MODELLING

Project: Analysis of different measures taken by different countries to control the spread of Covid-19 virus

Team Members

Nisha Ramrakhyani (Student Id: 801208678)
Punit Mashruwala (Student Id: 801208416)
Zalak Panchal (Student Id: 801196881)

Research Question: *Building a model to forecast the number of Covid cases across the world*

This basic Jupyter Notebook shows exploratory analysis of number of covid cases across the world, no. of deaths across the world and the predictive model for forecasting the number of covid cases across the world.

In [10]:

```
import numpy as np
import pandas as pd

from sklearn.preprocessing import LabelEncoder
from sklearn.impute import SimpleImputer

from matplotlib import pyplot as plt
import seaborn as sns

from sklearn.linear_model import LinearRegression
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import PolynomialFeatures
from sklearn.svm import SVR
from sklearn.metrics import mean_squared_error, mean_absolute_error
```

In [4]:

```python
dataset = pd.read_excel('covid_19_data.xlsx')
# print(dataset.head())
print(dataset.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4143 entries, 0 to 4142
Data columns (total 19 columns):
 #   Column              Non-Null Count  Dtype
---  ------              --------------  -----
 0   ID                  4143 non-null   int64
 1   ISO                 4143 non-null   object
 2   COUNTRY             4143 non-null   object
 3   REGION              4143 non-null   object
 4   LOG_TYPE            4143 non-null   object
 5   CATEGORY            4143 non-null   object
 6   MEASURE             4143 non-null   object
 7   TARGETED_POP_GROUP  1386 non-null   object
 8   COMMENTS            4137 non-null   object
 9   NON_COMPLIANCE      4095 non-null   object
 10  DATE_IMPLEMENTED    4117 non-null   datetime64[ns]
 11  SOURCE              4142 non-null   object
 12  SOURCE_TYPE         4142 non-null   object
 13  LINK                4141 non-null   object
 14  ENTRY_DATE          4143 non-null   datetime64[ns]
 15  covid_case_per_date 4112 non-null   float64
 16  Total_Covid_cases   4114 non-null   float64
 17  Total no. of tests  2857 non-null   object
 18  population          4143 non-null   int64
dtypes: datetime64[ns](2), float64(2), int64(2), object(13)
memory usage: 615.1+ KB
None
```

In [5]:

```
df = dataset[['COUNTRY','CATEGORY', 'MEASURE', 'COMMENTS', 'DATE_IMPLEMENTED'
print(df.head())
```

```
     COUNTRY                                CATEGORY  \
0  Australia  Governance and socio-economic measures
1  Australia  Governance and socio-economic measures
2  Australia                   Movement restrictions
3  Australia                  Public health measures
4  Australia                  Public health measures

                                             MEASURE  \
0  Emergency administrative structures activated ...
1                                  Economic measures
2                                  Visa restrictions
3                     Isolation and quarantine policies
4                 Strengthening the public health system

                                            COMMENTS DATE_IMPLEMENTED  \
0  Australian Health Sector Emergency Plan Activated       2020-02-17
1  Implementation of an economic response to the ...       2020-03-01
2  Citizens from China, Italy, South Korea, Iran,...       2020-03-01
3  14 days self-quarantine, for nationals arrivin...       2020-03-01
4                          Additional masks and funding       2020-03-12

   covid_case_per_date  population
0                 15.0    25499884
1                 14.0    25499884
2                 14.0    25499884
3                 14.0    25499884
4                 28.0    25499884
```

In [6]:

```
df['DATE_IMPLEMENTED'] =  pd.to_datetime(df['DATE_IMPLEMENTED'])
print(df['DATE_IMPLEMENTED'])
```

```
0      2020-02-17
1      2020-03-01
2      2020-03-01
3      2020-03-01
4      2020-03-12
          ...
4138   2020-11-02
4139   2020-11-02
4140   2020-11-02
4141   2020-11-02
4142   2020-11-02
Name: DATE_IMPLEMENTED, Length: 4143, dtype: datetime64[ns]

<ipython-input-6-4e7c7897de5b>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-doc
s/stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://p
andas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-vi
ew-versus-a-copy)
  df['DATE_IMPLEMENTED'] =  pd.to_datetime(df['DATE_IMPLEMENTED'])
```

