Capstone Project: Data Analysis of the Covid-19 pandemia in Greece

July 13, 2020

1 Capstone Project: Covid-19 in Greece

The Corona-virus disease 2019 (COVID-19) is a pandemic first originated in Wuhan the capital of Hubei province, China in December 2019 and then spread globally. It is caused by SARS-CoV-2. The project includes the latest updates as have been released daily by the Greek Civil Protection Department on COVID-19 pandemics in Greece; while this preliminary analysis is performed under the scope of the Coursera-IBM Professional Certified Data Analysis Course (9), as its final capstone. The specific work has been developed with Python-3 on macOS, and it has been inspired by similar works, papers and examples that I have either found online or via the course labs. The full version of the code is available on my GitHub repository (https://github.com/karentzos/Coursera_Capstone/tree/master).

1.0.1 Data Resources

1. **wikipedia**
   https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Greece
2. **govgr**:
   https://covid19.gov.gr/covid19-live-analytics/
3. **govgr-pdf**:
   https://eody.gov.gr/wp-content/uploads/2020/06/covid-gr-daily-report-20200624.pdf
4. **WHO**:
   https://covid19.who.int
5. **Generic**:
   https://www.google.com/search?client=safari&rls=en&q=covid-19+greece&ie=UTF-8&oe=UTF-8

1.0.2 Analysis Plan and Methodology

1. Installing necessary libraries and importing modules

2. Importing data and extracting fields Firstly, we will import all the necessary libraries, then the latest version of the Greek COVID dataset from the Civil Protection account and we store it into a Pandas DataFrame. Then, we will explore the structure of the table, in order to have a clear view on the variables, and eventually we will try to model the confirmed cases in Greece.

3. Calculate the daily increase of the confirmed cases, initially on a worldwide scale while later on we will continue our analysis only with one country, Greece.

4. Visualizing the data Select the target country, and compare it with the World, the World Patient-0 (China), the European Patient-0 (Italy), and the current over-'deceased' country (USA).

5. Cleaning the data and correcting biases if needed. A possible methodology for correcting systematic biases consists in the calculation of the moving average, which is normally used to analyze time-series by calculating averages of different subsets of the complete dataset, in our case 7 days. The first moving average is calculated by averaging the first subset of 7 days, and then the subset is changed by moving forward to the next fixed subset, and so on. In general, the moving average smoothens the data, and it reduces anomalies like our weekend bias. Unfortunately, there are several unconsidered factors that undermines the validity of this analysis. Just to mention some of these: testing procedures have changed considerably over time, ranging from testing only severe symptomatic patients to mass testing of entire populations in specific districts, and the swabs methodology varies between regions. Moreover, data on new confirmed cases might refer to tests conducted in previous days, from 1 up to 7 days before. And just to make things even more complicated, some patients can also be tested multiple times, and there is no way to detect this from our dataset. Surely it is not perfect, since it can also be prone to underestimation, mostly during the acute peak of the crisis where the health system might be stressed and hospitals might be saturated. However, after that critical phase it should reflect pretty well the number of patients that are affected most severely by the virus.

6. Creating derived variable(s) for the model AND select with which country we will continue our analysis.

   - Visualization

     a. Plot the confirmed, fatal and recovered cases in Greece over time.
     b. Group data by region, age and sex. Afterwards, use the Folium module in order to demonstrate the cases per prefecture in a choropleth graph. The confirmed cases as grouped by the age and the sex will be plotted in bar or/and pie(donut) graphs.

   - Calculate the Mortality and Recovery Rates

   - Plot the top 10 hospitals that are traeting the most of the cases in the last 60 days.

     This will probably show to us the prefecture/cities that have already uplift the measures and the passage of the boarders from tourists via neighbour countries (Bulgaria) can be done freely. If the city of Xanthi will provide more cases than other cities (Patra, Athens, etc) we will know that these cases 'infiltrated' in Greece by the land and not from the air or the sea.

   - Active cases, Closed Cases and the Growth factor.

7. Modeling the epidemic trend

   1. We now can build a model and train it with the data of from the date that the decrease started.

      Linear Regression is one of the most popular classical machine learning algorithms for supervised learning. This algorithm is relatively easy to implement and works well when the relationship to between covariates and response variable is known to be linear (in our case: date VS cases). A clear disadvantage is that Linear Regression over simplifies many real world problems. Similarly, he can check other models, SVM, Holt, Polynomial, Bayesian, AR Model, MA model, Sarima and more, from where we can extract their efficiency on the data.

  2. Predict future trend

  3. Plot the forecast

8. Summarizing the models' efficiency.

9. General table demonstrating the position of Greece worlwide based on the mortality rate.

2 Modules and libraries importation

[4]:
```
#. Installing necessary libraries
#. and importing modules

import pandas as pd
import numpy as np
import json      # library to handle JSON files
import requests  # library to handle requests
import urllib.request
from urllib.request import urlopen
import time

!pip install lxml
import lxml

!pip install geopy
from geopy.geocoders import Nominatim # convert an address into latitude and␣
↪longitude values
")

from pandas.io.json import json_normalize # tranform JSON file into a pandas␣
↪dataframe

# Matplotlib and associated plotting modules
#!pip install matplotlib
import matplotlib.pyplot as plt
from matplotlib.ticker import StrMethodFormatter
from matplotlib import rcParams
import matplotlib.cm as cm
import matplotlib.colors as colors


# import k-means from clustering stage
!pip install -U scikit-learn scipy matplotlib
from sklearn.cluster import KMeans

!conda install -c conda-forge folium=0.5.0 --yes
import folium # map rendering library

!pip install BeautifulSoup4
from bs4 import BeautifulSoup
```

3 Data collection, wrangling and Initial Analysis

The data for the capstone project of the corona-virus analysis have been obtained from different sources (1.0.1 Data Resources), based on the analysis needs and also from their availability. Here, two main datasets are used, concerning the world and the greek cases data respectively. The data have been transformed into a more appropriate and valuable for a variety of downstream purposes format, such as pandas dataframe. An idea of the data loaded from the specific dataset are shown in the following raw table format.

[5]:
```
#. Obtaining data from Wikipedia
source = requests.get('https://en.wikipedia.org/wiki/
↪COVID-19_pandemic_in_Greece').text
soup = BeautifulSoup(source, 'lxml')
#soup.encode("utf-8-sig")
```

[6]:
```
  Province/State Country/Region      Lat     Long  1/22/20  1/23/20  1/24/20  \
0            NaN    Afghanistan  33.0000  65.0000        0        0        0
1            NaN        Albania  41.1533  20.1683        0        0        0
2            NaN        Algeria  28.0339   1.6596        0        0        0
3            NaN        Andorra  42.5063   1.5218        0        0        0
4            NaN         Angola -11.2027  17.8739        0        0        0
[5 rows x 173 columns]
```

Figure 1 demonstrates the number of the confirmed cases of Covid-19 over time globally, in days since the 22th of January, 2020. After the 50th day the increase in cases increased rapidly, indicating the severeness and the fast spread of the disease among the country's population. That was the initial recognition of the upcoming pandemia's starting point. The brief embedded table shows the confirmed Covid-19 cases in China the first 5 days from the counting day.

