Programming and frameworks for ML

Python for data analyis

About Me

Big Data Consultant at Santander / Big Data Lecturer

- More than 20 years of experience in different environments, technologies, customers, countries ...
- Passionate about data and technology
- Enthusiastic about Big Data world and NoSQL

Daniel Villanueva Jiménez

Arquitecto de Datos at Santander Tecnología

Greater Madrid Metropolitan Area · 500+ connections ·

Santander Tecnología

Universidad Pontificia de Salamanca

Agenda

- Reading / Writing data
- Exploring a DataFrame
- Renaming columns
- Filtering Columns
- Filtering Rows
- Sorting Data
- Adding new columns
- Deleting Data
- Grouping Data
- Concatenating Data
- Joining Data
- Pivot Tables

Reading / Writing data

- Pandas supports the integration with many file formats or data sources out of the box (csv, excel, sql, json, parquet,…).

Reading data in text format

- The function **pd.read_csv()** allows you to read a file and store it in a DataFrame
- With the default options, files must have a header (first row) and the separator is a comma
- The file could be both on disk and on the network
- The file can be compressed!

```
pd.read_csv("Sacramento-RealEstate-Transactions.csv")

pd.read_csv("https://raw.githubusercontent.com/Sacramento-RealEstate-Transactions.csv")

pd.read_csv("Sacramento-RealEstate-Transactions.gz")
```

https://pandas.pydata.org/pandas-docs/stable/user_guide/io.html

Reading data in text format

- Sometimes the separator is something different to a comma, for example a pipe (|).
- Use the **sep** argument to change the separator

```
%%writefile input_data.txt
a|b|c|d|message
1|2|3|4|hello
5|6|7|8|world
9|10|11|12|foo
```

```
Writing input_data.txt
```

```
pd.read_csv("input_data.txt", sep = "|")
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world
2	9	10	11	12	foo

Reading data in text format

- We can use the **header** parameter to tell pandas where the header is located (None if the data don't have a header)

```
%%writefile input_data.txt
1|2|3|4|hello
5|6|7|8|world
9|10|11|12|foo
```

```
Overwriting input_data.txt
```

```
pd.read_csv("input_data.txt", sep = "|", header = None)
```

	0	1	2	3	4
0	1	2	3	4	hello
1	5	6	7	8	world
2	9	10	11	12	foo

Reading data in text format

- If the file don’t have a header we can specify the columns’ names with the **names** parameter

```
%%writefile input_data.txt
1|2|3|4|hello
5|6|7|8|world
9|10|11|12|foo
```

```
Overwriting input_data.txt
```

```
pd.read_csv("input_data.txt", sep = "|", header = None,
                names = ["a", "b", "c", "d", "names"])
```

	a	b	c	d	names
0	1	2	3	4	hello
1	5	6	7	8	world
2	9	10	11	12	foo

Reading data in text format

- The **na_values** parameter specifies the format of null values in the dataset

```
%%writefile input_data.txt
a|b|c|d|message
1|2|3|NA|hello
5|6|7|8|world
9|NA|11|12|foo
```

```
Overwriting input_data.txt
```

```
pd.read_table("input_data.txt", sep = '|', na_values=['NA'])
```

	a	b	c	d	message
0	1	2.0	3	NaN	hello
1	5	6.0	7	8.0	world
2	9	NaN	11	12.0	foo

Reading data in text format

- The **pd.read_fwf()** function allows you to read a file when the columns have fixed positions

```
%%writefile input_data.txt
a  b    c  d message
1  2 223  4 hello
5  6    7  8 world
9 10   11 12 foo
```

```
Overwriting input_data.txt
```

```
pd.read_fwf("input_data.txt")
```

	a	b	c	d	message
0	1	2	223	4	hello
1	5	6	7	8	world
2	9	10	11	12	foo

Reading data in text format

- The **colspecs** parameter allows you specify the actual positions for the columns

```
%%writefile input_data.txt
a  b  c   d   message
1  2  3   4   hello
5  6  5   8   world
9  10 11  12  foo
```

```
Overwriting input_data.txt
```

```
colspecs = [(0, 2), (3, 5), (6, 8), (13, 30)]
pd.read_fwf("input_data.txt", colspecs=colspecs)
```

	a	b	c	message
0	1	2	3	hello
1	5	6	5	world
2	9	10	11	foo

Reading data from Excel

- Pandas also allows you to read an Excel format file
- If we want to read several sheets of the same Excel file, it is convenient to first load the file in memory with the **pd.ExcelFile()** method

```
dataframe = pd.read_excel("FL_insurance_sample.xlsx")
dataframe = pd.read_excel("FL_insurance_sample.xlsx", 'FL_insurance_sample')
```

```
xlsx = pd.ExcelFile("FL_insurance_sample.xlsx")
dataframe = pd.read_excel(xlsx, 'FL_insurance_sample')
```

Reading data from a JSON file

- Using the **pd.read_json**() function, pandas will **read** data in JSON format and load it into a DataFrame

```
%%writefile input_data.json
[{"a": 1, "b": 2, "c": 3},
 {"a": 4, "b": 5, "c": 6},
 {"a": 7, "b": 8, "c": 9}]
```

```
Overwriting input_data.json
```

```
pd.read_json("input_data.json")
```

	a	b	c
0	1	2	3
1	4	5	6
2	7	8	9

Reading data from a JSON file

- An alternative is to use the **json** library with the Pandas **Dataframe** function

```
%%writefile input_data.json
{
    "name": "Wes",
    "places_lived": ["United States", "Spain", "Germany"],
    "siblings": [
        {"age": 30, "name": "Scott", "pets": ["Zeus", "Zuko"]},
        {"age": 38, "name": "Katie", "pets": ["Sixes", "Stache", "Cisco"]}
    ]
}
```

```
Overwriting input_data.json
```

```
import json

with open('input_data.json') as json_data:
    result = json.load(json_data)

pd.DataFrame(result['siblings'], columns=['name', 'age'])
```

	name	age
0	Scott	30
1	Katie	38

Reading data from a Web Service

- To get data from a web service we could use the **request** library

```
import requests
```

```
url = 'https://api.github.com/repos/pandas-dev/pandas/issues'
resp = requests.get(url)

if resp.ok:
    data = resp.json()
    dataframe = pd.DataFrame(data, columns=['number', 'title', 'labels', 'state'])

dataframe.head()
```

	number	title	labels	state
0	21649	DOC: Fix versionadded directive typos in Inter...	[{'id': 134699, 'node_id': 'MDU6TGFiZWwxMzQ2OT...	open
1	21648	API: Categorical.unique() should not drop unus...	[]	open
2	21647	addresses GH #21646	[]	open
3	21646	Test fixture datapath uses relative instead of...	[]	open
4	21645	ENH: add return_inverse to df.duplicated	[{'id': 76812, 'node_id': 'MDU6TGFiZWw3NjgxMg=...	open

https://api.github.com/repos/pandas-dev/pandas/issues

Exploring data from a Web Service

- To explore data from a web service we could use the **curl** command

```
!curl https://api.github.com/repos/pandas-dev/pandas/issues
```


```
[
  {
    "url": "https://api.github.com/repos/pandas-dev/pandas/issues/41247",
    "repository_url": "https://api.github.com/repos/pandas-dev/pandas",
    "labels_url": "https://api.github.com/repos/pandas-dev/pandas/issues/41247/labels{/name}",
    "comments_url": "https://api.github.com/repos/pandas-dev/pandas/issues/41247/comments",
    "events_url": "https://api.github.com/repos/pandas-dev/pandas/issues/41247/events",
    "html_url": "https://github.com/pandas-dev/pandas/pull/41247",
    "id": 873495489,
    "node_id": "MDExOlB1bGxSZXF1ZXN0NjI4MzAyMTg0",
    "number": 41247,
    "title": "CLN: standardize naming in core.groupby",
    "user": {
      "login": "jbrockmendel",
      "id": 8078968,
      "node_id": "MDQ6VXNlcjgwNzg5Njg=",
      "avatar_url": "https://avatars.githubusercontent.com/u/8078968?v=4",
      "gravatar_id": "",
      "url": "https://api.github.com/users/jbrockmendel",
      "html_url": "https://github.com/jbrockmendel",
      "followers_url": "https://api.github.com/users/jbrockmendel/followers",
```


Reading data from HTML

- Pandas allows to read a file with HTML format through the **read_html**() function

Politics [edit]

Main article: Politics of Minnesota

See also: List of political parties in Minnesota, United States congressional delegations from Minnesota, Minnesota's congressional districts, and Political party strength in Minnesota

Minnesota is known for a politically active citizenry, and populism has been a long-standing force among the state's political parties.[150][151] Minnesota has a consistently high voter turnout. In the 2008 U.S. presidential election, 78.2% of eligible Minnesotans voted – the highest percentage of any U.S. state – versus the national average of 61.2%.[152] Voters can register on election day at their polling places with evidence of residency.[153]

Hubert Humphrey brought national attention to the state with his address at the 1948 Democratic National Convention. Minnesotans have consistently cast their Electoral College votes for Democratic presidential candidates since 1976, longer than any other state. Minnesota is the only state in the nation that did not vote for Ronald Reagan in either of his presidential runs. Minnesota has gone for the Democratic Party in every presidential election since 1960, with the exception of 1972, when it was carried by Republican Richard Nixon.

Both the Democratic and Republican parties have major-party status in Minnesota, but its state-level Democratic party has a different name, officially known as the Minnesota Democratic-Farmer-Labor Party (DFL). It was formed out of a 1944 alliance of the Minnesota Democratic and Farmer-Labor parties.

The state has had active third-party movements. The Reform Party, now the Independence Party, was able to elect former mayor of Brooklyn Park and professional wrestler Jesse Ventura to the governorship in 1998. The

Election results from statewide races[149]

Year	Office	GOP	DFL	Others
2020	President	45.3%	**52.4%**	2.3%
	Senator	43.5%	**48.8%**	7.7%
2018	Governor	42.4%	**53.9%**	3.7%
	Senator	36.2%	**60.3%**	3.4%
	Senator	42.4%	**53.0%**	4.6%
2016	President	44.9%	**46.4%**	8.6%
2014	Governor	44.5%	**50.1%**	5.4%
	Senator	42.9%	**53.2%**	3.9%
2012	President	45.1%	**52.8%**	2.1%
	Senator	30.6%	**65.3%**	4.1%
2010	Governor	43.2%	**43.7%**	13.1%

https://en.wikipedia.org/wiki/Minnesota

Reading data from HTML

- This function returns a list of dataframes (there may be several tables on the website)

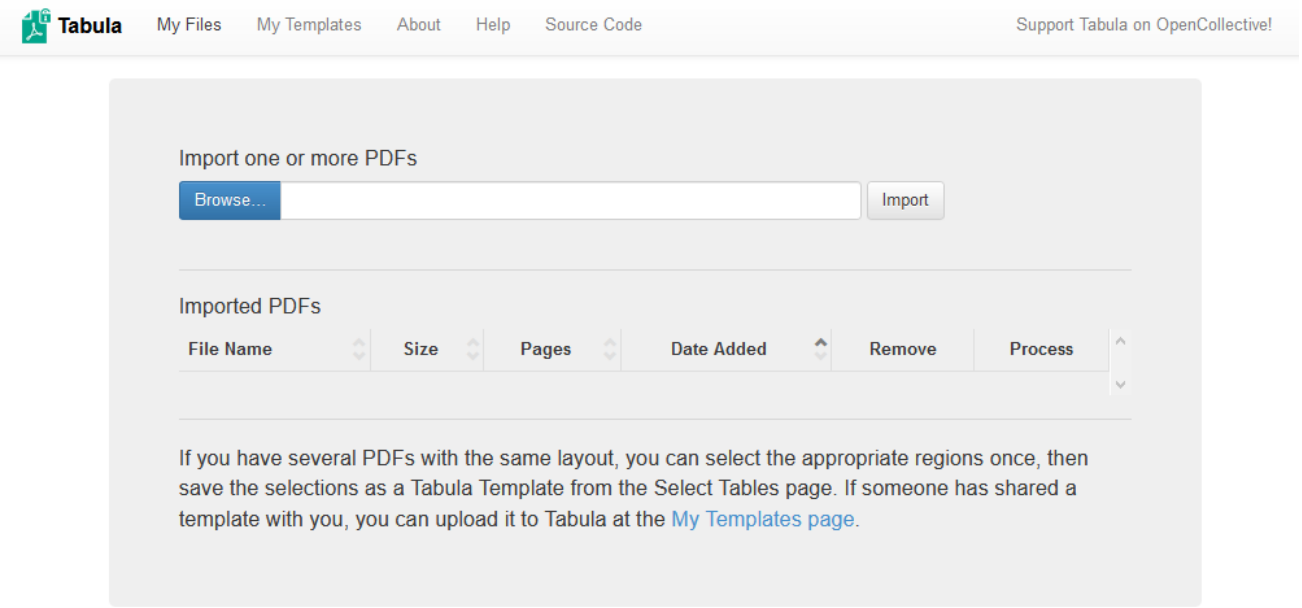
```
dataframes = pd.read_html('https://en.wikipedia.org/wiki/Minnesota',
                          match='Election results from statewide races')

