index=['a', 'b', 'c']),
     'two'   : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c', 'd']),
     'three' : pd.Series([10,20,30],   index=['a','b','c'])
    }
df = pd.DataFrame(d)
print ("Our dataframe is:")
print(df)

# using del function
print("Deleting the first column using DEL function:")
del df['one']
print(df)

# using pop function
print("Deleting another column using POP function:")
df.pop('two')
print(df)
```

```
Our dataframe is:
   one  two  three
a  1.0    1   10.0
b  2.0    2   20.0
c  3.0    3   30.0
d  NaN    4    NaN

Deleting the first column:
    two  three
a     1   10.0
b     2   20.0
c     3   30.0
d     4    NaN

Deleting another column:
a   10.0
b   20.0
c   30.0
d    NaN
```

More Examples: Slicing in DataFrames

```
import pandas as pd
d = {'one' : pd.Series([1, 2, 3],    index=['a', 'b', 'c']),
     'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c','d'])
    }
df = pd.DataFrame(d)
print(df[2:4])
```

```
   one    two
c  3.0    3
d  NaN    4
```

More Examples: Addition of rows

```python
import pandas as pd
d = {'one' : pd.Series([1, 2, 3],    index=['a', 'b', 'c']),
     'two' : pd.Series([1, 2, 3, 4], index=['a', 'b', 'c','d'])
    }
df = pd.DataFrame(d)
print(df)

df2 = pd.DataFrame([[5,6], [7,8]], columns = ['a', 'b'])
df = df.append(df2 )
print(df)
```

```
   one  two
a  1.0    1
b  2.0    2
c  3.0    3
d  NaN    4


   one  two    a    b
a  1.0  1.0  NaN  NaN
b  2.0  2.0  NaN  NaN
c  3.0  3.0  NaN  NaN
d  NaN  4.0  NaN  NaN
0  NaN  NaN  5.0  6.0
1  NaN  NaN  7.0  8.0
```

More Examples: Deletion of rows

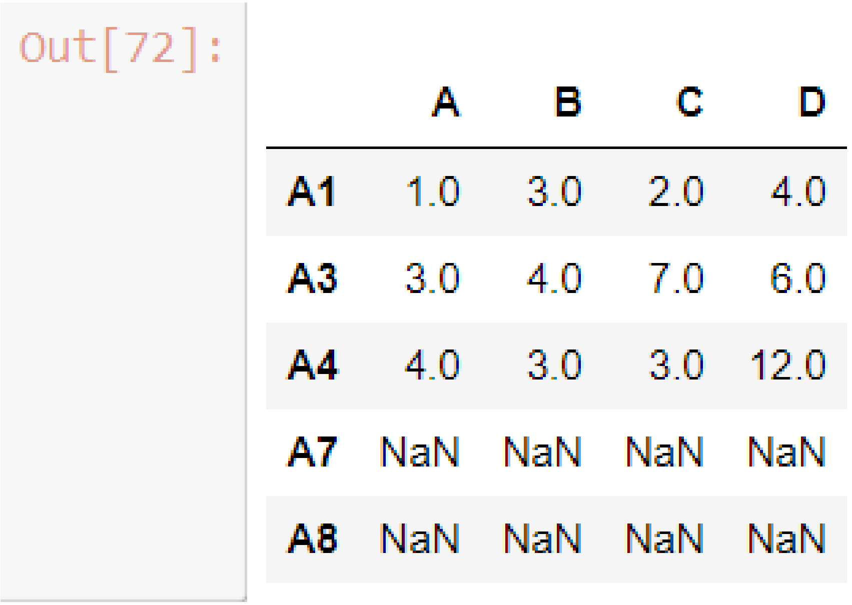
```
import pandas as pd
d = {'one':pd.Series([1, 2, 3],    index=['a','b','c']),
     'two':pd.Series([1, 2, 3, 4], index=['a','b','c','d'])
    }
df = pd.DataFrame(d)
print(df)

df2 = pd.DataFrame([[5,6], [7,8]], columns = ['a', 'b'])
df = df.append(df2 )
print(df)

df = df.drop(0)
print(df)
```

```
   one  two
a  1.0    1
b  2.0    2
c  3.0    3
d  NaN    4

   one  two    a    b
a  1.0  1.0  NaN  NaN
b  2.0  2.0  NaN  NaN
c  3.0  3.0  NaN  NaN
d  NaN  4.0  NaN  NaN
0  NaN  NaN  5.0  6.0
1  NaN  NaN  7.0  8.0

   one  two    a    b
a  1.0  1.0  NaN  NaN
b  2.0  2.0  NaN  NaN
c  3.0  3.0  NaN  NaN
d  NaN  4.0  NaN  NaN
1  NaN  NaN  7.0  8.0
```

More Examples: Reindexing

```
import pandas as pd
# Creating the first dataframe
df1 = pd.DataFrame({"A":[1, 5, 3, 4, 2],
             "B":[3, 2, 4, 3, 4],
             "C":[2, 2, 7, 3, 4],
             "D":[4, 3, 6, 12, 7]},
             index =["A1", "A2", "A3", "A4", "A5"])

# Creating the second dataframe
df2 = pd.DataFrame({"A":[10, 11, 7, 8, 5],
             "B":[21, 5, 32, 4, 6],
             "C":[11, 21, 23, 7, 9],
             "D":[1, 5, 3, 8, 6]},
             index =["A1", "A3", "A4", "A7", "A8"])

# Print the first dataframe
print(df1)
print(df2)
# find matching indexes
df1.reindex_like(df2)
```

- Pandas **`dataframe.reindex_like()`** function return an object with matching indices to myself.
- Any non-matching indexes are filled with NaN values.



Out[72]:

	A	B	C	D
A1	1.0	3.0	2.0	4.0
A3	3.0	4.0	7.0	6.0
A4	4.0	3.0	3.0	12.0
A7	NaN	NaN	NaN	NaN
A8	NaN	NaN	NaN	NaN

More Examples:
Concatenating Objects (Data Frames)

```
import pandas as pd
df1 = pd.DataFrame({'Name':['A','B'], 'SSN':[10,20], 'marks':[90, 95] })
df2 = pd.DataFrame({'Name':['B','C'], 'SSN':[25,30], 'marks':[80, 97] })
df3 = pd.concat([df1, df2])
df3
```