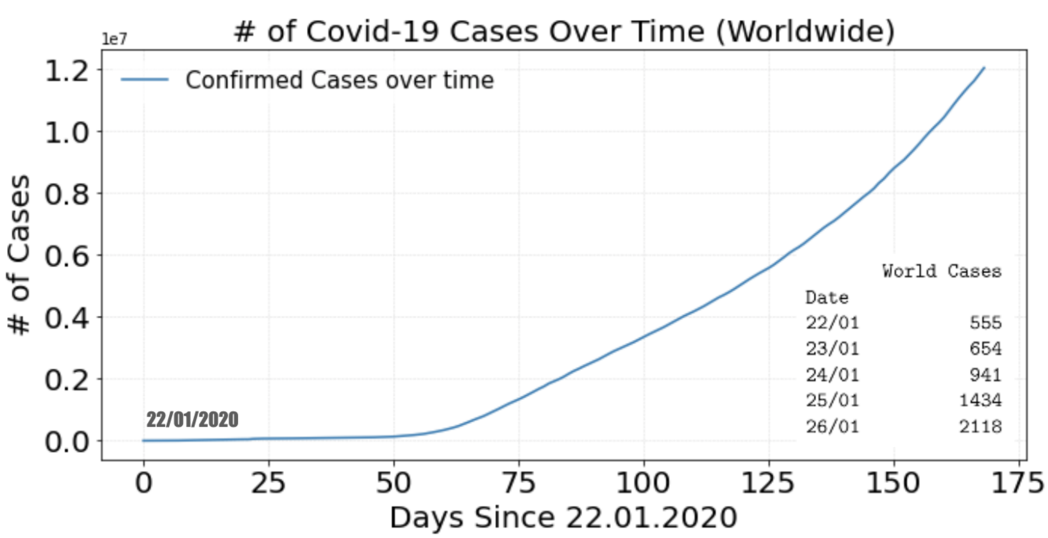
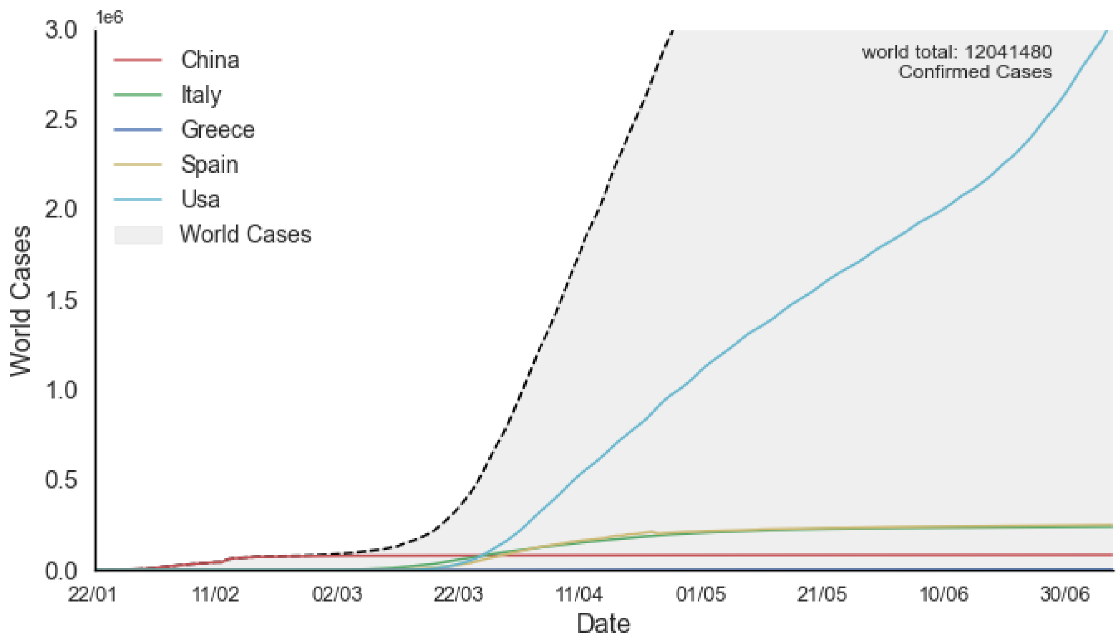


Figure 2 illustrates the number of the confirmed cases of Covid-19 as has been evolved over time in the most severely affected countries, in days since the 22th of January, 2020. The most affected countries after the patient-0 (China) are Italy, Spain, and USA. Anyhow, a lot of European countries (France, Germany, etc) have been affected from the Covid-19 but here are included only the cases where their health system have been saturated. Additionally, Greece is included for two reasons. Firstly, this is the country selected for further analysis and also because it was one of the first countries applying confinement measures fast enough, fighting efficiently against Covid-19, and be today a perfect example for other countries.

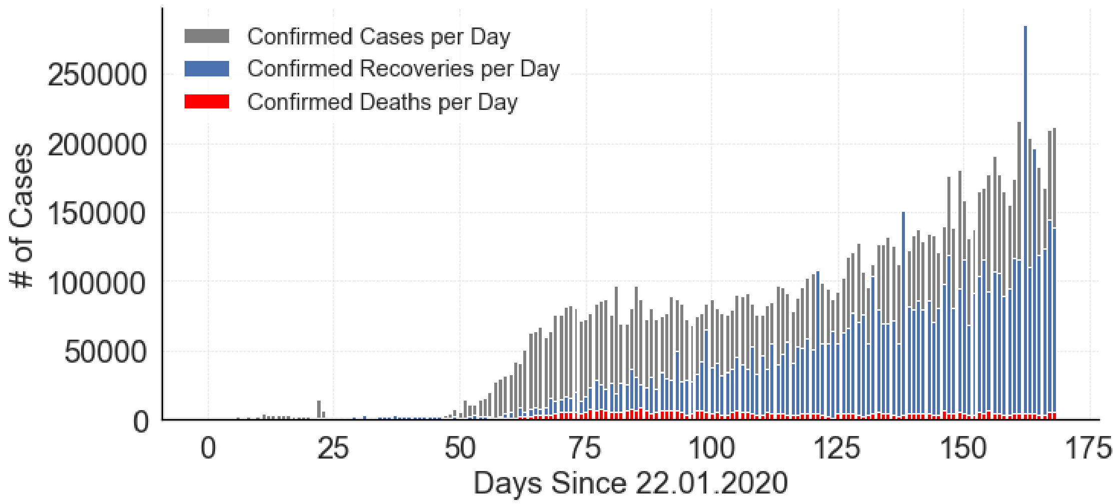


The following raw table shows the confirmed cases per country as have been selected based on their severity. The spread of Covid-19 in Europe based on the datasets arrived in Italy on the 31.01.2020. At the same time China had already approximately 10000 confirmed cases.