In [7]:

```
df.isnull().sum()
```

Out[7]:

```
COUNTRY              0
CATEGORY             0
MEASURE              0
COMMENTS             6
DATE_IMPLEMENTED    26
covid_case_per_date 31
population           0
dtype: int64
```

In [8]:

```
df = df[df['DATE_IMPLEMENTED'].notna()]
df = df[df['covid_case_per_date'].notna()]
df.isnull().sum()
```

Out[8]:

```
COUNTRY             0
CATEGORY            0
MEASURE             0
COMMENTS            5
DATE_IMPLEMENTED    0
covid_case_per_date 0
population          0
dtype: int64
```

In [9]:

```
country_array = df.COUNTRY.unique()
country_array.sort()
country_array
```

Out[9]:

```
array(['Australia', 'Belgium', 'Canada', 'France', 'Germany', 'India',
       'Italy', 'Mexico', 'New Zealand', 'Norway', 'Singapore', 'Spain',
       'Sri Lanka', 'Sweden', 'United Kingdom', 'United States'],
      dtype=object)
```

In [11]:

```
covid_data = pd.read_excel("new_covid.xlsx")
covid_data
print(covid_data.isnull().sum())
```

```
iso_code             0
continent            0
location             0
date                 0
total_cases        196
new_cases           23
total_deaths       764
new_deaths          23
new_tests         1866
total_tests       2075
tests_per_case    1654
population           0
dtype: int64
```

In [12]:

```
constant_imputer=SimpleImputer(strategy='constant', fill_value=0)
covid_data.iloc[:]=constant_imputer.fit_transform(covid_data)
print(covid_data.isnull().sum())
```

```
iso_code          0
continent         0
location          0
date              0
total_cases       0
new_cases         0
total_deaths      0
new_deaths        0
new_tests         0
total_tests       0
tests_per_case    0
population        0
dtype: int64
```

In [13]:

```
dates = covid_data['date'].unique()
```

In [16]:

```
# here selected countries are: 'Australia', 'Belgium', 'Canada', 'France', 'G
confirmed_cases = []
confirmed_deaths = []
test_conducted = []
for i in dates:
    dataaa = covid_data[covid_data['date'] == i]
    confirmed_sum = dataaa['total_cases'].sum()
    death_sum = dataaa['total_deaths'].sum()
    test_sum = dataaa['total_tests'].sum()

    confirmed_cases.append(confirmed_sum)
    confirmed_deaths.append(death_sum)
    test_conducted.append(test_sum)

# Removing last data as in some of records they are not captured
confirmed_cases = confirmed_cases[:320]
confirmed_deaths = confirmed_deaths[:320]
test_conducted = test_conducted[:320]
# print(confirmed_cases)
# print(confirmed_deaths)
# print(test_conducted)
print(len(confirmed_cases))
print(len(confirmed_deaths))
print(len(test_conducted))
```

```
320
320
320
```

In [17]:

```
def diff_function(data):
    d = []
    for i in range(len(data)):
        if i == 0:
            d.append(data[0])
        else:
            val = data[i]-data[i-1]
            if val < 0:
                d.append(0)
            else:
                d.append(val)

    return d
```

In [18]:

```
daily_increase = diff_function(confirmed_cases)
daily_death = diff_function(confirmed_deaths)
daily_test = diff_function(test_conducted)
# daily_increase
```

In [19]:

```
days_since = np.array([i for i in range(len(dates))]).reshape(-1, 1)
# print(days_since)
days_since = days_since[:320]

confirmed_cases = np.array(confirmed_cases).reshape(-1, 1)
confirmed_deaths = np.array(confirmed_deaths).reshape(-1, 1)
test_conducted = np.array(test_conducted).reshape(-1, 1)
```

