Data Analysis in Python

Pandas

Pandas is a python module for data handling and analysis, with it's explicit aim to handle missing data in an elegant way.

In the following example, we read a `.csv` file into a data frame. We can see that missing data are represented as `NaN` values.

In [67]:
```python
import pandas as pd

# Data containing characteristics of various electronic dance music genres
df = pd.read_csv("edm_songs.csv")
df.head()
```

Out[67]:

	danceability	energy	key	loudness	mode	speechiness	acousticness	instrumentalness	liveness	valence	tempo	duration_ms	tir
0	0.806	0.950	7	-6.782	1	0.0811	0.000957	0.920	0.1130	0.580	127.997	197499	
1	0.803	0.697	6	-9.479	1	0.0599	0.000130	0.888	0.3560	0.350	126.008	507998	
2	0.729	0.978	10	-6.645	1	0.0420	0.062300	0.908	0.0353	0.778	124.994	206000	
3	0.724	0.792	4	-8.555	0	0.0405	0.019100	0.812	0.1080	0.346	124.006	199839	
4	0.700	0.898	8	-6.099	1	0.2570	0.053000	0.418	0.5740	0.791	125.031	173861	

Once data is in a data frame format, quick analyses can be performed.

In [68]:
```python
df.mean()
```

Out[68]:
```
danceability             0.602479
energy                   0.871618
key                      5.600952
loudness                -5.869761
mode                     0.514667
speechiness              0.093811
acousticness             0.022772
instrumentalness         0.497083
liveness                 0.233391
valence                  0.294767
tempo                  143.431358
duration_ms         309236.525095
time_signature           3.976714
dtype: float64
```

In [69]:
```python
df.std()
```

Out[69]:
```
danceability             0.144944
energy                   0.116026
key                      3.623975
loudness                 2.862706
mode                     0.499797
speechiness              0.091243
acousticness             0.062071
instrumentalness         0.372952
liveness                 0.195299
valence                  0.215407
tempo                   15.669134
duration_ms         105583.387028
time_signature           0.192434
dtype: float64
```

In [86]:
```python
df.genre.unique()
```

Out[86]:
```
array(['techhouse', 'techno', 'trance', 'psytrance', 'trap', 'dnb',
       'hardstyle'], dtype=object)
```

In [71]:
```python
# See the average value of each feature for a specific class
df.groupby('genre').mean()
```

Out[71]:

genre	danceability	energy	key	loudness	mode	speechiness	acousticness	instrumentalness	liveness	valence	
dnb	0.520877	0.873539	5.614000	-4.065679	0.447000	0.083955	0.020010	0.459334	0.203153	0.253628	173.8
hardstyle	0.478675	0.896620	5.691333	-4.328503	0.363000	0.096933	0.041238	0.136239	0.273899	0.267960	150.8
psytrance	0.616325	0.902170	5.984000	-6.709473	0.598000	0.060667	0.006569	0.765212	0.292965	0.259317	142.8
techhouse	0.786642	0.833436	5.800333	-7.065800	0.566000	0.072241	0.014439	0.580296	0.141252	0.567592	124.9
techno	0.714229	0.797653	5.699667	-9.277120	0.582000	0.066108	0.039427	0.846473	0.149674	0.193564	129.2
trance	0.507682	0.892384	5.391333	-6.907811	0.443000	0.071296	0.012967	0.495438	0.296911	0.220306	134.6
trap	0.592924	0.905522	5.026000	-2.733938	0.603667	0.205480	0.024753	0.196592	0.275886	0.301005	147.7

Querying Data

Columns

Columns can be selected from a data frame using the syntax `df.col_name` or `df["col_name"]`. To select multiple columns, `df[["col1", "col2"]]`.

In [72]:
```python
df[["genre", "instrumentalness"]]
```

Out[72]:

	genre	instrumentalness
0	techhouse	0.920000
1	techhouse	0.888000
2	techhouse	0.908000
3	techhouse	0.812000
4	techhouse	0.418000
...	...	...
20995	hardstyle	0.000345
20996	hardstyle	0.000018
20997	hardstyle	0.000242
20998	hardstyle	0.029600
20999	hardstyle	0.000055

21000 rows × 2 columns

Rows

Rows can be selected using the `df.loc[i]` function.

In [73]:
```python
# Select the first 5 rows of specific columns
df.loc[0:5, ["acousticness", "instrumentalness"]]
```

Out[73]:

	acousticness	instrumentalness
0	0.000957	0.920
1	0.000130	0.888
2	0.062300	0.908
3	0.019100	0.812
4	0.053000	0.418
5	0.000301	0.926

Adding Columns

Columns can be added to an existing data frame using the syntax, `df["new_col"] = new_col_data`.

In [74]:
```python
# Boolean column which classes a song as fast if > 170 bpm
df["is_fast_song"] = [x > 170 for x in df.tempo]
df.groupby("genre").mean()[["tempo", "is_fast_song"]]
```

Out[74]:

genre	tempo	is_fast_song
dnb	173.843173	0.983667
hardstyle	150.808505	0.000000
psytrance	142.835830	0.000000
techhouse	124.924629	0.000000
techno	129.213673	0.000000
trance	134.630759	0.000000
trap	147.762937	0.000000

Filtering Data

Data frames can be filtered using conditional statements as shown below.