dataframes[0].head(5)
```

	Year	Office	GOP	DFL	Others
0	2020	President	45.3%	52.4%	2.3%
1	2020	Senator	43.5%	48.8%	7.7%
2	2018	Governor	42.4%	53.9%	3.7%
3	2018	Senator	36.2%	60.3%	3.4%
4	2018	Senator	42.4%	53.0%	4.6%

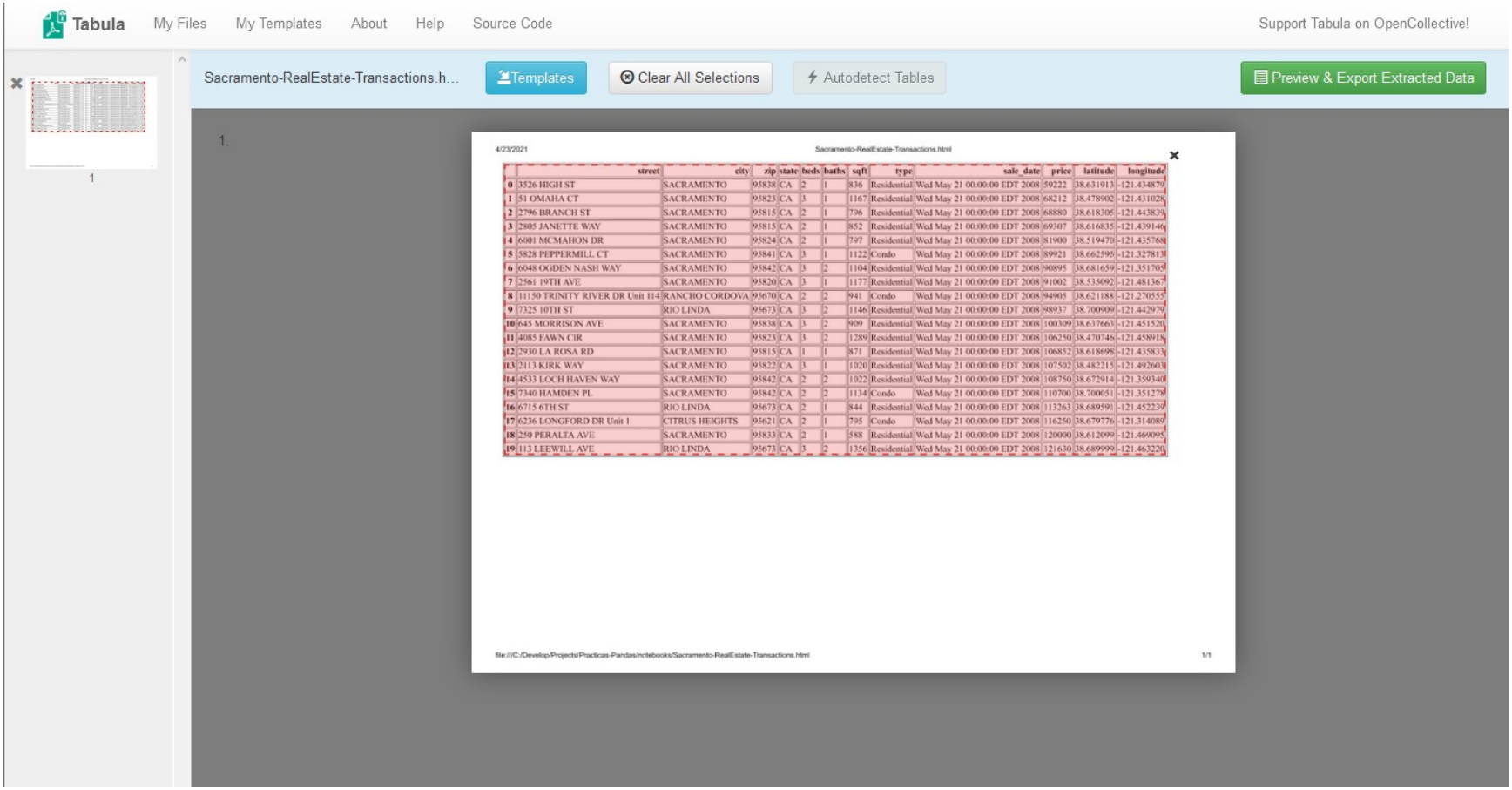
Reading data from PDF

- There are several options to read data from PDF format
- One option is to use a open source utility called **tabula** (java required)



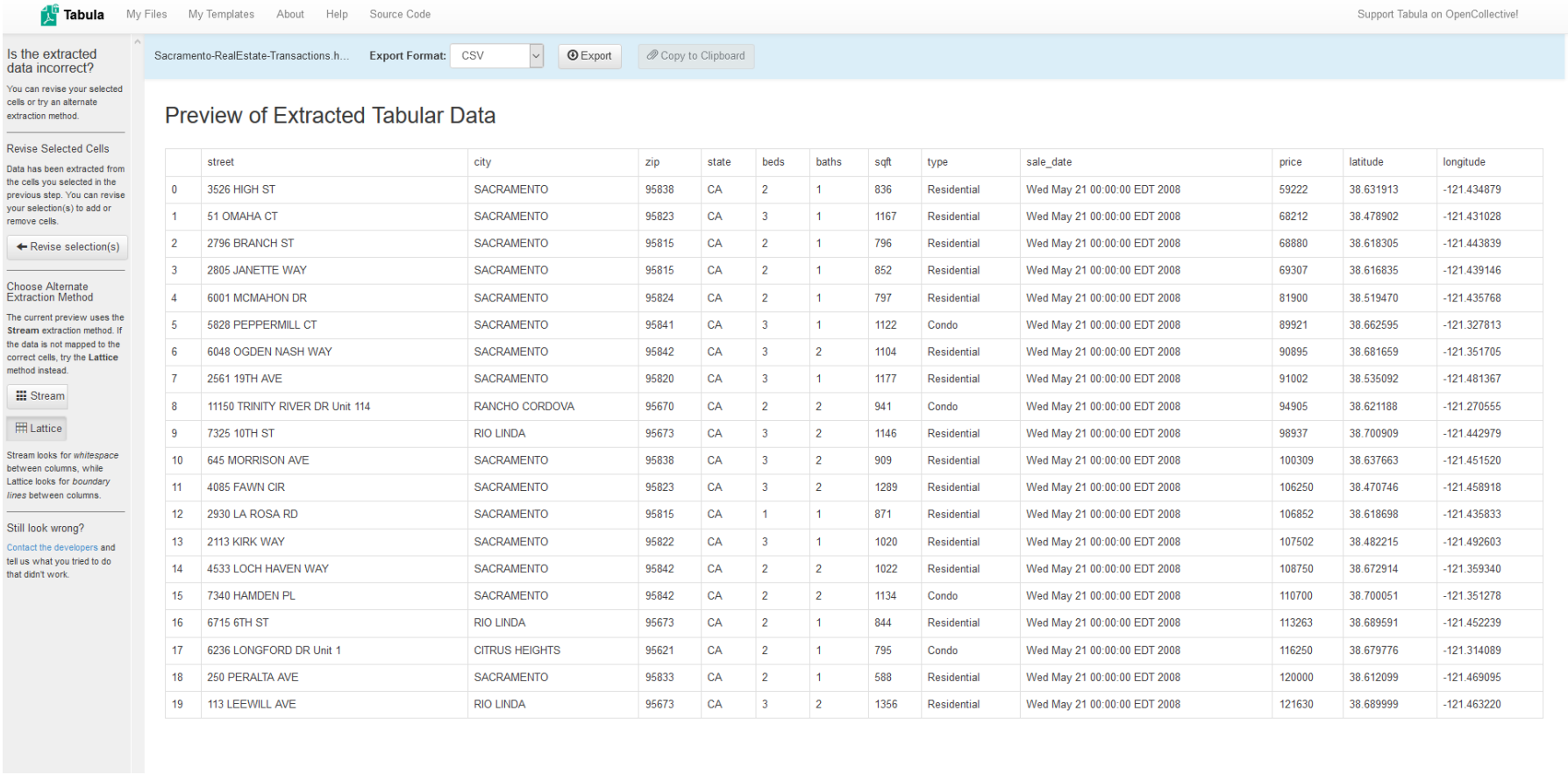
https://tabula.technology/

Reading data from PDF



	street	city	zip	state	beds	baths	sqft	type	sale_date	price	latitude	longitude
0	3526 HIGH ST	SACRAMENTO	95838	CA	2	1	836	Residential	Wed May 21 00:00:00 EDT 2008	59222	38.631913	-121.434879
1	51 OMAHA CT	SACRAMENTO	95823	CA	3	1	1167	Residential	Wed May 21 00:00:00 EDT 2008	68212	38.478902	-121.431028
2	2796 BRANCH ST	SACRAMENTO	95815	CA	2	1	796	Residential	Wed May 21 00:00:00 EDT 2008	68880	38.618305	-121.443839
3	2805 JANETTE WAY	SACRAMENTO	95815	CA	2	1	852	Residential	Wed May 21 00:00:00 EDT 2008	69307	38.616835	-121.439146
4	6001 MCMAHON DR	SACRAMENTO	95824	CA	2	1	797	Residential	Wed May 21 00:00:00 EDT 2008	81900	38.519470	-121.435768
5	5828 PEPPERMILL CT	SACRAMENTO	95841	CA	3	1	1122	Condo	Wed May 21 00:00:00 EDT 2008	89921	38.662595	-121.327813
6	6048 OGDEN NASH WAY	SACRAMENTO	95842	CA	3	2	1104	Residential	Wed May 21 00:00:00 EDT 2008	90895	38.681659	-121.351705
7	2561 19TH AVE	SACRAMENTO	95820	CA	3	1	1177	Residential	Wed May 21 00:00:00 EDT 2008	91002	38.535092	-121.481367
8	11150 TRINITY RIVER DR Unit 114	RANCHO CORDOVA	95670	CA	2	2	941	Condo	Wed May 21 00:00:00 EDT 2008	94905	38.621188	-121.270555
9	7325 10TH ST	RIO LINDA	95673	CA	3	2	1146	Residential	Wed May 21 00:00:00 EDT 2008	98937	38.700909	-121.442979
10	645 MORRISON AVE	SACRAMENTO	95838	CA	3	2	909	Residential	Wed May 21 00:00:00 EDT 2008	100309	38.637663	-121.451520
11	4085 FAWN CIR	SACRAMENTO	95823	CA	3	2	1289	Residential	Wed May 21 00:00:00 EDT 2008	106250	38.470746	-121.458918
12	2930 LA ROSA RD	SACRAMENTO	95815	CA	1	1	871	Residential	Wed May 21 00:00:00 EDT 2008	106852	38.618698	-121.435833
13	2113 KIRK WAY	SACRAMENTO	95822	CA	3	1	1020	Residential	Wed May 21 00:00:00 EDT 2008	107502	38.482215	-121.492603
14	4533 LOCH HAVEN WAY	SACRAMENTO	95842	CA	2	2	1022	Residential	Wed May 21 00:00:00 EDT 2008	108750	38.672914	-121.359340
15	7340 HAMDEN PL	SACRAMENTO	95842	CA	2	2	1134	Condo	Wed May 21 00:00:00 EDT 2008	110700	38.700051	-121.351278
16	6715 6TH ST	RIO LINDA	95673	CA	2	1	844	Residential	Wed May 21 00:00:00 EDT 2008	113263	38.689591	-121.452239
17	6236 LONGFORD DR Unit 1	CITRUS HEIGHTS	95621	CA	2	1	795	Condo	Wed May 21 00:00:00 EDT 2008	116250	38.679776	-121.314089
18	250 PERALTA AVE	SACRAMENTO	95833	CA	2	1	588	Residential	Wed May 21 00:00:00 EDT 2008	120000	38.612099	-121.469095
19	113 LEEWILL AVE	RIO LINDA	95673	CA	3	2	1356	Residential	Wed May 21 00:00:00 EDT 2008	121630	38.689999	-121.463220

Reading data from PDF



	street	city	zip	state	beds	baths	sqft	type	sale_date	price	latitude	longitude
0	3526 HIGH ST	SACRAMENTO	95838	CA	2	1	836	Residential	Wed May 21 00:00:00 EDT 2008	59222	38.631913	-121.434879
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2	2796 BRANCH ST	SACRAMENTO	95815	CA	2	1	796	Residential	Wed May 21 00:00:00 EDT 2008	68880	38.618305	-121.443839
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4	6001 MCMAHON DR	SACRAMENTO	95824	CA	2	1	797	Residential	Wed May 21 00:00:00 EDT 2008	81900	38.519470	-121.435768
5	5828 PEPPERMILL CT	SACRAMENTO	95841	CA	3	1	1122	Condo	Wed May 21 00:00:00 EDT 2008	89921	38.662595	-121.327813
6	6048 OGDEN NASH WAY	SACRAMENTO	95842	CA	3	2	1104	Residential	Wed May 21 00:00:00 EDT 2008	90895	38.681659	-121.351705
7	2561 19TH AVE	SACRAMENTO	95820	CA	3	1	1177	Residential	Wed May 21 00:00:00 EDT 2008	91002	38.535092	-121.481367
8	11150 TRINITY RIVER DR Unit 114	RANCHO CORDOVA	95670	CA	2	2	941	Condo	Wed May 21 00:00:00 EDT 2008	94905	38.621188	-121.270555
9	7325 10TH ST	RIO LINDA	95673	CA	3	2	1146	Residential	Wed May 21 00:00:00 EDT 2008	98937	38.700909	-121.442979
10	645 MORRISON AVE	SACRAMENTO	95838	CA	3	2	909	Residential	Wed May 21 00:00:00 EDT 2008	100309	38.637663	-121.451520
11	4085 FAWN CIR	SACRAMENTO	95823	CA	3	2	1289	Residential	Wed May 21 00:00:00 EDT 2008	106250	38.470746	-121.458918
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13	2113 KIRK WAY	SACRAMENTO	95822	CA	3	1	1020	Residential	Wed May 21 00:00:00 EDT 2008	107502	38.482215	-121.492603
14	4533 LOCH HAVEN WAY	SACRAMENTO	95842	CA	2	2	1022	Residential	Wed May 21 00:00:00 EDT 2008	108750	38.672914	-121.359340
15	7340 HAMDEN PL	SACRAMENTO	95842	CA	2	2	1134	Condo	Wed May 21 00:00:00 EDT 2008	110700	38.700051	-121.351278
16	6715 6TH ST	RIO LINDA	95673	CA	2	1	844	Residential	Wed May 21 00:00:00 EDT 2008	113263	38.689591	-121.452239
17	6236 LONGFORD DR Unit 1	CITRUS HEIGHTS	95621	CA	2	1	795	Condo	Wed May 21 00:00:00 EDT 2008	116250	38.679776	-121.314089
18	250 PERALTA AVE	SACRAMENTO	95833	CA	2	1	588	Residential	Wed May 21 00:00:00 EDT 2008	120000	38.612099	-121.469095
19	113 LEEWILL AVE	RIO LINDA	95673	CA	3	2	1356	Residential	Wed May 21 00:00:00 EDT 2008	121630	38.689999	-121.463220

Writing Data

- Once we have a DataFrame in memory, we could write it to disk with one of the following functions:
  - dataframe. **to_csv**("file.csv")
  - dataframe. **to_excel**("file.xlsx")
  - dataframe. **to_json**("file.json")

```
dataframe = pd.read_excel("FL_insurance_sample.xlsx")
dataframe = pd.read_excel("FL_insurance_sample.xlsx", 'FL_insurance_sample')
dataframe = pd.read_json("FL_insurance_sample.json")
```

```
xlsx = pd.ExcelWriter("file.xlsx")
dataframe1.to_excel(xlsx, 'Sheet1')
dataframe1.to_excel(xlsx, 'Sheet1', index = False)
xlsx.save()
```

Working with databases

- The **sqlalchemy** package allows you to connect to a relational database
- We have to create an **engine** to connect with the database and use the appropiate connecting string

```
import pandas as pd
from sqlalchemy import create_engine
```

```
engine = create_engine('mysql://scott:tiger@localhost/test')
engine = create_engine('postgresql://scott:tiger@localhost:5432/mydatabase')
engine = create_engine('sqlite:///:memory:', echo=False)
```

https://www.sqlalchemy.org/

Working with databases

- **pd.to_sql**() funcion allows you to save a Pandas Dataframe to the database