[18]:

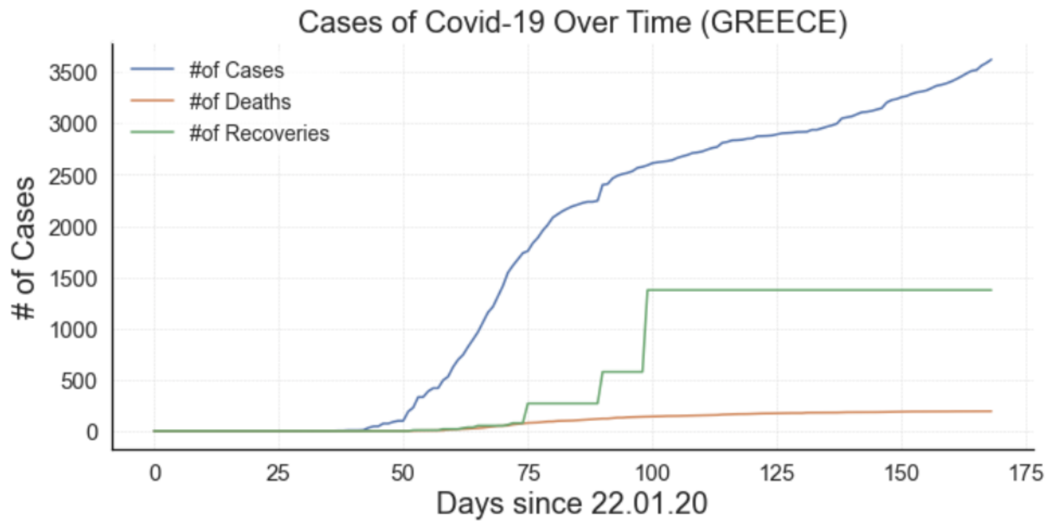
	Date	World Cases	China	Italy	Greece	Spain	US	Rest
0	22/01	555	548	0	0	0	1	6
1	23/01	654	643	0	0	0	1	10
...								
8	30/01	8234	8141	0	0	0	5	88
9	31/01	9927	9802	2	0	0	7	116

Trying to visualize the data and get a first understanding of the situation, Figure 3 shows the daily increase in confirmed, fatal and recovery cases worldwide. As can been seen after one and half month the virus had already contaminated more than 50000 people all over the globe. The cases reached their first maximum around the day 75, followed a plateau and continue to increasing today. The first small plateau, follows the delay on the pandemic definition of the virus from the health organizations, alongside with the different measures taken from different countries. The recovery cases started slowly to increase because of the unknown character of the virus, which hasn't yet have a known treatment.



4 Covid-19 in GREECE

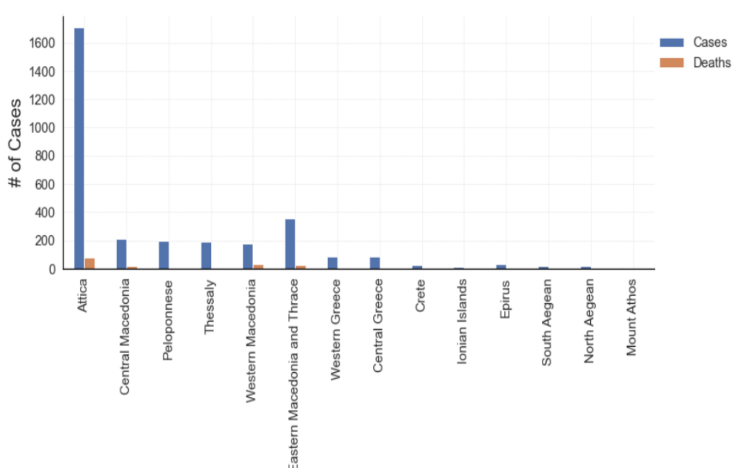
The COVID-19 pandemic in Greece is part of the worldwide pandemic of corona-virus disease 2019 (COVID-19) caused by severe acute respiratory syndrome corona-virus-2 (SARS-CoV-2). The first case in Greece was confirmed on 26 February 2020, when a 38-year-old woman from Thessaloniki who had recently visited Northern Italy, was confirmed to be infected. Subsequent cases in late February and early March related to people who had traveled to Italy and a group of pilgrims who had traveled to Israel and Egypt, as well as their contacts. The first death from COVID-19 in Greece was a 66-year-old man, who died on 12 March. As of 12 July 2020, there have been 3,803 confirmed cases and 193 deaths. After the opening of the Greek borders to tourists at the end of June, the daily number of confirmed cases announced includes those detected following tests at the country's entry gates. Figure 4 illustrates the number of the confirmed, fatal and recovery cases of Covid-19 over time in Greece since 22.01.2020, as have been plotted with data taken from the pandas dataframe 4 .



	Date	Confirmed_New_Cases	Deaths_New_cases	Recoveries_New_cases	Confirmed_Total_cases	Total_num_of_Deaths	Recoveries_Total_cases	In_Car
0	26 February 2020	1	0	0	1	0	0	
1	27 February 2020	2	0	0	3	0	0	
2	28 February 2020	1	0	0	4	0	0	
3	29 February 2020	3	0	0	7	0	0	
4	1 March 2020	0	0	0	7	0	0	