In [20]:

```
days_in_future = 20
print(len(dates))
future_forecast = np.array([i for i in range(len(dates)+days_in_future)]).res
adjusted_dates = future_forecast[:-49]
print(len(adjusted_dates))
future_forecast
```

In [21]:

```
import datetime
start = '1/22/2020'
start_date = datetime.datetime.strptime(start, '%m/%d/%Y')
future_forecast_dates = []
for i in range(len(future_forecast)):
    future_forecast_dates.append((start_date + datetime.timedelta(days=i)).st
```

In [22]:

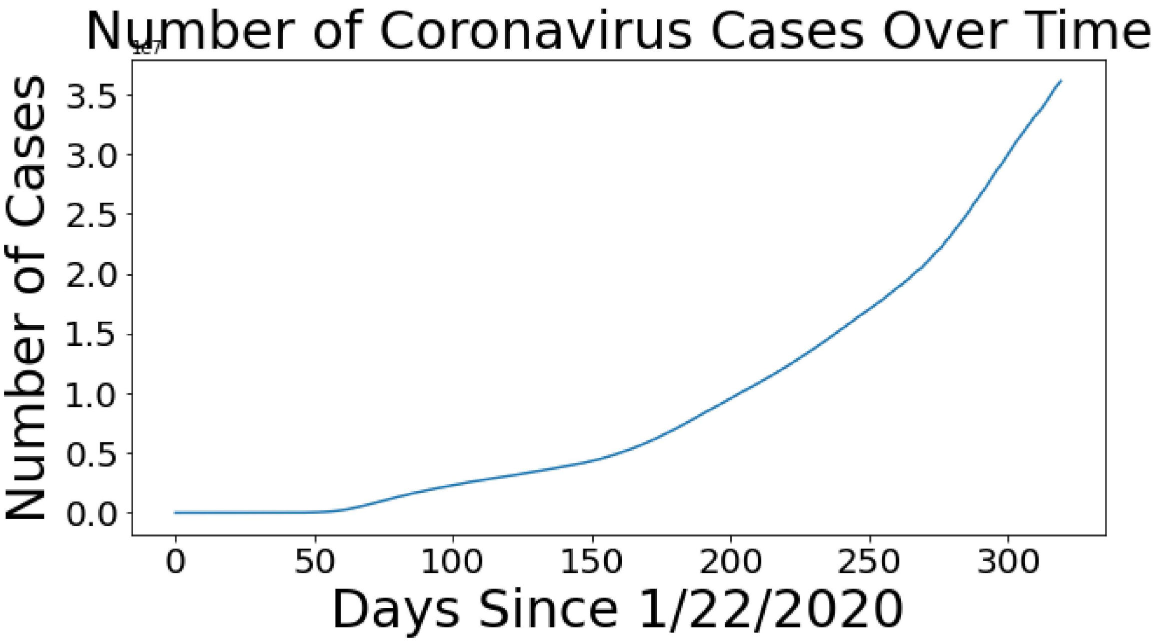
```
future_forecast_dates
```

Out[22]:

```
['01/22/2020',
 '01/23/2020',
 '01/24/2020',
 '01/25/2020',
 '01/26/2020',
 '01/27/2020',
 '01/28/2020',
 '01/29/2020',
 '01/30/2020',
 '01/31/2020',
 '02/01/2020',
 '02/02/2020',
 '02/03/2020',
 '02/04/2020',
 '02/05/2020',
 '02/06/2020',
 '02/07/2020',
 '02/08/2020',
 '02/09/2020',
```