```
%%writefile input_data.txt
a|b|c|d|message
1|2|3|4|hello
5|6|7|8|world
9|10|11|12|foo
```

```
Overwriting input_data.txt
```

```
df = pd.read_csv("input_data.txt", sep = "|")
df
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world
2	9	10	11	12	foo

```
engine = create_engine('sqlite:///database.db', echo=False)
```

```
df.to_sql('table', engine, if_exists = 'append', index = False)
```

Note: The ‘echo’ param shows the commands sent to de Database

Working with databases

- **pd.read_sql_table**() and **pd.read_sql_query**() allow you to read data from a database to a Pandas Dataframe

```
pd.read_sql_table("table", engine)
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world
2	9	10	11	12	foo

```
pd.read_sql_query("select * from 'table' where a <= 5", engine)
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world

Working with databases

- **Jupyter** and the **ipython_sql** extension lets you work wih SQL and Pandas

```
%load_ext sql
%sql sqlite:///database.db
```

```
%%sql

select * from 'table' where a <= 5
```

```
 * sqlite:///database.db
Done.
```

a	b	c	d	message
1	2	3	4	hello
5	6	7	8	world

```
df=%sql select * from 'table' where a <= 5
```

```
 * sqlite:///database.db
Done.
```

```
df
```

a	b	c	d	message
1	2	3	4	hello
5	6	7	8	world

Pickle data format

- **Picket** is a binary **file format** for storing python objects.
- Faster than CSV (~200%) and smaller (~50%)
- Keeps the information about data types

```
df.to_pickle("data.pickle")
```

```
pd.read_pickle("data.pickle")
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world

```
df
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world

Feather data format

- **Feather** is a portable **file format** for storing data frames (from languages like Python or R)

```
import feather

feather.write_dataframe(df, 'test.feather')
feather.read_dataframe("test.feather")
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world

```
df
```

	a	b	c	d	message
0	1	2	3	4	hello
1	5	6	7	8	world

```
feather.read_dataframe("cars.feather")
```

	speed	dist
0	4.0	2.0
1	4.0	10.0
2	7.0	4.0
3	7.0	22.0
4	8.0	16.0

Feather data format

- We can save data in Python and reading the same data in R

```
library(arrow)
```

```
df <- read_feather("test.feather")
df
```

A tibble: 2 × 5

a <int>	b <int>	c <int>	d <int>	message <chr>
1	2	3	4	hello
5	6	7	8	world

```
write_feather(cars, "cars.feather")
```

```
head(cars)
```

A data.frame: 6 × 2

	speed <dbl>	dist <dbl>
1	4	2
2	4	10
3	7	4
4	7	22
5	8	16
6	9	10

Fake Data

- There are times when we need to quickly generate fake data

```
from faker import Faker

def create_rows(num=1):
    fake = Faker()
    output = [{"name":fake.name(),
               "address":fake.address(),
               "name":fake.name(),
               "email":fake.free_email(),
               "address":fake.address(),
               "city":fake.city(),
               "state":fake.state()
              } for x in range(num)]
    return output

df = pd.DataFrame(create_rows(10))
```

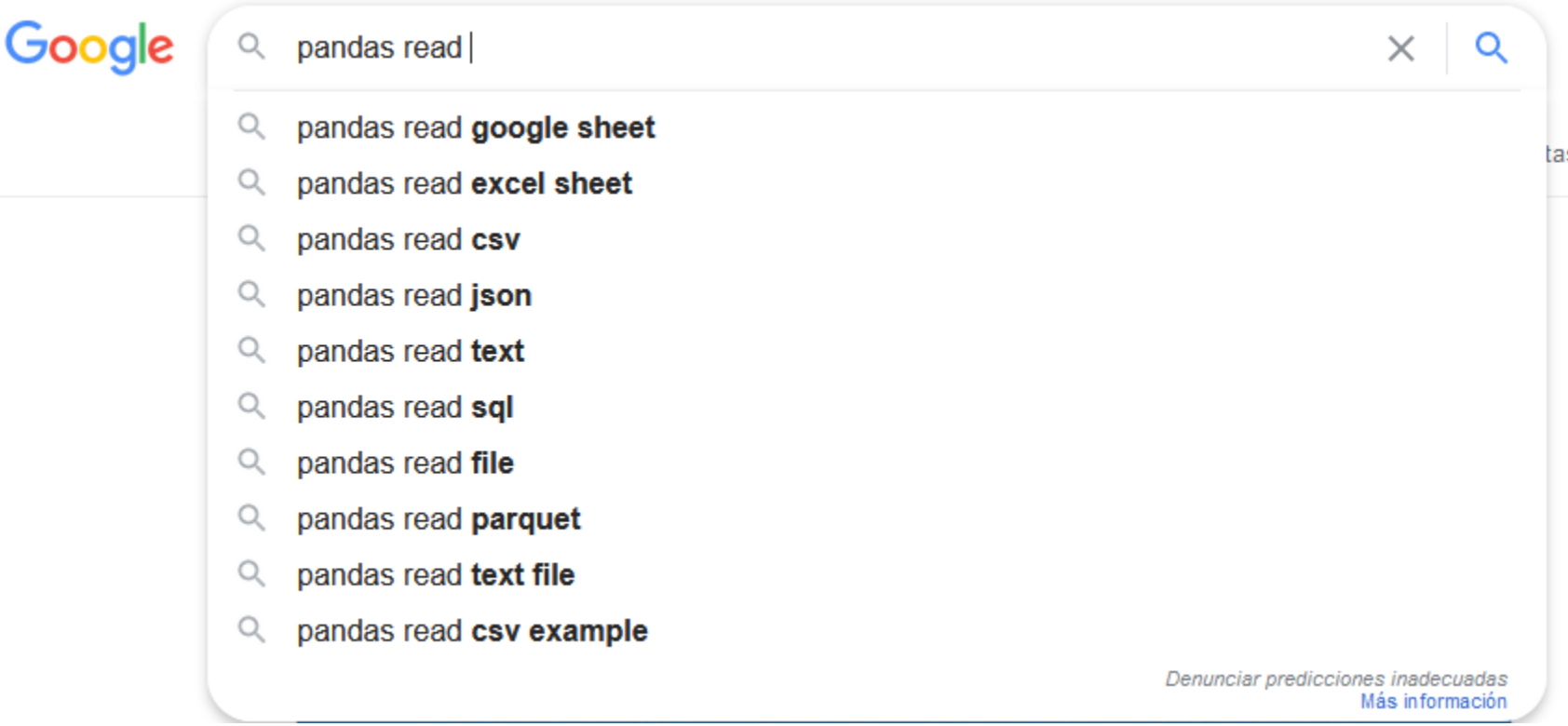
df

	name	address	email	city	state
0	Jeffrey Aguirre	PSC 6238, Box 6681\nAPO AA 79034	lisa48@gmail.com	Lake Melanie	Mississippi
1	Brenda Lewis	678 Frederick Mews\nMillershire, AR 03554	johnwells@yahoo.com	Moralesview	Nevada
2	Matthew Williams	696 Elizabeth Mission Suite 478\nLake Alicevie...	thernandez@gmail.com	North Jimmybury	Maryland
3	Michelle Powers	014 Snyder Squares Suite 211\nWest Patricia, V...	areese@yahoo.com	Foleychester	Tennessee
4	Dawn Miller	815 David Circles\nVargasberg, WY 39498	lindaday@gmail.com	East Johnbury	Tennessee
5	Katie Hale	87663 Elizabeth Circles\nGarciashire, UT 81092	garrettwilliams@hotmail.com	South Amandaberg	Louisiana
6	Thomas Clark	6942 Gallagher Squares\nHannahshire, MT 36652	mariamartinez@yahoo.com	New Sonyaton	Utah
7	Kelly Fisher	55835 Scott Circles\nKimberlyview, CT 52635	erogers@yahoo.com	North Timothyport	South Carolina
8	Sharon Castro	68617 Eric Ridge Suite 348\nNew Danahaven, PA ...	jeffreyfernandez@yahoo.com	Cassandraview	West Virginia
9	Victoria Pitts	48143 Jose Cliffs\nEast Andrew, TN 86824	nrussell@yahoo.com	Holttown	Vermont

- https://faker.readthedocs.io/

Other sources

- We can read data from practically any source



Exercise 1

- Load the information from the following url into a Dataframe called 'df1':

  https://raw.githubusercontent.com/justmarkham/DAT8/master/data/chipotle.tsv

- Load in a Dataframe called 'df2', the information of the following url:

  https://raw.githubusercontent.com/justmarkham/DAT8/master/data/u.user

	order_id	quantity	item_name	choice_description	item_price
0	1	1	Chips and Fresh Tomato Salsa	NaN	$2.39
1	1	1	Izze	[Clementine]	$3.39
2	1	1	Nantucket Nectar	[Apple]	$3.39
3	1	1	Chips and Tomatillo-Green Chili Salsa	NaN	$2.39
4	2	2	Chicken Bowl	[Tomatillo-Red Chili Salsa (Hot), [Black Beans...	$16.98

	user_id	age	gender	occupation	zip_code
0	1	24	M	technician	85711
1	2	53	F	other	94043
2	3	23	M	writer	32067
3	4	24	M	technician	43537
4	5	33	F	other	15213

Exercise 2

- Write the dataframes from the previous exercise in an excel called "Data.xlsx"
  - df1' save it on a sheet called 'chipotle' (without the index)
  - 'df2' on another sheet called 'user'

- Recover in a different DataFrame the information from the 'user' sheet of the excel file "Data.xlsx".

	user_id	age	gender	occupation	zip_code
0	1	24	M	technician	85711
1	2	53	F	other	94043
2	3	23	M	writer	32067
3	4	24	M	technician	43537
4	5	33	F	other	15213

Exercise 3

- Read the dataset “Provincias” from

https://sedeaplicaciones.minetur.gob.es/ServiciosRESTCarburantes/PreciosCarburantes/Listados/Provincias/

	IDPovincia	IDCCAA	Provincia	CCAA
0	2	7	ALBACETE	Castilla la Mancha
1	3	10	ALICANTE	Comunidad Valenciana
2	4	1	ALMERÍA	Andalucia
3	1	16	ARABA/ÁLAVA	País Vasco
4	33	3	ASTURIAS	Asturias
5	5	8	ÁVILA	Castilla y León
6	6	11	BADAJOZ	Extremadura
7	7	4	BALEARS (ILLES)	Baleares

Agenda

- Reading / Writing data
- Exploring a DataFrame
- Renaming columns
- Filtering Columns
- Filtering Rows
- Sorting Data
- Adding new columns
- Deleting Data
- Grouping Data
- Concatenating Data
- Joining Data
- Pivot Tables

Exploring a DataFrame

- **df.info**() shows summary information about the DataFrame

```
dataframe.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 32 entries, 0 to 31
Data columns (total 12 columns):
 #   Column  Non-Null Count  Dtype
---  ------  --------------  -----
 0   model   32 non-null     object
 1   mpg     32 non-null     float64
 2   cyl     32 non-null     int64
 3   disp    32 non-null     float64
 4   hp      32 non-null     int64
 5   drat    32 non-null     float64
 6   wt      32 non-null     float64
 7   qsec    32 non-null     float64
 8   vs      32 non-null     int64
 9   am      32 non-null     int64
 10  gear    32 non-null     int64
 11  carb    32 non-null     int64
dtypes: float64(5), int64(6), object(1)
memory usage: 3.1+ KB
```

Exploring a DataFrame

- **df.describe**() returns a DataFrame with statistical information of each of the numerical columns

```
dataframe.describe()
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
count	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.0000
mean	20.090625	6.187500	230.721875	146.687500	3.596563	3.217250	17.848750	0.437500	0.406250	3.687500	2.8125
std	6.026948	1.785922	123.938694	68.562868	0.534679	0.978457	1.786943	0.504016	0.498991	0.737804	1.6152
min	10.400000	4.000000	71.100000	52.000000	2.760000	1.513000	14.500000	0.000000	0.000000	3.000000	1.0000
25%	15.425000	4.000000	120.825000	96.500000	3.080000	2.581250	16.892500	0.000000	0.000000	3.000000	2.0000
50%	19.200000	6.000000	196.300000	123.000000	3.695000	3.325000	17.710000	0.000000	0.000000	4.000000	2.0000
75%	22.800000	8.000000	326.000000	180.000000	3.920000	3.610000	18.900000	1.000000	1.000000	4.000000	4.0000
max	33.900000	8.000000	472.000000	335.000000	4.930000	5.424000	22.900000	1.000000	1.000000	5.000000	8.0000

https://www.w3resource.com/pandas/dataframe/dataframe-describe.php

Exploring a DataFrame

- **df.describe**() only describe numerical columns but can be fixed with the "**include**" parameter

```
dataframe.describe(include='all')
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
count	32	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.000000	32.0000
unique	32	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
top	Honda Civic	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
freq	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
mean	NaN	20.090625	6.187500	230.721875	146.687500	3.596563	3.217250	17.848750	0.437500	0.406250	3.687500	2.8125
std	NaN	6.026948	1.785922	123.938694	68.562868	0.534679	0.978457	1.786943	0.504016	0.498991	0.737804	1.6152
min	NaN	10.400000	4.000000	71.100000	52.000000	2.760000	1.513000	14.500000	0.000000	0.000000	3.000000	1.0000
25%	NaN	15.425000	4.000000	120.825000	96.500000	3.080000	2.581250	16.892500	0.000000	0.000000	3.000000	2.0000
50%	NaN	19.200000	6.000000	196.300000	123.000000	3.695000	3.325000	17.710000	0.000000	0.000000	4.000000	2.0000
75%	NaN	22.800000	8.000000	326.000000	180.000000	3.920000	3.610000	18.900000	1.000000	1.000000	4.000000	4.0000
max	NaN	33.900000	8.000000	472.000000	335.000000	4.930000	5.424000	22.900000	1.000000	1.000000	5.000000	8.0000

Exploring a DataFrame

- **describe**() function can be applied to a **Serie**
- Returns different information depending on the type of the Serie

```
dataframe.mpg.describe()
```

```
count    32.000000
mean     20.090625
std       6.026948
min      10.400000
25%      15.425000
50%      19.200000
75%      22.800000
max      33.900000
Name: mpg, dtype: float64
```

```
pd.Series(["Value1", "Value2"]).describe()
```

```
count          2
unique         2
top       Value1
freq           1
dtype: object
```

Exploring a DataFrame

- **df.corr**() returns a DataFrame with the result of applying the correlation function in each of the numerical columns (all with all)