4.1 Group data by Region

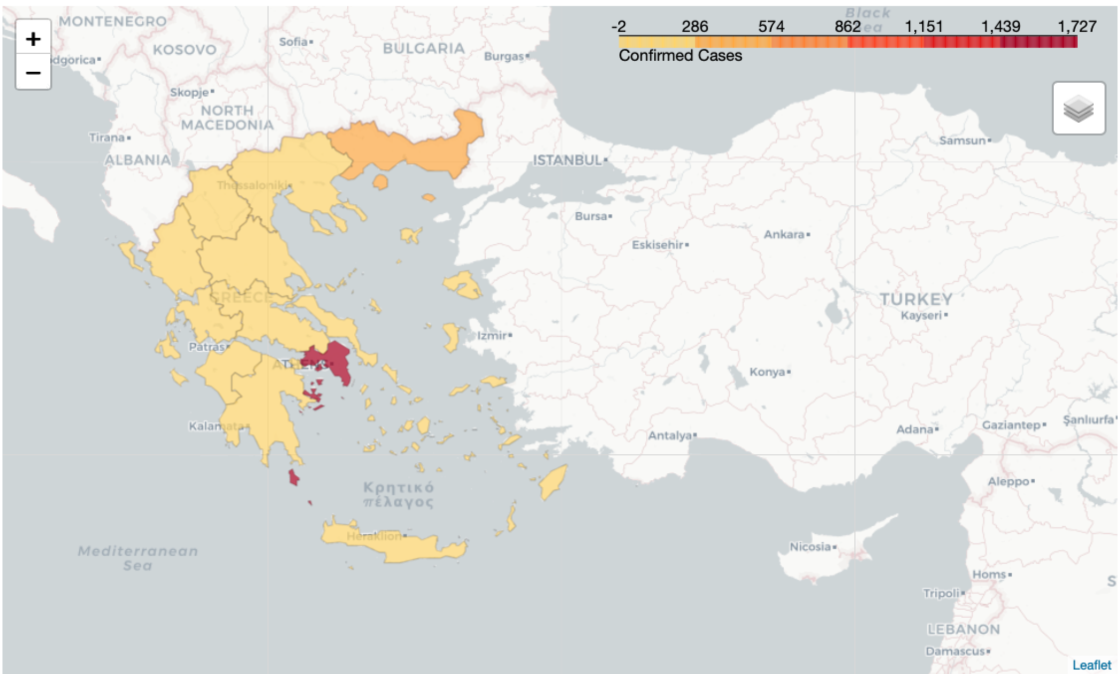
In order to visualize better the data, all the number of the confirmed cases of Covid-19 in Greece have been grouped by the Greek states where they stem from. Figure 5 depicts in a bar plot the grouped by the states data, accompanied by the relevant dataframe.



	Region	Cases	Deaths
0	Attica	1710	81
1	Central Macedonia	213	18
2	Peloponnese	200	1
3	Thessaly	188	2
4	Western Macedonia	180	29
5	Eastern Macedonia and Thrace	357	22
6	Western Greece	86	5
7	Central Greece	85	0
8	Crete	22	1
9	Ionian Islands	15	2
10	Epirus	31	0
11	South Aegean	21	0
12	North Aegean	19	1
13	Mount Athos	4	0

4.1.1 Folium and Choropleth visualization

Folium is a built on top python and it is used to visualize data through interactive maps, choropleth visualization, as well as parsing markers on data. To create a base map, simply pass your starting coordinates to Folium, and then use the choropleth module! The choropleth can be easily created by binding the data between Pandas DataFrames-Series and Geo-TopoJSON geometries. Here, the greece-regions.geojson file has been used, alongside with the data from the relevant dataframe. One point of interest is that the dataframe and the geojson file should have the same data format! In our case, the **cartodb_id** parameter has been used to matched the data. Figure 6, depicts the map of the Covid-19 outbreak in Greece as of 31th June, 2020 in for each greek state.

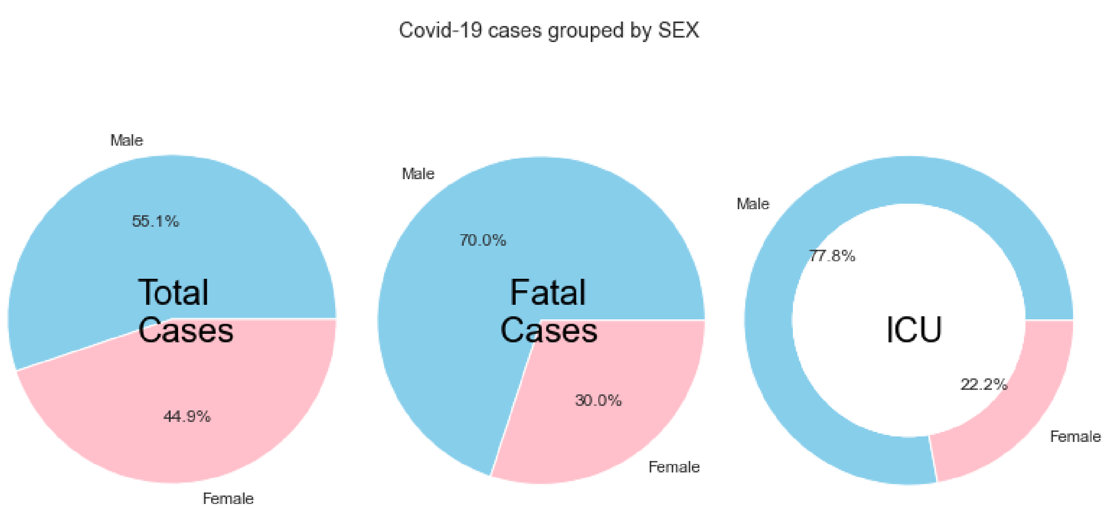


[522]:
```python
#. Create Map - Folium
#. Greece-healthsites-geojson
gr_geo          = 'http://data.humdata.org/dataset/
↪525dea17-87af-4521-9c0d-ce67994daa38/resource/
↪c7939d32-d451-4e7b-a9c6-ee77cf1b4166/download/greece.geojson'

#. Greece-prefectures-geojson
gr_prefectures = 'https://raw.githubusercontent.com/codeforamerica/
↪click_that_hood/master/public/data/greece-prefectures.geojson'

#. Greece-regions-geojson
gr_regions      = 'https://raw.githubusercontent.com/codeforamerica/
↪click_that_hood/master/public/data/greece-regions.geojson'

#. Reshape the dataframe to match the geojson file:
cov19_groupByRegion = cov19_groupByRegion_dropF
```

```python
#. Greece location :
latitude_ath     = 37.983810
longitude_ath    = 23.727539
location_gr      = [latitude_ath, longitude_ath]

wmap = folium.Map(location_gr, tiles='cartodbpositron', zoom_start=5.8)
wmap.choropleth(
    geo_data=gr_regions,
    name='choropleth',
    data=cov19_groupByRegion,
    columns=['cartodb_id','Cases'],
    key_on='feature.properties.cartodb_id',
    fill_color='YlOrRd',#'BuPu', #'YlOrRd',
    fill_opacity=0.7,
    line_opacity=0.2,
    legend_name='Confirmed Cases'
)
folium.LayerControl().add_to(wmap)
wmap
```