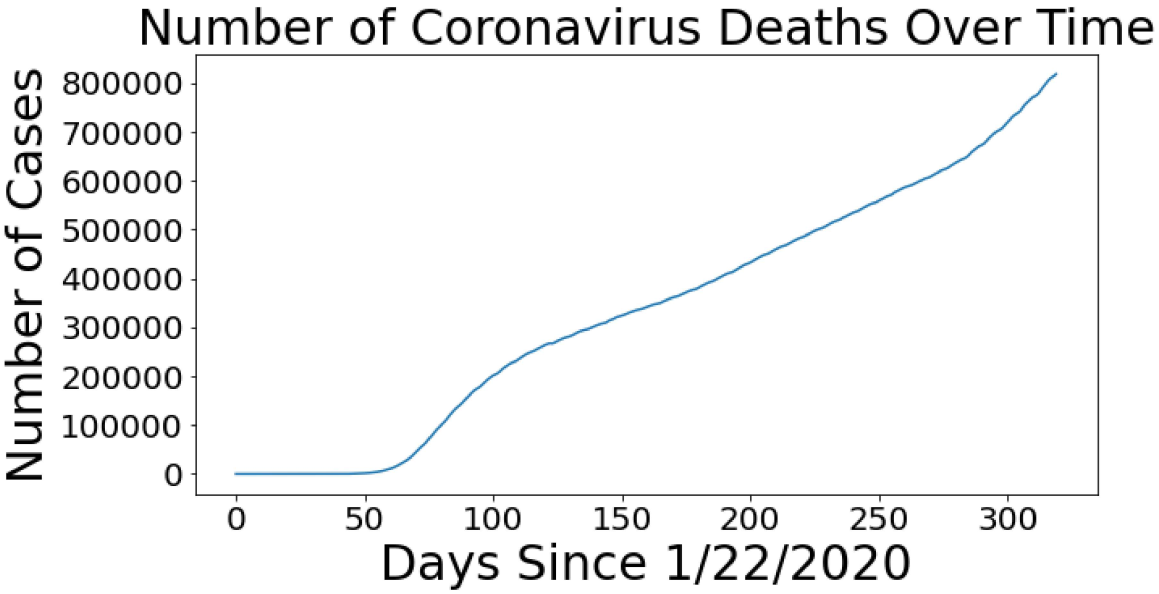
In [32]:

```
adjusted_dates = adjusted_dates.reshape(1, -1)[0]
plt.figure(figsize=(10, 5))
plt.plot(adjusted_dates, confirmed_cases)
plt.title('Number of Coronavirus Cases Over Time', size=30)
plt.xlabel('Days Since 1/22/2020', size=30)
plt.ylabel('Number of Cases', size=30)
plt.xticks(size=20)
plt.yticks(size=20)
plt.show()
```



In [33]:

```
plt.figure(figsize=(10,5))
plt.plot(adjusted_dates, confirmed_deaths)
plt.title('Number of Coronavirus Deaths Over Time', size=30)
plt.xlabel('Days Since 1/22/2020', size=30)
plt.ylabel('Number of Cases', size=30)
plt.xticks(size=20)
plt.yticks(size=20)
plt.show()
```



In [23]:

```
from sklearn.model_selection import train_test_split
X_train_confirmed, X_test_confirmed, y_train_confirmed, y_test_confirmed = tr
print(len(X_train_confirmed))
print(len(X_test_confirmed))
print(len(y_train_confirmed))
print(len(y_test_confirmed))
```

```
220
100
220
100
```

In [24]:

```
# Predicting using Polynomial Features
poly = PolynomialFeatures(degree=3)
poly_X_train_confirmed = poly.fit_transform(X_train_confirmed)
poly_X_test_confirmed = poly.fit_transform(X_test_confirmed)
poly_future_forecast = poly.fit_transform(future_forecast)
```

In [25]:

```
# Linear regression
linear_model = LinearRegression(normalize=True, fit_intercept=False)
linear_model.fit(poly_X_train_confirmed, y_train_confirmed)
test_linear_pred = linear_model.predict(poly_X_test_confirmed)
linear_pred = linear_model.predict(poly_future_forecast)
print('MAE:', mean_absolute_error(test_linear_pred, y_test_confirmed))
print('MSE:',mean_squared_error(test_linear_pred, y_test_confirmed))
```