```
dataframe.corr()
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
mpg	1.000000	-0.852162	-0.847551	-0.776168	0.681172	-0.867659	0.418684	0.664039	0.599832	0.480285	-0.550925
cyl	-0.852162	1.000000	0.902033	0.832447	-0.699938	0.782496	-0.591242	-0.810812	-0.522607	-0.492687	0.526988
disp	-0.847551	0.902033	1.000000	0.790949	-0.710214	0.887980	-0.433698	-0.710416	-0.591227	-0.555569	0.394977
hp	-0.776168	0.832447	0.790949	1.000000	-0.448759	0.658748	-0.708223	-0.723097	-0.243204	-0.125704	0.749812
drat	0.681172	-0.699938	-0.710214	-0.448759	1.000000	-0.712441	0.091205	0.440278	0.712711	0.699610	-0.090790
wt	-0.867659	0.782496	0.887980	0.658748	-0.712441	1.000000	-0.174716	-0.554916	-0.692495	-0.583287	0.427606
qsec	0.418684	-0.591242	-0.433698	-0.708223	0.091205	-0.174716	1.000000	0.744535	-0.229861	-0.212682	-0.656249
vs	0.664039	-0.810812	-0.710416	-0.723097	0.440278	-0.554916	0.744535	1.000000	0.168345	0.206023	-0.569607
am	0.599832	-0.522607	-0.591227	-0.243204	0.712711	-0.692495	-0.229861	0.168345	1.000000	0.794059	0.057534
gear	0.480285	-0.492687	-0.555569	-0.125704	0.699610	-0.583287	-0.212682	0.206023	0.794059	1.000000	0.274073
carb	-0.550925	0.526988	0.394977	0.749812	-0.090790	0.427606	-0.656249	-0.569607	0.057534	0.274073	1.000000

Exploring a DataFrame

- Using the Python visualization tools we could visualize the correlation matrix

```
corr = dataframe.corr()
corr.style.background_gradient(cmap='coolwarm')
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
mpg	1.000000	-0.852162	-0.847551	-0.776168	0.681172	-0.867659	0.418684	0.664039	0.599832	0.480285	-0.550925
cyl	-0.852162	1.000000	0.902033	0.832447	-0.699938	0.782496	-0.591242	-0.810812	-0.522607	-0.492687	0.526988
disp	-0.847551	0.902033	1.000000	0.790949	-0.710214	0.887980	-0.433698	-0.710416	-0.591227	-0.555569	0.394977
hp	-0.776168	0.832447	0.790949	1.000000	-0.448759	0.658748	-0.708223	-0.723097	-0.243204	-0.125704	0.749812
drat	0.681172	-0.699938	-0.710214	-0.448759	1.000000	-0.712441	0.091205	0.440278	0.712711	0.699610	-0.090790
wt	-0.867659	0.782496	0.887980	0.658748	-0.712441	1.000000	-0.174716	-0.554916	-0.692495	-0.583287	0.427606
qsec	0.418684	-0.591242	-0.433698	-0.708223	0.091205	-0.174716	1.000000	0.744535	-0.229861	-0.212682	-0.656249
vs	0.664039	-0.810812	-0.710416	-0.723097	0.440278	-0.554916	0.744535	1.000000	0.168345	0.206023	-0.569607
am	0.599832	-0.522607	-0.591227	-0.243204	0.712711	-0.692495	-0.229861	0.168345	1.000000	0.794059	0.057534
gear	0.480285	-0.492687	-0.555569	-0.125704	0.699610	-0.583287	-0.212682	0.206023	0.794059	1.000000	0.274073
carb	-0.550925	0.526988	0.394977	0.749812	-0.090790	0.427606	-0.656249	-0.569607	0.057534	0.274073	1.000000

Exploring a DataFrame

- **df.head**() returns the first rows of the DataFrame
- We can specify the number of rows

```
dataframe.head()
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
0	Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
1	Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
2	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
3	Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
4	Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2

```
dataframe.head(1)
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
0	Mazda RX4	21.0	6	160.0	110	3.9	2.62	16.46	0	1	4	4

Exploring a DataFrame

- **df.head**() is similar to the **LIMIT** clause in SQL

```
select *
from tabla
limit 5
```

Exploring a DataFrame

- **df.tail**() returns the last rows of the DataFrame
- We can specify the number of rows

```
dataframe.tail()
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
27	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.9	1	1	5	2
28	Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.5	0	1	5	4
29	Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.5	0	1	5	6
30	Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.6	0	1	5	8
31	Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.6	1	1	4	2

```
dataframe.tail(1)
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
31	Volvo 142E	21.4	4	121.0	109	4.11	2.78	18.6	1	1	4	2

Obtain a data sample

- **df.sample()** returns a sample of the Dataframe

```
dataframe.sample(2)
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
11	Merc 450SE	16.4	8	275.8	180	3.07	4.07	17.40	0	0	3	3
5	Valiant	18.1	6	225.0	105	2.76	3.46	20.22	1	0	3	1

Obtain a data sample

- If we want always the same sample we have to set the **random_state** parameter

```
dataframe.sample(2, random_state= 1000)
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
6	Duster 360	14.3	8	360.0	245	3.21	3.57	15.84	0	0	3	4
26	Porsche 914-2	26.0	4	120.3	91	4.43	2.14	16.70	0	1	5	2

```
dataframe.sample(2, random_state= 1000)
```

	model	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
6	Duster 360	14.3	8	360.0	245	3.21	3.57	15.84	0	0	3	4
26	Porsche 914-2	26.0	4	120.3	91	4.43	2.14	16.70	0	1	5	2

Exercise 4 (1/2)

- Load the league data that is in an Excel file called "LigaBBVA_20170329.xlsx" and load it into a variable called ‘liga’

	#	Equipo	PJ	V	E	D	GF	GC	PTS
0	0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0
3	3	Sevilla	28.0	17.0	6.0	5.0	52.0	34.0	57.0
4	4	Atlético Madrid	28.0	16.0	7.0	5.0	52.0	23.0	55.0
5	5	Villarreal	28.0	13.0	9.0	6.0	39.0	20.0	48.0
6	6	Real Sociedad	28.0	15.0	3.0	10.0	42.0	39.0	48.0
7	7	Ath. Bilbao	28.0	13.0	5.0	10.0	35.0	32.0	44.0
8	8	Eibar	28.0	11.0	8.0	9.0	44.0	39.0	41.0
9	9	RCD Espanyol	28.0	10.0	10.0	8.0	40.0	39.0	40.0

Exercise 4 (2/2)

- Display information about the Dataframe
- Describe all the dataset's columns
- Show the first 3 rows
- Show the last 2 rows
- Show a sample of 4 rows
- Check if any of the columns correlate with any other

Common operations in a Dataframe

- Pandas has a set of methods to perform lots of operations over a dataset to analyze and manipulate the data
- All these functions have in common is that they **do not modify** the dataframe, but return another dataframe
- This allows concatenate operations until the required result is achieved

Agenda

- Reading / Writing data
- Exploring a DataFrame
- Renaming columns
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- Concatenating Data
- Joining Data
- Pivot Tables

Rename columns

- This operation lets us **rename columns** in our dataset

```
select columna as "NewName"
from tabla
```

Rename columns

- The **rename()** method allows you to rename the column index of a Dataframe

```
dataframe = dataframe.rename(columns = {'C1' : 'Country',
                                        'C2' : 'Year',
                                        'C3' : 'Cases',
                                        'C4' : 'Population'})
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

	C1	C2	C3	C4
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Rename columns

- We could use a **lambda function** to make a transformation in the actual column names

```
[6]  dataframe.rename(columns = lambda column : column.lower())
```

	country	year	cases	population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

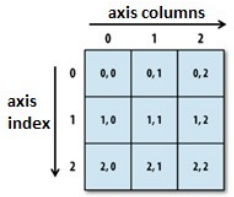
Rename columns

- Another option is use **set_axis()** method to rename the dataset with a list of columns

```
dataframe.set_axis(['Country', 'Year', 'Cases', 'Population'],
                   axis = 'columns')
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	C1	C2	C3	C4
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583



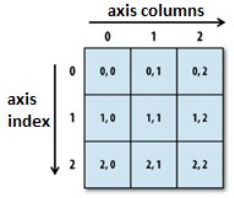
Rename columns

- There are certain cases where the header is a row from the dataset itself
- We have to drop the row with the header after the dataset is renamed

```
(dataframe
    .set_axis(dataframe.iloc[0], axis = 'columns')
    .drop(0)
)
```

	Country	Year	Cases	Population
1	Afghanistan	1999	745	19987071
2	Afghanistan	2000	2666	20595360
3	Brazil	1999	37737	172006362
4	Brazil	2000	80488	174504898
5	China	1999	212258	1272815272
6	China	2000	213766	1280428583

	C1	C2	C3	C4
0	Country	Year	Cases	Population
1	Afghanistan	1999	745	19987071
2	Afghanistan	2000	2666	20595360
3	Brazil	1999	37737	172006362
4	Brazil	2000	80488	174504898
5	China	1999	212258	1272815272
6	China	2000	213766	1280428583



Exercise 5

- About the DataFrame “liga”:
- Rename the name of the columns making sure they are materialized in the dataset

Antes	Después
#	Puesto
PJ	PartidosJugados
V	Victorias
E	Empates
D	Derrotas
GF	GolesFavor
GC	GolesContra
PTS	Puntos

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos
0	0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0
3	3	Sevilla	28.0	17.0	6.0	5.0	52.0	34.0	57.0

Exercise 6

- About the DataFrame “liga":
- Rename the columns to convert them to capital letters (but do not materialize it in the DataFrame)

	PUESTO	EQUIPO	PARTIDOSJUGADOS	VICTORIAS	EMPATES	DERROTAS	GOLESFAVOR	GOLESCONTRA	PUNTOS
0	0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0

Agenda

- Reading / Writing data
- Exploring a DataFrame
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- Grouping Data
- Concatenating Data
- Joining Data
- Pivot Tables

Column Selection

- This operation lets us **filter columns** in our dataset

```
SELECT column1, column2
FROM table
```

Column Selection

- The **filter**() function is used to Subset rows or columns of the dataframe according to labels in the specified index.

```
dataframe.filter(["Country", "Year"])
```

	Country	Year
0	Afghanistan	1999
1	Afghanistan	2000
2	Brazil	1999
3	Brazil	2000
4	China	1999
5	China	2000

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Column Selection

- The **filter**() function can be used to **reorder** the columns …

```
dataframe.filter(["Cases", "Population", "Country", "Year"])
```

	Cases	Population	Country	Year
0	745	19987071	Afghanistan	1999
1	2666	20595360	Afghanistan	2000
2	37737	172006362	Brazil	1999
3	80488	174504898	Brazil	2000
4	212258	1272815272	China	1999
5	213766	1280428583	China	2000

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Column Selection

- The **filter**() function admits a regular expresion instead a list of columns

```
dataframe.filter(regex= "^C")
```

	Country	Cases
0	Afghanistan	745
1	Afghanistan	2666
2	Brazil	37737
3	Brazil	80488
4	China	212258
5	China	213766

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Selecting unique values

- This operation lets us select **distinct values** in the columns of our dataset

```
select distinct column1, column2
from table
```

Selecting unique values

- To select unique values we have to use the df.**drop_duplicates()** function

```
(
 dataframe
    .filter(["Year", "Cases"])
    .drop_duplicates()
)
```

	Year	Cases
0	1999	745
1	2000	2666
3	2000	80488
4	1999	212258
5	2000	213766

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	745	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

```
select distinct Country
from dataset
```

Selecting unique values

- We can select one or more columns

```
dataframe.filter(["Year", "Cases"]) \
    .drop_duplicates()
```

	Year	Cases
0	1999	745
1	2000	2666
3	2000	80488
4	1999	212258
5	2000	213766

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	745	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

```
select distinct Year, Cases
from dataset
```

Exercise 7 (1/2)

- About the DataFrame “liga":
- Select the “Puesto" and "Puntos" columns. Limit to 3 rows

	Puesto	Puntos
0	1	65.0
1	2	63.0
2	3	57.0

- Select all the columns with “Puesto" and "Puntos“ using a regex

	PartidosJugados	GolesFavor	GolesContra
0	NaN	NaN	NaN
1	27.0	71.0	28.0
2	28.0	81.0	25.0
3	28.0	52.0	34.0
4	28.0	52.0	23.0

Exercise 7 (1/2)

- Select unique values of “PartidosJugados” and “Empates” columns

	PartidosJugados	Empates
0	27.0	5.0
1	28.0	6.0
3	28.0	7.0
4	28.0	9.0
5	28.0	3.0
6	28.0	5.0
7	28.0	8.0
8	28.0	10.0

Agenda

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Row filtering

- This operation lets us **filter rows** in our dataset

```
select *
from tabla
where columna = 'A'
```

Row filtering

- The **query()** function allows you to filter the rows of a Dataframe in the same way that the **WHERE** clause in a **SQL** statement does

```
dataframe.query("Country == 'China' or Year == 1999")
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
2	Brazil	1999	37737	172006362
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

```
dataframe.query("Year not in (2000, 2001)")
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
2	Brazil	1999	37737	172006362
4	China	1999	212258	1272915272

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

http://jose-coto.com/query-method-pandas

Row filtering

- Note that you have to use a backslash (\) with multiline querys

```
dataframe.query("Country == 'China' \
    or Year == 1999")
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
2	Brazil	1999	745	172006362
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Row filtering

- The **query()** function don't work with NULL expresions (at this very moment) but you can use **isnull**() or **notnull**() function

```
dataframe.query("Year is not NULL")
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
/usr/local/lib/python3.6/dist-packages/pandas/core/computation/scope.py in resolve(self, key, is_local)
    187             if self.has_resolvers:
--> 188                 return self.resolvers[key]
    189

                                22 frames
KeyError: 'NULL'

During handling of the above exception, another exception occurred:

KeyError                                  Traceback (most recent call last)
KeyError: 'NULL'

The above exception was the direct cause of the following exception:

UndefinedVariableError                    Traceback (most recent call last)
/usr/local/lib/python3.6/dist-packages/pandas/core/computation/scope.py in resolve(self, key, is_local)
    202                 from pandas.core.computation.ops import UndefinedVariableError
    203
--> 204                 raise UndefinedVariableError(key, is_local) from err
    205
    206     def swapkey(self, old_key: str, new_key: str, new_value=None):

UndefinedVariableError: name 'NULL' is not defined

SEARCH STACK OVERFLOW
```

Row filtering

- You can include any Pandas function in a query
- For older versions of Pandas (< 1.2) the parameter engine="python" is required.

```
dataframe.query("Year == 1999 \
    and Country.isin(['China']) \
    and Population.between(0, 3272815272) \
    and Cases.notnull()")
```

	Country	Year	Cases	Population
4	China	1999	212258	1272815272

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

https://pandas.pydata.org/pandas-docs/stable/reference/series.html

String Columns

- Pandas provides lots of vectorized string functions for string columns
- All these functions are available throw the **str** property

```
dataframe.query("Country.str.contains('^C') \
    and Country.str.len() == 5")
```