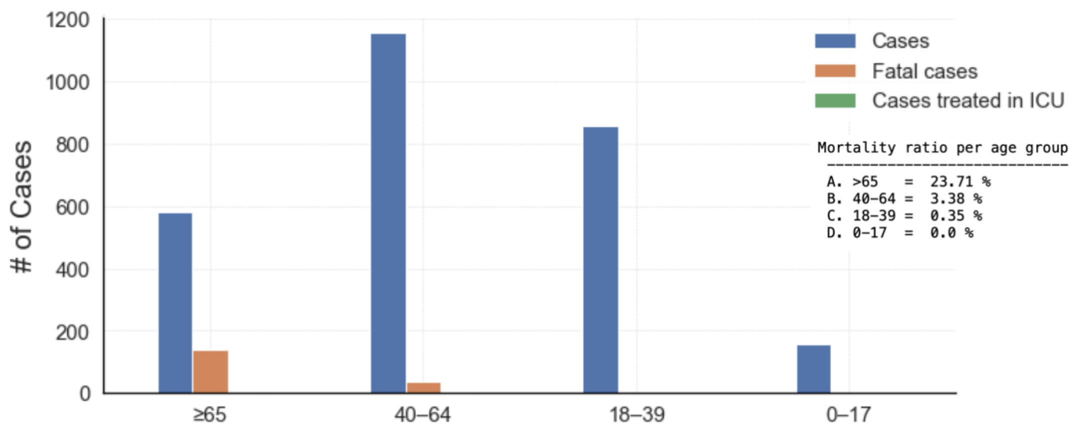
4.2 Group data by Sex

Figure 7 illustrates the Covid-19 outbreak in Greece, grouped by sex concerning the number of total, fatal and ICU cases, respectively. As can be deduced from the pie charts, men are more susceptible to the virus, having more intense symptoms as they hospitalized much more in ICUs than women, with a mortality rate of 8.3%.



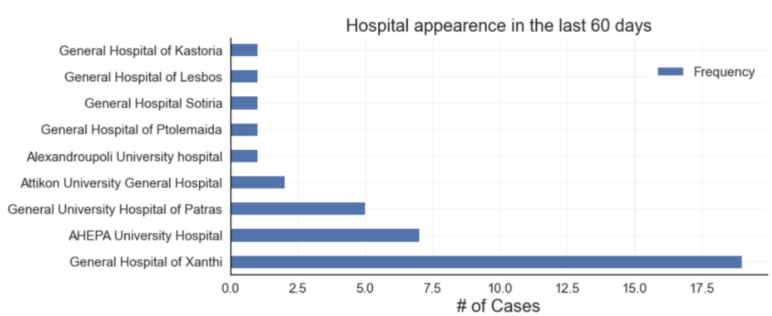
4.3 Group data by Age

The majority of people infected with coronavirus (COVID-19) in Greece were between the age of 40 to 64 years over the period under consideration. The younger ages are more tolerant against the virus and its symptoms, nonetheless, can be affected. On the most of the cases their symptoms are less intense or even absent. Figure 8 illustrates the Covid-19 outbreak in Greece, grouped by sex concerning the number of total, fatal and ICU cases, respectively. Additionally, the mortality ratio is also presented, where the mortality rate in case of contamination for the elders reaches the 23.7%.



4.4 Group data by Hospital name during the last 60 days

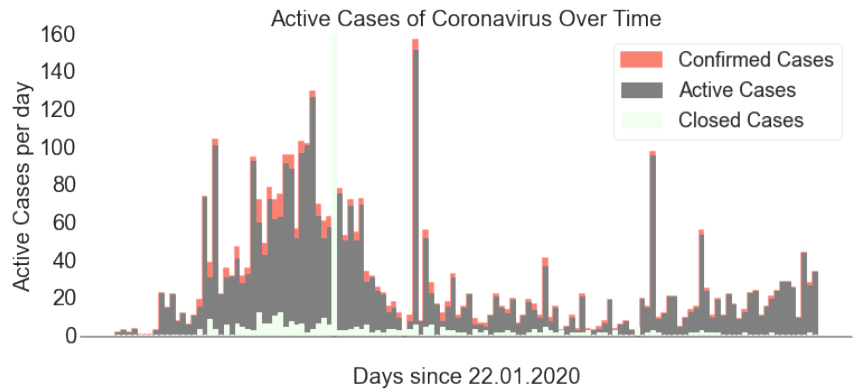
In this paragraph, the data are grouped based on the confirmed cases as published by the hospitals and their region. A file (covid19_tracking.xlsx) has been created, by gathering information from several covid-19 webpages around the web, but due to the size of the spread in Greece is quite tiny and new. That's is the reason along with the lack of time that made the select on the data that they are coming from the last 60 days of the pandemic. In order to process and visualize the data, they have been cleaned from empty, duplicate, meaningless data, and have been formatted accordingly in order to shape a pandas dataframe. Figure 9 illustrates the Covid-19 outbreak in Greece the last 60 days grouped by hospitals' name. The reason of this increase in smaller regions, like Xanthi, it is the lifting of measures especially between neighbor countries and especially, the boarder opening between Greece-Bulgaria. Roadtrips are now allowed for all Europe through Balkans while in these countries the Covid-19 is still high in numbers.



	Hospital	Frequency
0	General Hospital of Xanthi	19
1	AHEPA University Hospital	7
2	General University Hospital of Patras	5
3	Attikon University General Hospital	2
4	Alexandroupoli University hospital	1
5	General Hospital of Ptolemaida	1
6	General Hospital Sotiria	1
7	General Hospital of Lesbos	1
8	General Hospital of Kastoria	1

4.5 Active cases

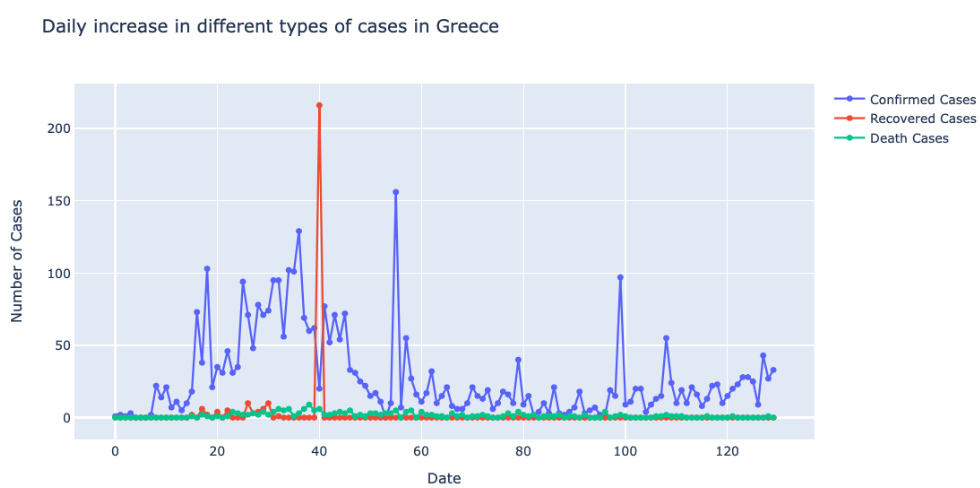
Most people who fall sick with COVID-19 will experience mild to moderate symptoms and recover without special treatment. Active cases are those that are confirmed without taking under consideration the closed cases, i.e. the fatal and the recovered ones. Figure 10 shows the number of confirmed, active and closed COVID-19 cases.