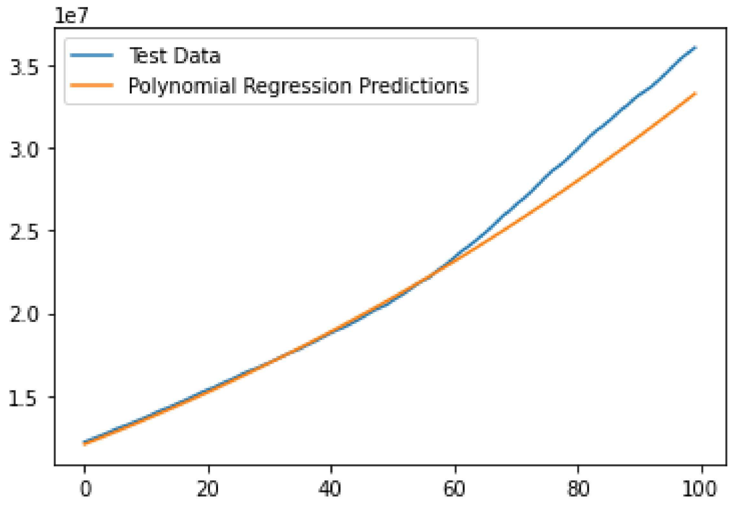
```
MAE: 760076.3281707081
MSE: 1467099793394.4988
```

In [26]:

```
plt.plot(y_test_confirmed)
plt.plot(test_linear_pred)
plt.legend(['Test Data', 'Polynomial Regression Predictions'])
```

Out[26]:

```
<matplotlib.legend.Legend at 0x1e79dbb48b0>
```



In [27]:

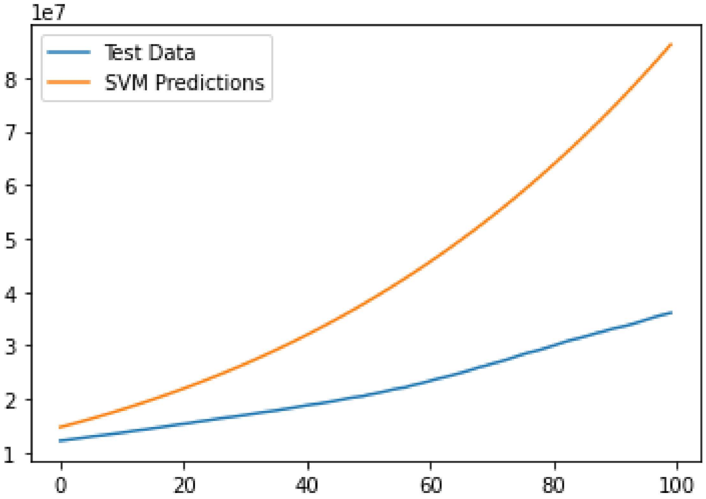
```
# Using SVM model to predict

# svm_confirmed = svm_search.best_estimator_
svm_confirmed = SVR(shrinking=True, kernel='poly',gamma=0.01, epsilon=1,degre
svm_confirmed.fit(X_train_confirmed, y_train_confirmed)
svm_pred = svm_confirmed.predict(future_forecast)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\utils\validation.py:72:
DataConversionWarning: A column-vector y was passed when a 1d array was exp
ected. Please change the shape of y to (n_samples, ), for example using rav
el().
  return f(**kwargs)
```

In [28]:

```
svm_test_pred = svm_confirmed.predict(X_test_confirmed)
plt.plot(y_test_confirmed)
plt.plot(svm_test_pred)
plt.legend(['Test Data', 'SVM Predictions'])
print('MAE:', mean_absolute_error(svm_test_pred, y_test_confirmed))
print('MSE:',mean_squared_error(svm_test_pred, y_test_confirmed))
```

```
MAE: 20024573.832694203
MSE: 586909261681649.8
```