	Country	Year	Cases	Population
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Date Columns

- It is posible compare a date column with a string literal with a specific format (‘YYYY-MM-DD’ or ‘YYYY-MM-DD HH:MM:DD’)
- A datetime column has the **dt** property to access individual components of a date

```
dataframe.query("Year >= '1999-06-01 04:33:22' \
    and Year == '2000-01-01' \
    and Year.dt.month == 1  \
    and Year.between('2000-01-01', '2003-03-01')")
```

	Country	Year	Cases	Population
1	Afghanistan	2000-01-01	2666	20595360
3	Brazil	2000-01-01	80488	174504898
5	China	2000-01-01	213766	1280428583

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999-01-01	745	19987071
1	Afghanistan	2000-01-01	2666	20595360
2	Brazil	1999-01-01	37737	172006362
3	Brazil	2000-01-01	80488	174504898
4	China	1999-01-01	212258	1272815272
5	China	2000-01-01	213766	1280428583

Slices

- We could select a subset of rows specifying a **slice** (two integer numbers separated by a colon) directly or using the **iloc** method

```
dataframe[4:]
```

	Country	Year	Cases	Population
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

```
dataframe.iloc[4:]
```

	Country	Year	Cases	Population
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Exercise 8

- About the DataFrame “liga":
- Search rows for Real Madrid and Barcelona

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0

- Search rows whose ‘Puesto’ is less than or equal to 2 or more than or equal to 20

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos
0	0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0
20	20	Osasuna	28.0	1.0	8.0	19.0	28.0	67.0	11.0

Exercise 9

- Search rows with the ‘Equipo’ field is NULL

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos
0	0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

- Search rows whose ‘Victorias’ are greater than or equal to 18 and the ‘Goles Favor’ are greater than 60

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0

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- Pivot Tables

Ordering rows

- This operation lets us **sort rows** in our dataset

```
SELECT column1, column2
FROM table
ORDER BY column1
```

Ordering rows

- The **sort_values**() function allows you to **sort** through the values of the DataFrame

```
dataframe.sort_values("Population")
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

```
dataframe.sort_values(["Country","Year"])
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Ordering rows

- The **ascending** parameter allows you to set the ascending / descending order

```
dataframe.sort_values(["Year","Country"],
                      ascending = [False, True])
```

	Country	Year	Cases	Population
1	Afghanistan	2000	2666	20595360
3	Brazil	2000	80488	174504898
5	China	2000	213766	1280428583
0	Afghanistan	1999	745	19987071
2	Brazil	1999	37737	172006362
4	China	1999	212258	1272915272

```
dataframe.sort_values(["Country","Year"],
                      ascending = [False, False])
```

	Country	Year	Cases	Population
5	China	2000	213766	1280428583
4	China	1999	212258	1272915272
3	Brazil	2000	80488	174504898
2	Brazil	1999	37737	172006362
1	Afghanistan	2000	2666	20595360
0	Afghanistan	1999	745	19987071

Exercise 10

- About the dataframe “league”
- Sort the Dataframe by “Puesto” (Descending)

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos
20	20	Osasuna	28.0	1.0	8.0	19.0	28.0	67.0	11.0
19	19	Granada	28.0	4.0	7.0	17.0	25.0	58.0	19.0

- Sort the DataFrame by the ‘PartidosJugados’ (Ascending), ‘Victorias’ (Descending) and ‘GolesFavor’ (Ascending) columns

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0
11	11	Celta de Vigo	27.0	11.0	5.0	11.0	40.0	45.0	38.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0
3	3	Sevilla	28.0	17.0	6.0	5.0	52.0	34.0	57.0
4	4	Atlético Madrid	28.0	16.0	7.0	5.0	52.0	23.0	55.0

Agenda

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- Deleting Data
- Grouping Data
- Concatenating Data
- Joining Data
- Pivot Tables

Change columns, or add new ones

- This operation lets us **add** new columns or **change** existings ones in our dataset

```
SELECT column1, column2,
       column1 + column2 as new_column
FROM table
```

Change columns, or add new ones

- The **assign**() function makes easier adding new columns to our dataset

```
SELECT column1, column2,
       column1 + column2 as new_column
FROM table
```

```
dataframe.assign(Id = range(len(dataframe)),
                 Id1 = 1)
```

	Country	Year	Cases	Population	Id	Id1
0	Afghanistan	1999	745	19987071	0	1
1	Afghanistan	2000	2666	20595360	1	1
2	Brazil	1999	37737	172006362	2	1
3	Brazil	2000	80488	174504898	3	1
4	China	1999	212258	1272815272	4	1
5	China	2000	213766	1280428583	5	1

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

Change columns, or add new ones

- It even allows us to change existing columns in our dataset

```
dataframe.assign(Year = dataframe.Year + 100)
```

	Country	Year	Cases	Population	Id	Id1
0	Afghanistan	2099	745	19987071	0	1
1	Afghanistan	2100	2666	20595360	1	1
2	Brazil	2099	37737	172006362	2	1
3	Brazil	2100	80488	174504898	3	1
4	China	2099	212258	1272815272	4	1
5	China	2100	213766	1280428583	5	1

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

```
dataframe.Year + 100
```

```
0    2099
1    2100
2    2099
3    2100
4    2099
5    2100
Name: Year, dtype: int64
```

Change columns, or add new ones

- We can use a **lambda** function or anything that returns a Serie

```
dataframe.assign(
    CasesPlusOne = dataframe.Cases + 1,
    CasesByPopulation = lambda row : row.Cases / row.Population
)
```

	Country	Year	Cases	Population	CasesPlusOne	CasesByPopulation
0	Afghanistan	1999-01-01	745	19987071	746	0.000037
1	Afghanistan	2000-01-01	2666	20595360	2667	0.000129
2	Brazil	1999-01-01	37737	172006362	37738	0.000219
3	Brazil	2000-01-01	80488	174504898	80489	0.000461
4	China	1999-01-01	212258	1272815272	212259	0.000167
5	China	2000-01-01	213766	1280428583	213767	0.000167

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

Change columns, or add new ones

- **Lambda** functions facilitates you concatentate operations in a dataframe

```
(
 dataframe
    .assign(CasesPlusOne = dataframe.Cases + 1)
    .assign(CasesMinusOne = lambda row : row.CasesPlusOne - 1)
)
```

	Country	Year	Cases	Population	CasesPlusOne	CasesMinusOne
0	Afghanistan	1999-01-01	745	19987071	746	745
1	Afghanistan	2000-01-01	2666	20595360	2667	2666
2	Brazil	1999-01-01	37737	172006362	37738	37737
3	Brazil	2000-01-01	80488	174504898	80489	80488
4	China	1999-01-01	212258	1272815272	212259	212258
5	China	2000-01-01	213766	1280428583	213767	213766

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

Change columns, or add new ones

- We can **only** use vectorized functions

```
dataframe.assign(
    CountryHash = hash(dataframe.Country)
)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-61-0b6c96b7446e> in <module>
      1 dataframe.assign(
----> 2     CountryHash = hash(dataframe.Country)
      3 )

c:\users\daniel\.virtualenvs\practicas-pandas-cjitosop\lib\site-packages\pan
   1783
   1784     def __hash__(self) -> int:
-> 1785         raise TypeError(
   1786             f"{repr(type(self).__name__)} objects are mutable, "
   1787             f"thus they cannot be hashed"

TypeError: 'Series' objects are mutable, thus they cannot be hashed
```

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

```
print(hash("Afghanistan"))
```

```
-1794632447089383926
```

Change columns, or add new ones

- **np.vectorize()** lets us to convert any python function into a vectorized one

```
hashed = np.vectorize(lambda x: hash(x))
dataframe.assign(
    CountryHash = hashed(dataframe.Country)
)
```

	Country	Year	Cases	Population	Id	Id1	CountryHash
0	Afghanistan	1999	745	19987071	0	1	7416641866878524706
1	Afghanistan	2000	2666	20595360	1	1	7416641866878524706
2	Brazil	1999	37737	172006362	2	1	-5670732118295316485
3	Brazil	2000	80488	174504898	3	1	-5670732118295316485
4	China	1999	212258	1272815272	4	1	9070864174946750906
5	China	2000	213766	1280428583	5	1	9070864174946750906

```
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

```
print(hash("Afghanistan"))
```

```
-1794632447089383926
```

Calculating Trends

- Calculating trends is common when we have a time serie

```
np.random.seed(seed=100)

time_serie = pd.DataFrame(
    {
        'Date' : pd.date_range(start = '2020-01-01', end = '2020-01-05', freq = 'D'),
        'Value' : np.random.randint(100, size = 5)
    }
)
```

```
time_serie
```

	Date	Value
0	2020-01-01	8
1	2020-01-02	24
2	2020-01-03	67
3	2020-01-04	87
4	2020-01-05	79

Calculating Trends

- The **shift()** function calculates the previous (or subsequent) value in the time serie

```
time_serie.assign(
    PreviousValue = lambda row : row.Value.shift(1),
    Increment = lambda row : row.Value - row.Value.shift(1),

)
```

	Date	Value	PreviousValue	Increment
0	2020-01-01	8	NaN	NaN
1	2020-01-02	24	8.0	16.0
2	2020-01-03	67	24.0	43.0
3	2020-01-04	87	67.0	20.0
4	2020-01-05	79	87.0	-8.0

Date Columns

- A datetime column has the **dt** property to access individual components of a date

```
df.assign(
    year = df.DoB.dt.year,
    month = df.DoB.dt.month,
    day = df.DoB.dt.day,
    week = df.DoB.dt.isocalendar().week,
    dayofweek = df.DoB.dt.dayofweek,
    is_leap_year = df.DoB.dt.is_leap_year
)
```

	name	DoB	year	month	day	week	dayofweek	is_leap_year
0	Tom	1997-08-05	1997	8	5	32	1	False
1	Andy	1996-04-28	1996	4	28	17	6	True
2	Lucas	1995-12-16	1995	12	16	50	5	False

```
df
```

	name	DoB
0	Tom	1997-08-05
1	Andy	1996-04-28
2	Lucas	1995-12-16

Exercise 11 (1/2)

- On the DataFrame “liga”, create the following columns:
- ‘DiferenciaGoles’= ‘GolesFavor’ minus ‘GolesContra’
- ‘PorcentajeGoles’ = ‘GolesFavor’ / Sum of the ‘GolesFavor’ of all the teams
- PercentageVictorias = Victories / Matches Played
- Materialize this new columns on the dataset

Exercise 11 (2/2)

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos	DiferenciaGoles	PorcentajeGoles	PorcentajeVictorias
0	0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0	43.0	0.087871	0.740741
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0	56.0	0.100248	0.678571
3	3	Sevilla	28.0	17.0	6.0	5.0	52.0	34.0	57.0	18.0	0.064356	0.607143
4	4	Atlético Madrid	28.0	16.0	7.0	5.0	52.0	23.0	55.0	29.0	0.064356	0.571429
5	5	Villarreal	28.0	13.0	9.0	6.0	39.0	20.0	48.0	19.0	0.048267	0.464286
6	6	Real Sociedad	28.0	15.0	3.0	10.0	42.0	39.0	48.0	3.0	0.051980	0.535714
7	7	Ath. Bilbao	28.0	13.0	5.0	10.0	35.0	32.0	44.0	3.0	0.043317	0.464286
8	8	Eibar	28.0	11.0	8.0	9.0	44.0	39.0	41.0	5.0	0.054455	0.392857
9	9	RCD Espanyol	28.0	10.0	10.0	8.0	40.0	39.0	40.0	1.0	0.049505	0.357143
10	10	Alavés	28.0	10.0	10.0	8.0	29.0	33.0	40.0	-4.0	0.035891	0.357143
11	11	Celta de Vigo	27.0	11.0	5.0	11.0	40.0	45.0	38.0	-5.0	0.049505	0.407407
12	12	U. D. Las Palmas	28.0	9.0	8.0	11.0	44.0	45.0	35.0	-1.0	0.054455	0.321429
13	13	Betis	28.0	8.0	7.0	13.0	31.0	44.0	31.0	-13.0	0.038366	0.285714
14	14	Valencia C. F.	28.0	8.0	6.0	14.0	38.0	51.0	30.0	-13.0	0.047030	0.285714
15	15	Málaga	28.0	6.0	9.0	13.0	33.0	45.0	27.0	-12.0	0.040842	0.214286
16	16	Deportivo	28.0	6.0	9.0	13.0	31.0	43.0	27.0	-12.0	0.038366	0.214286
17	17	Leganés	28.0	6.0	8.0	14.0	22.0	41.0	26.0	-19.0	0.027228	0.214286
18	18	Sporting Gijón	28.0	5.0	6.0	17.0	31.0	57.0	21.0	-26.0	0.038366	0.178571
19	19	Granada	28.0	4.0	7.0	17.0	25.0	58.0	19.0	-33.0	0.030941	0.142857
20	20	Osasuna	28.0	1.0	8.0	19.0	28.0	67.0	11.0	-39.0	0.034653	0.035714

Exercise 12 (1/2)

- On the DataFrame “liga", create the following columns:
- DiferenciaPuntos = Difference in ‘Puntos’ between a team and the team immediately below it in the ranking (series.shift(n))
- Temporada = "2016-2017”
- Materialize this new columns on the dataset

Exercise 12 (2/2)

	Puesto	Equipo	Puntos	DiferenciaPuntos	Temporada
0	0	NaN	NaN	NaN	2016-2017
1	1	Real Madrid	65.0	2.0	2016-2017
2	2	Barcelona	63.0	6.0	2016-2017
3	3	Sevilla	57.0	2.0	2016-2017
4	4	Atlético Madrid	55.0	7.0	2016-2017
5	5	Villarreal	48.0	0.0	2016-2017
6	6	Real Sociedad	48.0	4.0	2016-2017
7	7	Ath. Bilbao	44.0	3.0	2016-2017
8	8	Eibar	41.0	1.0	2016-2017
9	9	RCD Espanyol	40.0	0.0	2016-2017
10	10	Alavés	40.0	2.0	2016-2017
11	11	Celta de Vigo	38.0	3.0	2016-2017
12	12	U. D. Las Palmas	35.0	4.0	2016-2017
13	13	Betis	31.0	1.0	2016-2017
14	14	Valencia C. F.	30.0	3.0	2016-2017
15	15	Málaga	27.0	0.0	2016-2017
16	16	Deportivo	27.0	1.0	2016-2017
17	17	Leganés	26.0	5.0	2016-2017
18	18	Sporting Gijón	21.0	2.0	2016-2017
19	19	Granada	19.0	8.0	2016-2017
20	20	Osasuna	11.0	NaN	2016-2017

Agenda

- Reading / Writing data
- Exploring a DataFrame
- Renaming columns
- Filtering Columns
- Filtering Rows
- Sorting Data
- Adding new columns
- Deleting Data
- Grouping Data
- Concatenating Data
- Joining Data
- Pivot Tables

Deleting rows

- This operation lets us **delete rows** in our dataset