4.5.1 Growth Factor

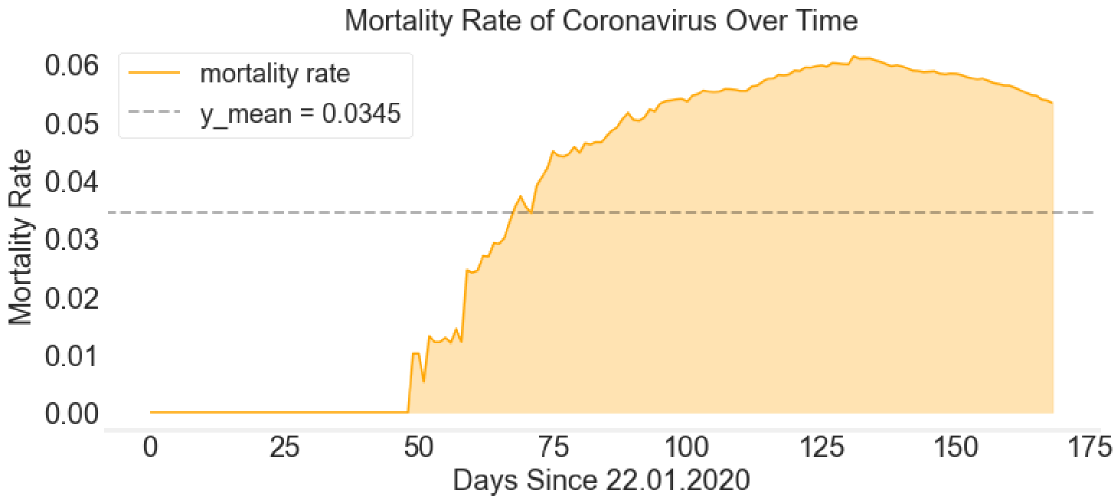
Growth factor is the factor by which a quantity multiplies itself over time. The formula used is, every day's new (Confirmed,Recovered,Deaths) over the new (Confirmed,Recovered,Deaths) on the previous day. A growth factor above 1 indicates an increase correspoding cases. A growth factor above 1 but trending downward is a positive sign, whereas a growth factor constantly above 1 is the sign of exponential growth. A growth factor constant at 1 indicates there is no change in any kind of cases. Figure 11 shows the daily increase in different type of COVID-19 cases.

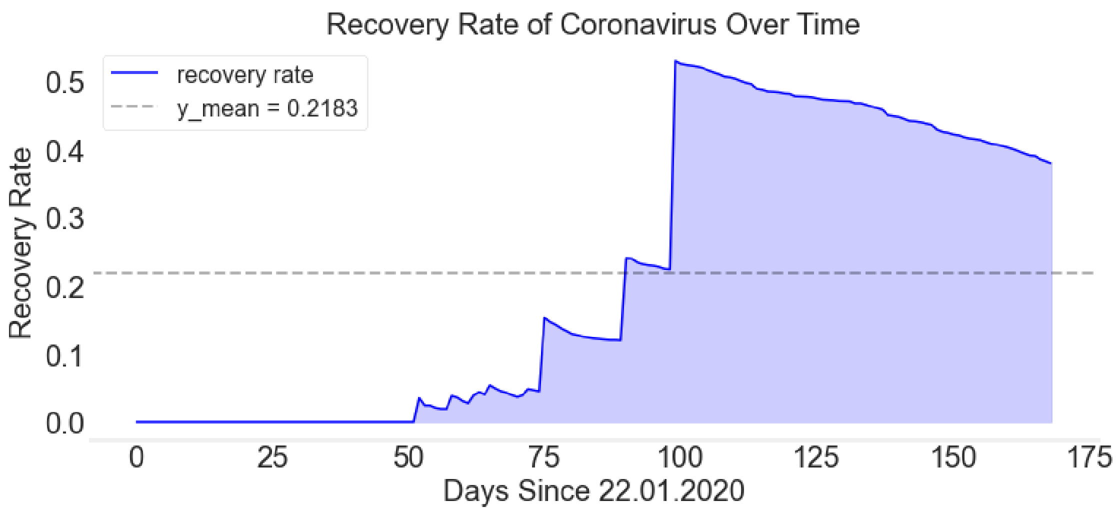
```
Median growth factor of number of Confirmed Cases :  1.0422535211267605
Median growth factor of number of Recovered Cases :  1.3333333333333333
Median growth factor of number of Death Cases     :  1.0
```



4.6 Greece: Mortality and Recovery Rates

The mortality statistics survey the number of deaths, while the recovery rate survey the number of recoveries accordingly. As has been calculated the average increase in number of Confirmed Cases every day is 28, from where there is an average increase in number of 2 recovered cases and 1 death cases every day respectively. Figure 12, and 13 are shown the mortality and recovery rates of Covid-19 cases over time.





5 Modeling

5.1 Predictions for confirmed coronavirus cases worldwide

Pre-processing is a crucial part to be done at the very beginning of any data science project. It includes dealing with NULL values, detecting outliers, removing irrelevant columns through analysis, and cleaning the data in general. First, let's make the necessary imports. We will make a few more when required down the line. Note that this is a relatively clean data set. Many real-life data sets contain a ton of missing values, outliers and completely irrelevant columns.

5.1.1 Import modeling modules

[68]:
```
import random
import math
import xgboost
from sklearn.linear_model import LinearRegression, BayesianRidge
from sklearn.model_selection import RandomizedSearchCV, train_test_split
from sklearn.preprocessing import PolynomialFeatures
from sklearn.tree import DecisionTreeRegressor
from sklearn.svm import SVR
from sklearn.metrics import mean_squared_error, mean_absolute_error
import operator
plt.style.use('fivethirtyeight')
%matplotlib inline
```