In [80]:
```python
# True if faster than average tempo
df["tempo"] > df.tempo.mean()
```

Out[80]:
```
0        False
1        False
2        False
3        False
4        False
         ...  
20995     True
20996     True
20997     True
20998     True
20999     True
Name: tempo, Length: 21000, dtype: bool
```

In [96]:
```python
# Shows tracks with tempos above 160 bpm
df[df["tempo"] > 160][["genre", "tempo"]]
```

Out[96]:

	genre	tempo
9067	psytrance	169.980
9078	psytrance	160.003
9087	psytrance	160.010
9110	psytrance	160.010
9154	psytrance	169.950
...	...	...
20573	hardstyle	160.047
20705	hardstyle	160.040
20815	hardstyle	160.023
20862	hardstyle	163.883
20967	hardstyle	160.143

3137 rows × 2 columns

In [97]:
```python
# Lists the genres which have at least one track over 160 bpm
df[df["tempo"] > 160].genre.unique()
```

Out[97]:
```
array(['psytrance', 'trap', 'dnb', 'hardstyle'], dtype=object)
```

In [108]:
```python
# Multiple conditional filter
df[(df.tempo > 160) & (df.genre == "trap")][["genre", "tempo"]]
```

Out[108]:

	genre	tempo
12002	trap	160.018
12138	trap	160.038
12161	trap	160.009
12174	trap	164.920
12218	trap	160.041
...	...	...
14736	trap	164.016
14823	trap	160.108
14844	trap	160.061
14859	trap	160.069
14971	trap	160.042

85 rows × 2 columns

Data Visualisation

Pandas

The most simple way of plotting a data frame is to use the `pandas` `df.plot()` function.

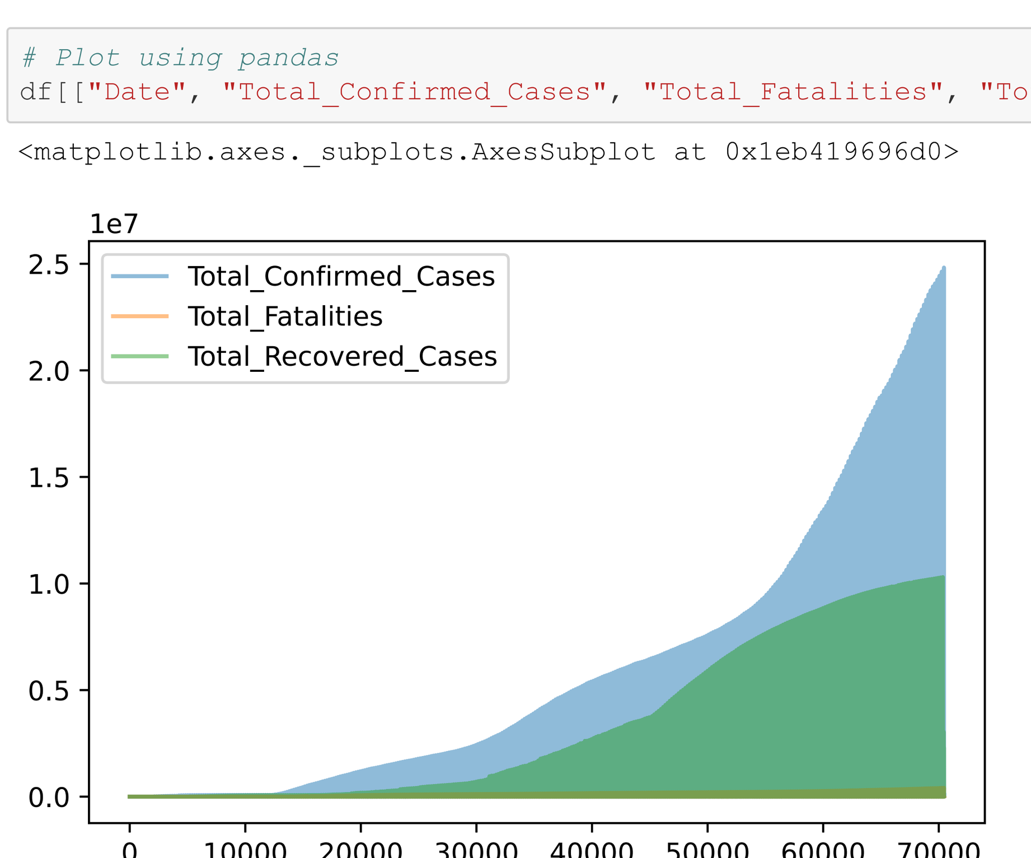
In [119]:
```python
# Data on COVID-19 pandemic
df = pd.read_csv("covid_data.csv")
df.head()
```

Out[119]:

	Date	Country_Region	alpha-3_code	Population	Total_Confirmed_Cases	Total_Fatalities	Total_Recovered_Cases	New_Confirmed_Case
0	22/01/2020	Afghanistan	AFG	37172386	0	0	0	
1	22/01/2020	Albania	ALB	2866376	0	0	0	
2	22/01/2020	Algeria	DZA	42228429	0	0	0	
3	22/01/2020	Andorra	AND	77006	0	0	0	
4	22/01/2020	Angola	AGO	30809762	0	0	0	

In [124]:
```python
# Plot using pandas
df[["Date", "Total_Confirmed_Cases", "Total_Fatalities", "Total_Recovered_Cases"]].plot(alpha=.5)
```

Out[124]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x1eb419696d0>
```



Seaborn

Seaborn as a third-party module that allows for simple plots which integrates well with data frames from `pandas`.

A seaborn theme can be set using `seaborn.set()` which updates the theme of seaborn and matplotlib plots and are generally more appealing than the default theme.

In [172]:
```python
import seaborn as sns

sns.set()

max_df = df.groupby("Country_Region").max()
max_df["Country"] = max_df.index
max_df = max_df.sort_values(by="Total_Confirmed_Cases").iloc[1:20]
fig = sns.relplot(data=max_df, x="Country", y="Total_Confirmed_Cases", hue="Total_Confirmed_Cases")
fig.set_xticklabels(rotation=90)
```

Out[172]:
```
<seaborn.axisgrid.FacetGrid at 0x1eb5296eee0>
```