```
DELETE FROM table
WHERE columnn1 = 'A'
```

Deleting rows

- The **drop()** function allows you to delete both rows and columns by specifying an array of index names
- It delete rows by default

```
dataframe.drop(0)
```

	Country	Year	Cases	Population
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

```
dataframe.drop([1,3])
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
2	Brazil	1999	37737	172006362
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Deleting rows

- We **can not** use a condition to delete rows with **drop**()

```
dataframe.drop(dataframe.Country != 'China')
```

```
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
<ipython-input-13-3d4fb419e98e> in <module>
----> 1 dataframe.drop(dataframe.Country != 'China')


c:\users\daniel\.virtualenvs\practicas-pandas-cjitosop\lib\site-packages\pandas\core\indexes\base.py in drop(self, labels, errors)
   5589         if mask.any():
   5590             if errors != "ignore":
-> 5591                 raise KeyError(f"{labels[mask]} not found in axis")
   5592             indexer = indexer[~mask]
   5593         return self.delete(indexer)

KeyError: '[ True  True  True  True False False] not found in axis'
```

Deleting rows

- An alternative to drop rows with a condition is selecting only the rows that we want to keep using then **query()** function

```
dataframe= dataframe.query("Country != 'China'")
dataframe
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Deleting rows

- Or we can delete rows selecting the rows we want to keep using the **iloc** property …

```
dataframe = dataframe.iloc[1:]
dataframe
```

	Country	Year	Cases	Population
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Deleting columns

```
dataframe.drop(columns = 'Year')
```

	Country	Cases	Population
0	Afghanistan	745	19987071
1	Afghanistan	2666	20595360
2	Brazil	37737	172006362
3	Brazil	80488	174504898
4	China	212258	1272815272
5	China	213766	1280428583

```
dataframe.drop(columns = ['Country', 'Year'])
```

	Cases	Population
0	745	19987071
1	2666	20595360
2	37737	172006362
3	80488	174504898
4	212258	1272815272
5	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Deleting columns

- An alternative is to select only with the columns that we want to keep in the dataset using the **filter()** function

```
dataframe.filter(['Cases', 'Population'])
```

	Cases	Population
0	745	19987071
1	2666	20595360
2	37737	172006362
3	80488	174504898
4	212258	1272815272
5	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Exercise 13 (1/2)

- About the DataFrame “league”
- Delete row 0
- Delete the “Temporada" column
- Materialize this changes on the dataset

Exercise 13 (2/2)

	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos	DiferenciaGoles	PorcentajeGoles	PorcentajeVictorias	DiferenciaPuntos
1	1	Real Madrid	27.0	20.0	5.0	2.0	71.0	28.0	65.0	43.0	0.087871	0.740741	2.0
2	2	Barcelona	28.0	19.0	6.0	3.0	81.0	25.0	63.0	56.0	0.100248	0.678571	6.0
3	3	Sevilla	28.0	17.0	6.0	5.0	52.0	34.0	57.0	18.0	0.064356	0.607143	2.0
4	4	Atlético Madrid	28.0	16.0	7.0	5.0	52.0	23.0	55.0	29.0	0.064356	0.571429	7.0
5	5	Villarreal	28.0	13.0	9.0	6.0	39.0	20.0	48.0	19.0	0.048267	0.464286	0.0
6	6	Real Sociedad	28.0	15.0	3.0	10.0	42.0	39.0	48.0	3.0	0.051980	0.535714	4.0
7	7	Ath. Bilbao	28.0	13.0	5.0	10.0	35.0	32.0	44.0	3.0	0.043317	0.464286	3.0
8	8	Eibar	28.0	11.0	8.0	9.0	44.0	39.0	41.0	5.0	0.054455	0.392857	1.0
9	9	RCD Espanyol	28.0	10.0	10.0	8.0	40.0	39.0	40.0	1.0	0.049505	0.357143	0.0
10	10	Alavés	28.0	10.0	10.0	8.0	29.0	33.0	40.0	-4.0	0.035891	0.357143	2.0
11	11	Celta de Vigo	27.0	11.0	5.0	11.0	40.0	45.0	38.0	-5.0	0.049505	0.407407	3.0
12	12	U. D. Las Palmas	28.0	9.0	8.0	11.0	44.0	45.0	35.0	-1.0	0.054455	0.321429	4.0
13	13	Betis	28.0	8.0	7.0	13.0	31.0	44.0	31.0	-13.0	0.038366	0.285714	1.0
14	14	Valencia C. F.	28.0	8.0	6.0	14.0	38.0	51.0	30.0	-13.0	0.047030	0.285714	3.0
15	15	Málaga	28.0	6.0	9.0	13.0	33.0	45.0	27.0	-12.0	0.040842	0.214286	0.0
16	16	Deportivo	28.0	6.0	9.0	13.0	31.0	43.0	27.0	-12.0	0.038366	0.214286	1.0
17	17	Leganés	28.0	6.0	8.0	14.0	22.0	41.0	26.0	-19.0	0.027228	0.214286	5.0
18	18	Sporting Gijón	28.0	5.0	6.0	17.0	31.0	57.0	21.0	-26.0	0.038366	0.178571	2.0
19	19	Granada	28.0	4.0	7.0	17.0	25.0	58.0	19.0	-33.0	0.030941	0.142857	8.0
20	20	Osasuna	28.0	1.0	8.0	19.0	28.0	67.0	11.0	-39.0	0.034653	0.035714	NaN

Agenda

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Grouping rows

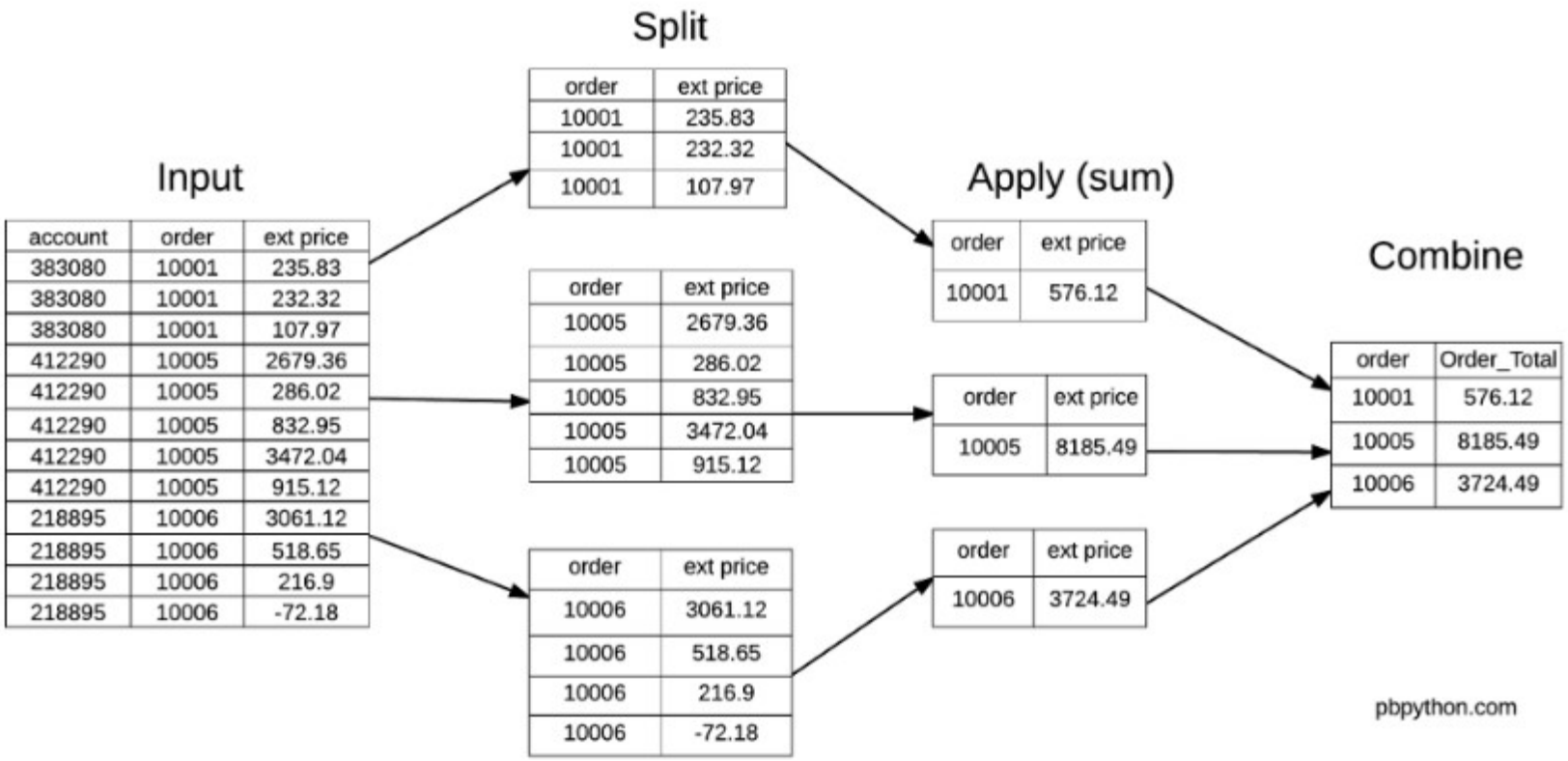
- This operation lets us **group rows** in our dataset

```
SELECT column1, column2, mean(column3), sum(column4)
FROM some_table
GROUP BY column1, column2
```

https://pandas.pydata.org/pandas-docs/stable/user_guide/groupby.html

Grouping rows

- Pandas has a series of functions that allow to obtain data from groupings



Grouping rows

- The **groupby()** function allows you to group rows and generate groups

```
grouped = dataframe.groupby("Country")
grouped.groups
```

```
{'Afghanistan': Int64Index([0, 1], dtype='int64'),
 'Brazil': Int64Index([2, 3], dtype='int64'),
 'China': Int64Index([4, 5], dtype='int64')}
```

```
for name, group in grouped:
   print(name)
   print(group)
```

```
Afghanistan
       Country  Year  Cases  Population
0  Afghanistan  1999    745    19987071
1  Afghanistan  2000   2666    20595360
Brazil
  Country  Year  Cases  Population
2  Brazil  1999  37737   172006362
3  Brazil  2000  80488   174504898
China
  Country  Year   Cases  Population
4   China  1999  212258  1272815272
5   China  2000  213766  1280428583
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Grouping rows

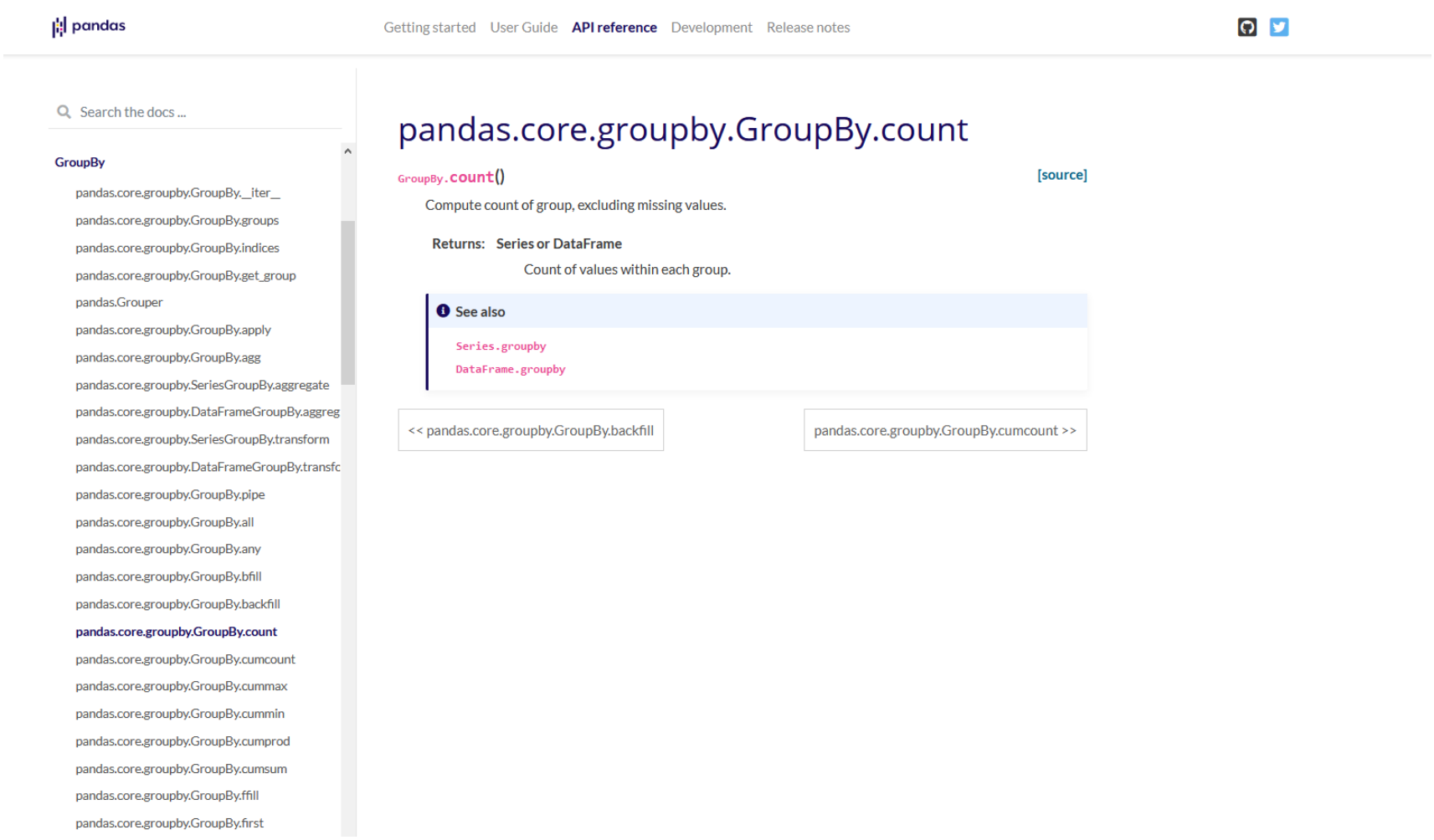
- Once you have a group, you can use grouping functions such as **count**(), **sum(), mean**(), **first**(), **last()** etc.

```
dataframe.groupby("Country").count()
```