[171]:
```
import warnings
warnings.filterwarnings('ignore')
import seaborn as sns
import plotly.express as px
import plotly.graph_objects as go
from plotly.subplots import make_subplots
import datetime as dt
from datetime import timedelta
from sklearn.model_selection import GridSearchCV
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from sklearn.metrics import silhouette_score,silhouette_samples
from sklearn.linear_model import LinearRegression,Ridge,Lasso
from sklearn.svm import SVR
from sklearn.metrics import mean_squared_error,r2_score
import statsmodels.api as sm
from statsmodels.tsa.api import Holt,SimpleExpSmoothing,ExponentialSmoothing

#. fbprophet:
#. Implements a procedure for forecasting time series data based on an additive␣
↪model, where non-linear trends are fit with yearly, weekly, and daily␣
↪seasonality, plus holiday effects.
#!pip install fbprophet
from fbprophet import Prophet
print('fbprophet has been imported.')

from sklearn.preprocessing import PolynomialFeatures
from statsmodels.tsa.stattools import adfuller
```

```
#. pyramid:
#. Pyramid is a no-nonsense statistical Python library with a
#. solitary objective: bring R's auto.arima functionality to Python.
#!pip install pyramid-arima
#from pyramid.arima import auto_arima
#. or
!pip install pmdarima
from pmdarima.arima import auto_arima
print('pyramid.arima has been imported.')
print('Done.')


std=StandardScaler()
#pd.set_option('display.float_format', lambda x: '%.6f' % x)
```

5.2 Prediction using Machine Learning Models

The modeling of the data can be a straight-forward procedure when the dataframe is prepared. The first thing is to split the dataframe to train and test datasets in an analogy of 80-20%, using the **Train Test Split** functionality. Because this is a time series forecast, we will "chop off" a portion of our latest data and use that as the test set. Then we will train on the rest of the data and forecast into the future. Afterwards we can compare our forecast with the section of data we chopped off. Now that the model has been fitted to the training data, we can forecast into the future.

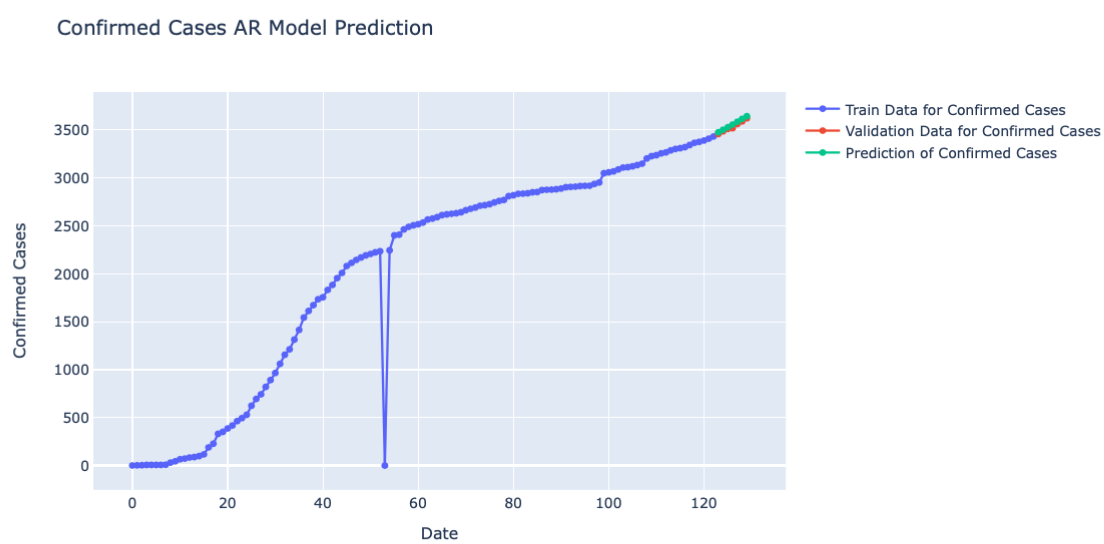
- Linear Regression for Prediction of Confirmed Cases
- Polynomial Regression for Prediction of Confirmed Cases
- Support Vector Machine ModelRegressor for Prediction of Confirmed Cases
- Time Series Forecasting (Holt's Linear Model, AR Model using AUTO ARIMA, MA Model using AUTO ARIMA and SARIMA Model using AUTO ARIMA)

We can then plot this to view how well our prediction forecast matched up with the test set for which we have the real data. We can also just compare this to the entire data set to get a larger picture of the context of our prediction. As can be seen from the table the best technique that can be used is the AR Model using AUTO ARIMA and it will be presented in the following subsection.

	Model Name	Root Mean Squared Error
4	Auto Regressive Model (AR)	23.73
3	Holt's Linear	30.89
5	Moving Average Model (MA)	34.96
6	SARIMA Model	34.96
1	Polynomial Regression	280.22
0	Linear Regression	475.25
2	Support Vector Machine Regressor	875.35

The Auto Regressive (AR) Model

The Auto-Regression is a time series model that uses observations from previous time steps as input to a regression equation to predict the value at the next time step. It is a very simple idea that can result in accurate forecasts on a range of time series problems. Time Series have several key features such as trend, seasonality, and noise. Forecasting is the process of making predictions of the future, based on past and present data. One of the most common methods for this is the ARIMA model, which stands for AutoRegressive Integrated Moving Average. Figure 16 is depicted the prediction of the Covid-19 confirmed cases for the next three weeks.



5.3 Use Foursquare location data for Athens, GR

Foursquare is a location technology platform dedicated to improving how people move through the real world. It put the most trusted, independent location data and technology platform to work for you. Python provides an advanced, but easy to use foursquare API client that handles OAuth, automatic retries, and other niceties. When the corresponding URL is defined, GET Request is sent to the Foursquare API and the API examines and returns the results.

[589]:
```
from geopy.geocoders import Nominatim

#Get coordinates of Athens
#address = 'Rimini Street 1, 12462, GR' #. Attikon Hospital
#address = 'Athens, GR' # Omonoia
address = '15 Dionysiou Areopagitou Street, 11742, GR' # Acropolis

geolocator = Nominatim(user_agent="foursquare_agent")
location = geolocator.geocode(address)
latitude = location.latitude
longitude = location.longitude
print('The geograpical coordinate of ATHENS are {}, {}.'.format(latitude,␣
↪longitude))
```

```
The geograpical coordinate of ATHENS are 37.9684941, 23.728487.
```

[667]:
```
CLIENT_ID = 'add-your-client-id' # your Foursquare ID
CLIENT_SECRET = 'add-your-client-secret' # your Foursquare Secret
VERSION = '20180605' # Foursquare API version

print('Your credentails:')
print('CLIENT_ID: ' + CLIENT_ID)
print('CLIENT_SECRET:' + CLIENT_SECRET)
```

```
Your credentails:
CLIENT_ID: add-your-client-id
CLIENT_SECRET:add-your-client-secret
```

[591]:
```
LIMIT  = 100 # limit of number of venues returned by Foursquare API
radius = 500 # define radius

# create URL
url = 'https://api.foursquare.com/v2/venues/explore?
↪&client_id={}&client_secret={}&v={}&ll={},{}&radius={}&limit={}'.format(
    CLIENT_ID,
    CLIENT_SECRET,
    VERSION,
    latitude,
    longitude,
    radius,
```

```
    LIMIT)
url
```