Country	Year	Cases	Population
Afghanistan	2	2	2
Brazil	2	2	2
China	2	2	2

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Grouping rows



https://pandas.pydata.org/pandas-docs/stable/reference/groupby.html

Grouping rows

```
dataframe.groupby("Country").sum()
```

Country	Year	Cases	Population
Afghanistan	3999	3411	40582431
Brazil	3999	118225	346511260
China	3999	426024	2553343855

```
dataframe.groupby("Country").first()
```

Country	Year	Cases	Population
Afghanistan	1999	745	19987071
Brazil	1999	37737	172006362
China	1999	212258	1272915272

```
dataframe.groupby("Country").mean()
```

Country	Year	Cases	Population
Afghanistan	1999.5	1705.5	2.029122e+07
Brazil	1999.5	59112.5	1.732556e+08
China	1999.5	213012.0	1.276672e+09

```
dataframe.groupby("Country").last()
```

Country	Year	Cases	Population
Afghanistan	2000	2666	20595360
Brazil	2000	80488	174504898
China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Grouping rows

- A column is shown depending of its type and the grouping function that we used

```
dataframe.groupby("Cases").mean()
```

Cases	Year	Population
745	1999	19987071
2666	2000	20595360
37737	1999	172006362
80488	2000	174504898
212258	1999	1272815272
213766	2000	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Grouping rows

- **size()** counts all rows including null values
- Return a Serie instead a Dataframe

```
dataframe.groupby("Country").size()
```

```
Country
Afghanistan    2
Brazil         2
China          2
dtype: int64
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Grouping rows

- **size()** allows to check if a group of columns has unique values in the dataset

```
dataframe.groupby(["Country", "Year"]).size()
```

```
Country      Year
Afghanistan  1999    1
             2000    1
Brazil       1999    1
             2000    1
China        1999    1
             2000    1
dtype: int64
```

```
dataframe.groupby(["Country", "Year"]).size() > 1
```

```
Country      Year
Afghanistan  1999    False
             2000    False
Brazil       1999    False
             2000    False
China        1999    False
             2000    False
dtype: bool
```

```
(dataframe.groupby(["Country", "Year"]).size() > 1).sum()
```

```
0
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Grouping rows by multiple columns

- In case of grouping for more than a column we will use a list of columns as parameter

```
dataframe.groupby(["Country", "Year"]).count()
```

		Cases	Population
Country	Year		
Afghanistan	1999	1	1
	2000	1	1
Brazil	1999	1	1
	2000	1	1
China	1999	1	1
	2000	1	1

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Grouping rows

- The **aggregate**() function allows you to apply a set of grouping functions
- Accept a list of functions as parameter

```
dataframe.groupby("Country").aggregate(["mean", "sum"])
```

	Year		Cases		Population	
	mean	sum	mean	sum	mean	sum
Country						
Afghanistan	1999.5	3999	1705.5	3411	20291215	40582431
Brazil	1999.5	3999	59112.5	118225	173255630	346511260
China	1999.5	3999	213012.0	426024	1276671927	2553343855

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

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

Grouping rows

- We can select a **specific column** from the result of the **aggregate**() function.

```
dataframe.groupby("Country").aggregate(["mean", "sum"])
```

	Year		Cases		Population	
	mean	sum	mean	sum	mean	sum
Country						
Afghanistan	1999.5	3999	1705.5	3411	2.029122e+07	40582431
Brazil	1999.5	3999	59112.5	118225	1.732556e+08	346511260
China	1999.5	3999	213012.0	426024	1.276622e+09	2553243855

```
dataframe.groupby("Country").aggregate(["mean", "sum"]).Population
```

	mean	sum
Country		
Afghanistan	2.029122e+07	40582431
Brazil	1.732556e+08	346511260
China	1.276622e+09	2553243855

Grouping rows

- The **agg**() function allows you to obtain new values by applying specific function to a given columns

```
dataframe.groupby("Country").agg({
    'Year' : "count",
    "Cases" : np.sum,
    "Population" : lambda column: column.mean()
})
```

Country	Year	Cases	Population
Afghanistan	2	3411	2.029122e+07
Brazil	2	118225	1.732556e+08
China	2	426024	1.276622e+09

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

```
SELECT country,
       count(Year),
       sum(Cases),
       mean(Poputation)
FROM dataframe
GROUP BY country
```

Transforming rows

- The **transform()** function applies a grouping function to a group, but returns an object with the same size as the original dataframe

```
dataframe.groupby("Country").Cases.sum()
```

```
Country
Afghanistan      3411
Brazil         118225
China          426024
Name: Cases, dtype: int64
```

```
dataframe.groupby("Country").Cases.transform("sum")
```

```
0      3411
1      3411
2    118225
3    118225
4    426024
5    426024
Name: Cases, dtype: int64
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Transforming rows

```
dataframe.assign(
    TotalCases = dataframe.groupby("Country").Cases.transform("sum")
)
```

	Country	Year	Cases	Population	TotalCases
0	Afghanistan	1999	745	19987071	3411
1	Afghanistan	2000	2666	20595360	3411
2	Brazil	1999	37737	172006362	118225
3	Brazil	2000	80488	174504898	118225
4	China	1999	212258	1272815272	426024
5	China	2000	213766	1280428583	426024

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Reseting the index

- The result of grouping multiple columns is a DataFrame with a **MultiIndex**

```
dataframe.groupby(["Country", "Year"]).count()
```

		Cases	Population
Country	Year		
Afghanistan	1999	1	1
	2000	1	1
Brazil	1999	1	1
	2000	1	1
China	1999	1	1
	2000	1	1

```
dataframe.groupby(["Country", "Year"]).count().index
```

```
MultiIndex([('Afghanistan', 1999),
            ('Afghanistan', 2000),
            (     'Brazil', 1999),
            (     'Brazil', 2000),
            (      'China', 1999),
            (      'China', 2000)],
           names=['Country', 'Year'])
```

```
dataframe.groupby(["Country", "Year"]).count().columns
```

```
Index(['Cases', 'Population'], dtype='object')
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Reseting the index

- We can incorportate the index as regular columns with the **reset_index**() function

```
dataframe.groupby(["Country", "Year"]).count()
```

		Cases	Population
Country	Year		
Afghanistan	1999	1	1
	2000	1	1
Brazil	1999	1	1
	2000	1	1
China	1999	1	1
	2000	1	1

```
dataframe.groupby(["Country", "Year"]).count().reset_index()
```

	Country	Year	Cases	Population
0	Afghanistan	1999	1	1
1	Afghanistan	2000	1	1
2	Brazil	1999	1	1
3	Brazil	2000	1	1
4	China	1999	1	1
5	China	2000	1	1

Reseting the index

- Another option is use the **as_index** parameter in the **groupby()** function

```
dataframe.groupby(["Country", "Year"], as_index = False ).count()
```

	Country	Year	Cases	Population	Date_str
0	Afghanistan	1999	1	1	1
1	Afghanistan	2000	1	1	1
2	Brazil	1999	1	1	1
3	Brazil	2000	1	1	1
4	China	1999	1	1	1
5	China	2000	1	1	1

Aggregate all the data

- This operation lets us **group rows** taking into consideration every row of our dataset

```
SELECT mean(column3), sum(column4)
FROM some_table
```

Aggregate all the data

- In these cases we can use functions like **agg** or **aggregate** without use **groupby** previosly

```
dataframe.aggregate("mean")
```

```
Year          1.999500e+03
Cases         9.127667e+04
Population    4.900563e+08
dtype: float64
```

```
dataframe[["Cases", "Population"]].aggregate(["mean", "sum"])
```

	Cases	Population
mean	91276.666667	4.900563e+08
sum	547660.000000	2.940338e+09

```
dataframe.agg({ "Cases": "mean", "Population" : np.sum})
```

```
Cases         9.127667e+04
Population    2.940338e+09
dtype: float64
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Exercise 14

- Load the “LigaBBVA_2017329_full.xlsx“ dataset
- Sum “Puntos” and “GolesFavor” for all teams

```
Puntos        766.0
GolesFavor    808.0
dtype: float64
```

- By zones, for the fields “Puntos” and “GolesFavor”, calculate the sum and count all rows

	Puntos		GolesFavor	
	sum	count	sum	count
Zona				
Champions	240	4	256	4
Descenso	30	2	53	2
Normal	496	14	499	14

Exercise 15

- About the DataFrame "liga“
- Filter the ‘Puesto’, ‘Zona’, ‘Equipo’, and ‘Puntos’ columns
- Add a new column with the average “Puntos” in each Zone

	Puesto	Zona	Equipo	Puntos	MediaPuntos
0	1	Champions	Real Madrid	65	60.000000
1	2	Champions	Barcelona	63	60.000000
2	3	Champions	Sevilla	57	60.000000
3	4	Champions	Atlético Madrid	55	60.000000
4	5	Normal	Villarreal	48	35.428571
5	6	Normal	Real Sociedad	48	35.428571
6	7	Normal	Ath. Bilbao	44	35.428571

Exercise 16 (1/2)

- By zones:
  - Sum of “PartidosJugados”
  - Sum of “GolesFalor”
  - Average in “Diferencia de Goles”

Zona	PartidosJugados	GolesFavor	DiferenciaGoles
Champions	111	64.000000	36.500000
Descenso	56	26.500000	-36.000000
Normal	391	35.642857	-5.285714

Exercise 16 (2/2)

- Add a new column to the previous dataset: ‘GolesPartido’ : ‘GolesFavor’ / ‘PartidosJugados’

Zona	PartidosJugados	GolesFavor	DiferenciaGoles	GolesPartido
Champions	111	64.000000	36.500000	0.576577
Descenso	56	26.500000	-36.000000	0.473214
Normal	391	35.642857	-5.285714	0.091158

- Show all the teams in each zone

Zona	Equipo
Champions	Real Madrid / Barcelona / Sevilla / Atlético M...
Normal	Villarreal / Real Sociedad / Ath. Bilbao / Eib...
Descenso	Granada / Osasuna

Agenda

- Reading / Writing data
- Exploring a DataFrame
- Renaming columns
- Filtering Columns
- Filtering Rows
- Sorting Data
- Adding new columns
- Deleting Data
- Grouping Data
- Concatenating Data
- Joining Data
- Pivot Tables

Concatenating rows

- This operation lets us **concatenate** two datasets

```
SELECT column1, column2,
FROM table1
UNION ALL
SELECT column1, column2
FROM table2
```

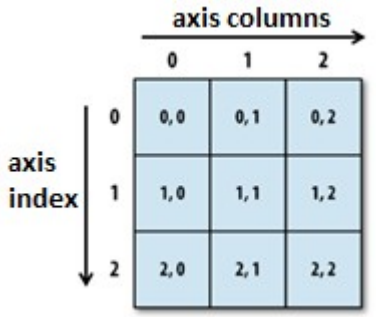
Concatenating rows

- The **concat**() function allows to join several DataFrames in a single one

```
pd.concat((dataframe, dataframe), axis = 'index')
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583



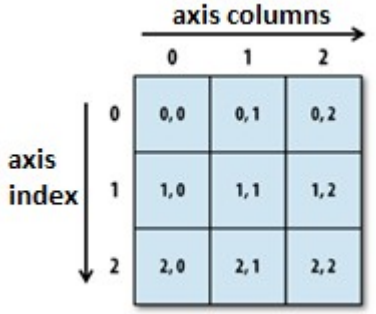
Concatenating rows

- The **reset_index**() function rebuilds the index after the concatenation ...

```
pd.concat((dataframe, dataframe), axis = 'index') \
  .reset_index()
```

	index	Country	Year	Cases	Population
0	0	Afghanistan	1999	745	19987071
1	1	Afghanistan	2000	2666	20595360
2	2	Brazil	1999	37737	172006362
3	3	Brazil	2000	80488	174504898
4	4	China	1999	212258	1272815272
5	5	China	2000	213766	1280428583
6	0	Afghanistan	1999	745	19987071
7	1	Afghanistan	2000	2666	20595360
8	2	Brazil	1999	37737	172006362
9	3	Brazil	2000	80488	174504898
10	4	China	1999	212258	1272815272
11	5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583



Concatenating rows

- A shortcut for the **concat()** function when two dataframes are joined is the **append**() function

```
dataframe.append(dataframe)
```

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Concatenating columns

- With the **axis** parameter we can concatenate columns instead of rows

```
pd.concat((dataset_1, dataset_2), axis = 'columns')
```

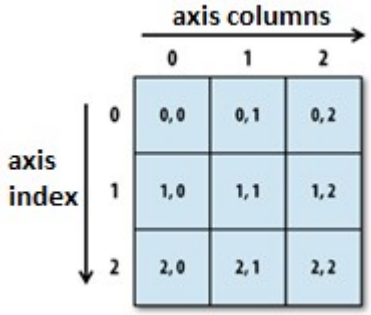
	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272815272
5	China	2000	213766	1280428583

dataset_1

	Country	Year
0	Afghanistan	1999
1	Afghanistan	2000
2	Brazil	1999
3	Brazil	2000
4	China	1999
5	China	2000

dataset_2

	Cases	Population
0	745	19987071
1	2666	20595360
2	37737	172006362
3	80488	174504898
4	212258	1272815272
5	213766	1280428583



Concatenating columns - Rankings

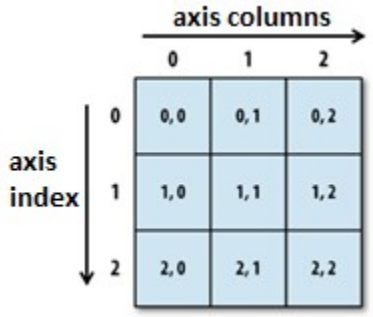
```
rank = dataframe.rank().rename(columns = lambda column: "Rank " + column)
rank
```

	Rank Country	Rank Year	Rank Cases	Rank Population
0	1.5	2.0	1.0	1.0
1	1.5	5.0	2.0	2.0
2	3.5	2.0	3.0	3.0
3	3.5	5.0	4.0	4.0
4	5.5	2.0	5.0	5.0
5	5.5	5.0	6.0	6.0

```
pd.concat((dataframe, rank), axis = 'columns')
```

	Country	Year	Cases	Population	Rank Country	Rank Year	Rank Cases	Rank Population
0	Afghanistan	1999	745	19987071	1.5	2.0	1.0	1.0
1	Afghanistan	2000	2666	20595360	1.5	5.0	2.0	2.0
2	Brazil	1999	37737	172006362	3.5	2.0	3.0	3.0
3	Brazil	2000	80488	174504898	3.5	5.0	4.0	4.0
4	China	1999	212258	1272815272	5.5	2.0	5.0	5.0
5	China	2000	213766	1280428583	5.5	5.0	6.0	6.0

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583



https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DataFrame.rank.html

Exercise 17

- Duplicate the content of the dataset "liga"
- Filter the columns “Puesto”, “Equipo”, “Zona” and “PartidosJugados”
- Show only the top three positions

	Puesto	Equipo	Zona	PartidosJugados
6	2	Barcelona	Champions	28
7	2	Barcelona	Champions	28
26	1	Real Madrid	Champions	27
27	1	Real Madrid	Champions	27
30	3	Sevilla	Champions	28
31	3	Sevilla	Champions	28

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- Concatenating Data
- Joining Data
- Pivot Tables

Join

- This operation lets us **join** two datasets by a specific column

```
SELECT A.column_PK, B.column
FROM table1 a A
INNER JOIN table2 as B ON A.column_PK = B.column_PK
```

Join

- The **merge**() function allows to make a join between two DataFrames

```
df_capitals = pd.DataFrame(
    {"Country" : ["Afghanistan", "Brazil", "Spain"],
     "Capital" : ["Kabul", "Brasilia", "Madrid"]},
     columns = ["Country", "Capital"]
)
df_capitals
```

	Country	Capital
0	Afghanistan	Kabul
1	Brazil	Brasilia
2	Spain	Madrid

Join

- The **merge**() function allows to make a join between two DataFrames

```
pd.merge(dataframe, df_capitals, on = "Country")
```

	Country	Year	Cases	Population	Capital
0	Afghanistan	1999	745	19987071	Kabul
1	Afghanistan	2000	2666	20595360	Kabul
2	Brazil	1999	37737	172006362	Brasilia
3	Brazil	2000	80488	174504898	Brasilia

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

	Country	Capital
0	Afghanistan	Kabul
1	Brazil	Brasilia
2	Spain	Madrid

(*) In case of multiple colunns it is posible specify an array of fields

Join

- The parameters **left_on** and **right_on** allow to specify different names in both dataframes

```
pd.merge(dataframe, df_capitals,
         left_on = "Country",
         right_on =  "Country")
```

	Country	Year	Cases	Population	Capital
0	Afghanistan	1999	745	19987071	Kabul
1	Afghanistan	2000	2666	20595360	Kabul
2	Brazil	1999	37737	172006362	Brasilia
3	Brazil	2000	80488	174504898	Brasilia

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

	Country	Capital
0	Afghanistan	Kabul
1	Brazil	Brasilia
2	Spain	Madrid

Join

- The parameter **how** allows to specify different join methods: ‘left’, ‘right’, ‘outer’, ‘inner’

```
pd.merge(dataframe, df_capitals, on = "Country", how = "inner")
```

	Country	Year	Cases	Population	Capital
0	Afghanistan	1999	745	19987071	Kabul
1	Afghanistan	2000	2666	20595360	Kabul
2	Brazil	1999	37737	172006362	Brasilia
3	Brazil	2000	80488	174504898	Brasilia

```
pd.merge(dataframe, df_capitals, on = "Country", how = "outer")
```

	Country	Year	Cases	Population	Capital
0	Afghanistan	1999.0	745.0	1.998707e+07	Kabul
1	Afghanistan	2000.0	2666.0	2.059536e+07	Kabul
2	Brazil	1999.0	37737.0	1.720064e+08	Brasilia
3	Brazil	2000.0	80488.0	1.745049e+08	Brasilia
4	China	1999.0	212258.0	1.272815e+09	NaN
5	China	2000.0	213766.0	1.280429e+09	NaN
6	Spain	NaN	NaN	NaN	Madrid

```
pd.merge(dataframe, df_capitals, on = "Country", how = "left")
```

	Country	Year	Cases	Population	Capital
0	Afghanistan	1999	745	19987071	Kabul
1	Afghanistan	2000	2666	20595360	Kabul
2	Brazil	1999	37737	172006362	Brasilia
3	Brazil	2000	80488	174504898	Brasilia
4	China	1999	212258	1272815272	NaN
5	China	2000	213766	1280428583	NaN

```
pd.merge(dataframe, df_capitals, on = "Country", how = "right")
```

	Country	Year	Cases	Population	Capital
0	Afghanistan	1999.0	745.0	19987071.0	Kabul
1	Afghanistan	2000.0	2666.0	20595360.0	Kabul
2	Brazil	1999.0	37737.0	172006362.0	Brasilia
3	Brazil	2000.0	80488.0	174504898.0	Brasilia
4	Spain	NaN	NaN	NaN	Madrid

Anti Join

- The parameter **indicator** allows to show those rows that are not included in the join

```
pd.merge(dataframe, df_capitals, on = "Country", how = "left", indicator = True)
```

	Country	Year	Cases	Population	Capital	_merge
0	Afghanistan	1999	745	19987071	Kabul	both
1	Afghanistan	2000	2666	20595360	Kabul	both
2	Brazil	1999	37737	172006362	Brasilia	both
3	Brazil	2000	80488	174504898	Brasilia	both
4	China	1999	212258	1272815272	NaN	left_only
5	China	2000	213766	1280428583	NaN	left_only

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

	Country	Capital
0	Afghanistan	Kabul
1	Brazil	Brasilia
2	Spain	Madrid

Anti Join

- The parameter **how** allows to choose in which table you want apply the anti-join

```
pd.merge(dataframe, df_capitals, on = "Country", how = "left",
                                                 indicator = True) \
  .query("_merge == 'left_only'") \
  .drop('_merge', axis= 'columns')
```

	Country	Year	Cases	Population	Capital
4	China	1999	212258	1272815272	NaN
5	China	2000	213766	1280428583	NaN

```
pd.merge(dataframe, df_capitals, on = "Country", how = "right",
                                                 indicator = True) \
  .query("_merge == 'right_only'") \
  .drop('_merge', axis='columns')
```

	Country	Year	Cases	Population	Capital
4	Spain	NaN	NaN	NaN	Madrid

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

	Country	Capital
0	Afghanistan	Kabul
1	Brazil	Brasilia
2	Spain	Madrid

Exercise 18

- Create a DataFrame called “equipos" with the content of the Excel file “Equipos.xlsx“

	Equipo	Provincia	Comunidad Autónoma
0	Real Madrid	Madrid	Madrid
1	Barcelona	Barcelona	Cataluña
2	Sevilla	Sevilla	Andalucia
3	Atlético Madrid	Madrid	Madrid
4	Villarreal	Castellón	Comunidad Valenciana

- In the DataFrame “liga“, assign new columns with the province of the team and another one with its autonomous community (materialize the columns)

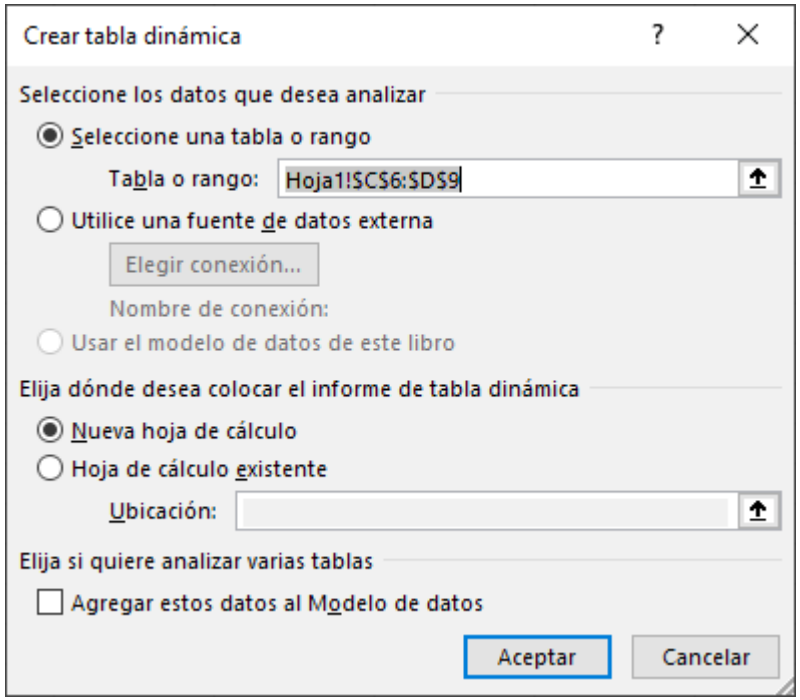
	Puesto	Equipo	PartidosJugados	Victorias	Empates	Derrotas	GolesFavor	GolesContra	Puntos	DiferenciaGoles	DiferenciaPuntos	PorcentajeGoles	PorcentajeVictorias	Zona	Provincia	Comunidad Autónoma
0	1	Real Madrid	27	20	5	2	71	28	65	43	2.0	0.087871	0.740741	Champions	Madrid	Madrid
1	2	Barcelona	28	19	6	3	81	25	63	56	6.0	0.100248	0.678571	Champions	Barcelona	Cataluña
2	3	Sevilla	28	17	6	5	52	34	57	18	2.0	0.064356	0.607143	Champions	Sevilla	Andalucia
3	4	Atlético Madrid	28	16	7	5	52	23	55	29	7.0	0.064356	0.571429	Champions	Madrid	Madrid
4	5	Villarreal	28	13	9	6	39	20	48	19	0.0	0.048267	0.464286	Normal	Castellón	Comunidad Valenciana
5	6	Real Sociedad	28	15	3	10	42	39	48	3	4.0	0.051980	0.535714	Normal	Guipúzcoa	Pais Vasco
6	7	Ath. Bilbao	28	13	5	10	35	32	44	3	3.0	0.043317	0.464286	Normal	Vizcaya	Pais Vasco

Agenda

- Reading / Writing data
- Exploring a DataFrame
- Renaming columns
- Filtering Columns
- Filtering Rows
- Sorting Data
- Adding new columns
- Deleting Data
- Grouping Data
- Concatenating Data
- Joining Data
- Pivot Tables

Pivot Tables

- The function **pivot_table** () allows us to create a table where we apply a series of grouping functions in a set of values and categories at the same time.



https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.pivot_table.html

Pivot Tables

- The simplest pivot table must have a DataFrame and an **index** parameter

```
dataframe.pivot_table(
    index = "Country"
)
```

Country	Cases	Population	Year
Afghanistan	1705.5	2.029122e+07	1999.5
Brazil	59112.5	1.732556e+08	1999.5
China	213012.0	1.276622e+09	1999.5

```
dataframe.pivot_table(
    index = ["Year", "Country"]
)
```

Year	Country	Cases	Population
1999	**Afghanistan**	745	19987071
	Brazil	37737	172006362
	China	212258	1272815272
2000	**Afghanistan**	2666	20595360
	Brazil	80488	174504898
	China	213766	1280428583

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Pivot Tables

- You can add the **values** parameter to filter the values that are shown (by default it will show all the numerical values)

```
dataframe.pivot_table(
    index = "Country"
)
```

Country	Cases	Population	Year
Afghanistan	1705.5	2.029122e+07	1999.5
Brazil	59112.5	1.732556e+08	1999.5
China	213012.0	1.276622e+09	1999.5

```
dataframe.pivot_table(
    index = "Country",
    values = "Cases"
)
```

Country	Cases
Afghanistan	1705.5
Brazil	59112.5
China	213012.0

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Pivot Tables

- By default, **pivot_table** uses the **mean** as aggregate function but it can be changed with the **aggfunc** parameter

```
dataframe.pivot_table(
    index = ["Country"],
    values = ["Cases"]
)
```

Country	Cases
Afghanistan	1705.5
Brazil	59112.5
China	213012.0

```
dataframe.pivot_table(
    index = "Country",
    values = "Cases",
    aggfunc = "sum"
)
```

Country	Cases
Afghanistan	3411
Brazil	118225
China	426024

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Pivot Tables

- You can use a list of aggregate funcions instead a single value

```
dataframe.pivot_table(
    index = "Country",
    values = "Cases",
    aggfunc = [np.sum, "mean"]
)
```

	sum	mean
	Cases	Cases
Country		
Afghanistan	3411	1705.5
Brazil	118225	59112.5
China	426024	213012.0

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Pivot Tables

- Using the appropriate function you can aggregate non numerical columns …

```
dataframe.pivot_table(
    index = "Year",
    values = "Country",
    aggfunc = lambda x: ' / '.join(x)
)
```

Year	Country
1999	Afghanistan / Brazil / China
2000	Afghanistan / Brazil / China

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Pivot Tables

- The **columns** parameter provide an additional way to segment the actual values you care about.

```
dataframe.pivot_table(
    index = "Country",
    columns = "Year",
    values = "Cases",
    aggfunc = np.sum
)
```

Year	1999	2000
Country		
Afghanistan	745	2666
Brazil	37737	80488
China	212258	213766

	Country	Year	Cases	Population
0	Afghanistan	1999	745	19987071
1	Afghanistan	2000	2666	20595360
2	Brazil	1999	37737	172006362
3	Brazil	2000	80488	174504898
4	China	1999	212258	1272915272
5	China	2000	213766	1280428583

Exercise 19

- About the DataFrame “liga",
- Create a pivot table with the average points per autonomous community
- Sort the result from highest to lowest

Comunidad Autónoma	Puntos
Cataluña	51.500000
Madrid	48.666667
Pais Vasco	43.250000
Comunidad Valenciana	39.000000
Canarias	35.000000
Andalucia	33.500000
Galicia	32.500000
Asturias	21.000000
Navarra	11.000000

Exercise 20

- Create a pivot table with the average of “Puntos” and “DiferenciaGoles” by autonomous community and province

		DiferenciaGoles	Puntos
Comunidad Autónoma	Provincia		
Andalucia	Granada	-33.000000	19.000000
	Malaga	-12.000000	27.000000
	Sevilla	2.500000	44.000000
Asturias	Asturias	-26.000000	21.000000
Canarias	Las Palmas	-1.000000	35.000000
Cataluña	Barcelona	28.500000	51.500000
Comunidad Valenciana	Castellón	19.000000	48.000000
	Valencia	-13.000000	30.000000
Galicia	A Coruña	-12.000000	27.000000
	Pontevedra	-5.000000	38.000000
Madrid	Madrid	17.666667	48.666667
Navarra	Navarra	-39.000000	11.000000
Pais Vasco	Guipúzcoa	4.000000	44.500000
	Vizcaya	3.000000	44.000000
	Álava	-4.000000	40.000000

Exercise 21

- Create a pivot table comparing the “Zona” and the autonomous community, where the average points are shown, using a fill value of 0 (fill_value)

Zona Comunidad Autónoma	Champions	Normal	Descenso
Andalucia	57	29.00	19
Asturias	0	21.00	0
Canarias	0	35.00	0
Cataluña	63	40.00	0
Comunidad Valenciana	0	39.00	0
Galicia	0	32.50	0
Madrid	60	26.00	0
Navarra	0	0.00	11
Pais Vasco	0	43.25	0

THANKS FOR YOUR ATTENTION

Daniel Villanueva Jiménez
daniel.villanueva@immune.institute
@dvillaj