[591]: 'https://api.foursquare.com/v2/venues/explore?&client_id=NNXML3OL3WRORKINO5CD5TS DESZWULPTOTIWM1OJLWY35GSE&client_secret=RZLDDFAE4VR24V4IBQBUD2DZSVC3IARI450G34QX ZAOOFPWT&v=20180605&ll=37.9684941,23.728487&radius=500&limit=100'

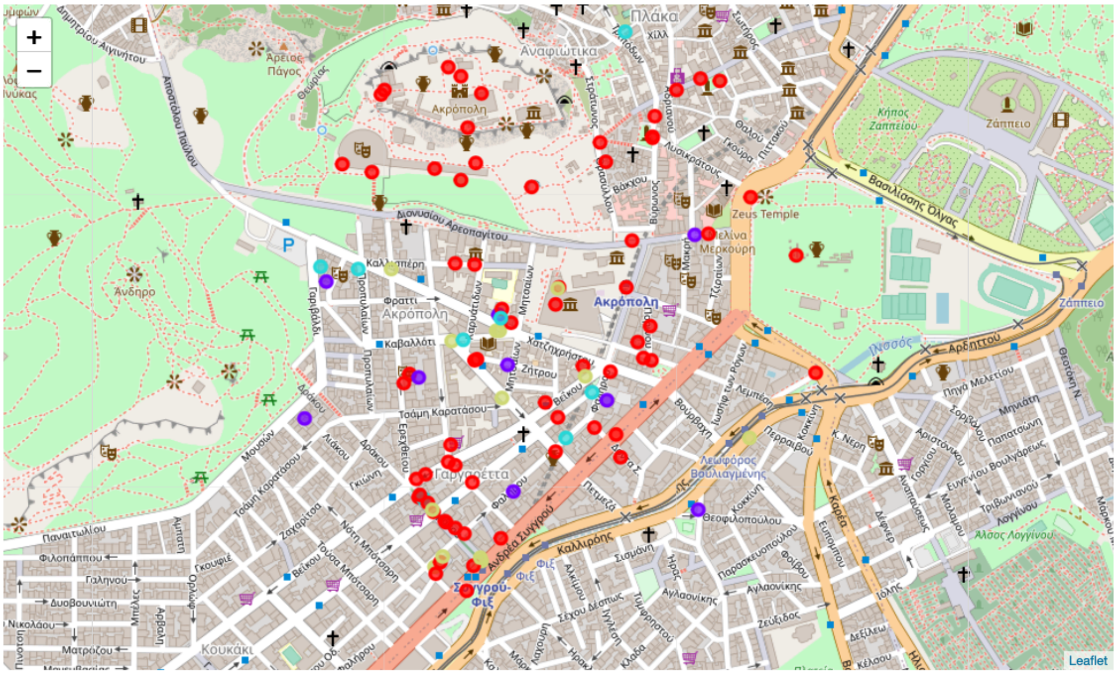
[592]:
```
results = requests.get(url).json()
results
```

Now the data from foursquare, in JSON format, can be transformed into a pandas dataframe. From there, select a city with its address and get the category types. From them the venues can be extracted and filtered based on the vicinity to the selected borough. Once again with the use of folium a map can be generated in order to visualize the location of the venues. Most importantly, the classification of these venues can give us a useful insight.

5.3.1 Cluster Analysis

In this part, we will conduct K-means clustering to group the boroughs according to what convenience facilities they have using Foursquare data. Figure **??** illustrates the clusterization of the Acropolis borough in Athens. As can been seen from the clusterization of the nearby venues, several touristic attractions are located in Acropolis. There are plenty of places in this iconic neighbourhood of Athens, that can either boost the economy by welcoming more clients especially the Spring and Summer periods or deteriorate the health system by strengthening the spread of the virus, creating new hot spots.

[598]:
```
# K Means Clustering
from sklearn.cluster import KMeans
import matplotlib.cm as cm
import matplotlib.colors as colors
```



5.4 What we have learnt:

This tutorial has described a simple method to build a predictor for the end of the COVID-19 epidemics in Greece. From this tutorial we have learned that:

1. a preliminary data exploration must be done before building a predictor.
2. the predictor should be built by taking into account also the real life (in our case, the restriction laws introduced by the Greek government and their effects after a week);
3. once the predictor is built, also errors should be considered. Thus the range of errors must be calculated in order to have a more accurate prediction;
4. a comparison between real (new) data and the predictor is always welcome, because it allows you to verify whether the model is correct or not.

5.5 Measures in Greece

Greece applied plenty of measures before, during and after the lockdown. All of them are summarized here briefly.

1. Restrictions concerning third-country nationals
2. Restrictions regarding passenger transport
3. Extensions of seafarers' certificates

4. Suspension of businesses and workplaces
5. Closure of educational institutions
6. Suspension of religious services
7. Refugees and migrants

8. Personal protection equipment and distance.

The aforementioned measures following the safety of the public against this pandemia, led to several problems nationwide. The main problem arisen from the economy while the health of the public was prioritized and protected in order to avoid saturations as has been observed in other severely affected countries. Several relief measures (tax, employment, social security and more) have been applied by the greek goverment in order to protect everyone. The Hellenic Ministry of Health has formed a 3-member committee responsible for the review and employment of all the donations in support of the National Healthcare System during the COVID-19 pandemic. Exemptions including cargo, sanitary, humanitarian, state, military, ferry and Frontex flights, as well as flights in support of the Hellenic National Healthcare System, those for repatriation of Greek citizens and emergency flights have been arranged accordingly.

5.6 Conclusion

As can been seen from the clusterization of the nearby venues, several touristic attractions are located in Acropolis, which can be equally safe or risky for both locals and tourists. There are plenty of places in this iconic neighbourhood of Athens, that can either boost the economy by welcoming more clients especially the Spring and Summer periods or deteriorate the health system by strengthening the spread of the virus, creating new hot spots. In other terms, during the confinement measures all the businesses and workplaces (cafeterias, restaurants, museums, hotels, etc.) closed in order to limit the spread of the covid-19 virus. Public transportation had a limited per capacity use, with an obligatory use of Personal Protection Equipment (mask, gloves, gels, face-screens, etc.) in the closed spaces. Only some exemptions were applied on cafes and restaurants that they are able to provide their services by working with deliveries. Later on, people were able to enjoy their staying outside for an hour providing all the necessary details via sms or paper. However, at first glance it is either the economy or the health system of a country that will be affected by the pandemia. In some case unfortunately this happened simultaneously... Before the pandemia an iconic place like Acropolis used to be described as a history in motion, the center of intellect, entertainment and gastronomy... while during the pandemia can be refered as potentially dangerous for the public health due to its variety. Haelth versus economy all day long... Without a balance economy might and will be unfortunately translated to health...