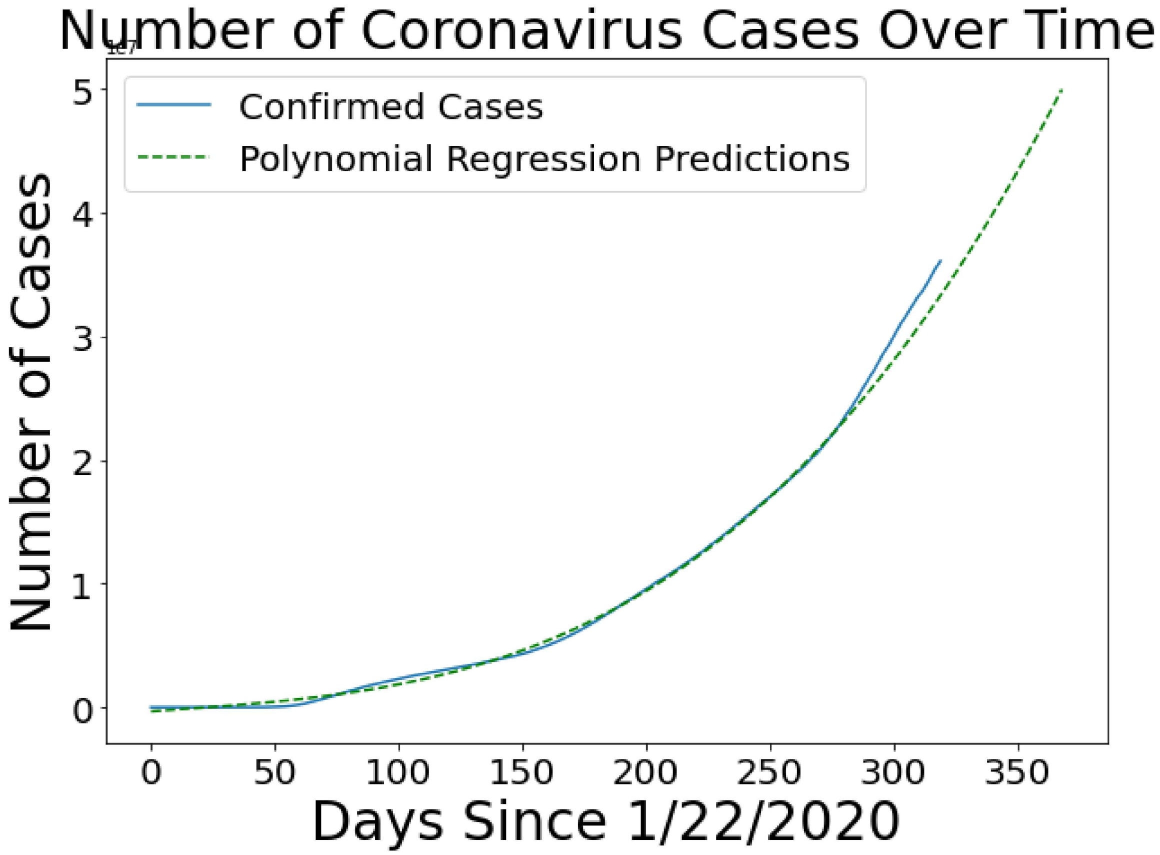


In [36]:

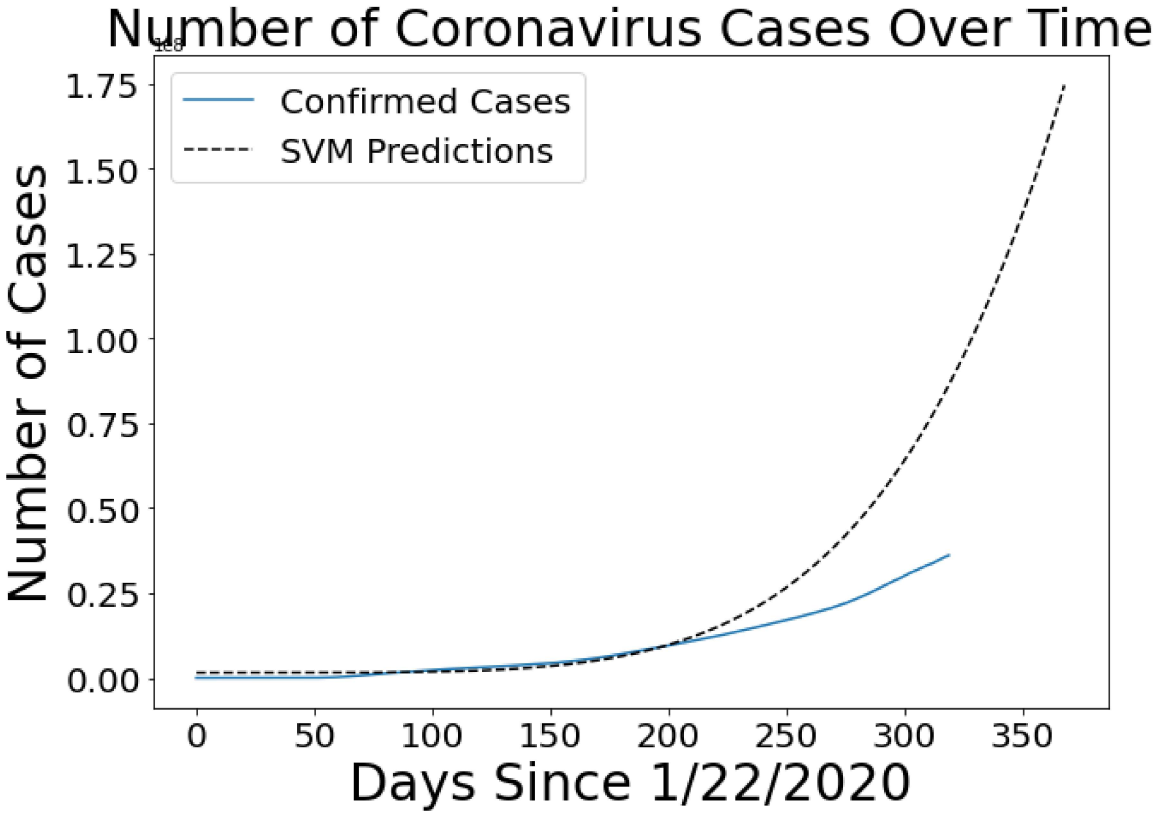
```
def plot_predictions(x, y, pred, algo_name, color, line_style, title, x_title
    plt.figure(figsize=(10,7))
    plt.plot(x, y)
    plt.plot(future_forecast, pred, linestyle=line_style, color=color)
    plt.title(title, size=30)
    plt.xlabel(x_title, size=30)
    plt.ylabel(y_title, size=30)
    plt.legend(['Confirmed Cases', algo_name], prop={'size': 20})
    plt.xticks(size=20)
    plt.yticks(size=20)
    plt.show()
```

In [37]:

```
plot_predictions(adjusted_dates, confirmed_cases, linear_pred, 'Polynomial Re
```



```
In [39]:   tes, confirmed_cases, svm_pred, 'SVM Predictions', 'black', 'dashed', 'Number
```



In [41]:

```
plt.style.use('fivethirtyeight')
# Future predictions using polynomial regression
linear_pred = linear_pred.reshape(1,-1)[0]
poly_df = pd.DataFrame({'Date': future_forecast_dates[-20:], 'Predicted numbe
poly_df
```

Out[41]:

	Date	Predicted number of Confirmed Cases
0	01/05/2021	42945960.0
1	01/06/2021	43296904.0
2	01/07/2021	43649815.0
3	01/08/2021	44004697.0
4	01/09/2021	44361556.0
5	01/10/2021	44720399.0
6	01/11/2021	45081230.0
7	01/12/2021	45444056.0
8	01/13/2021	45808882.0
9	01/14/2021	46175713.0
10	01/15/2021	46544557.0
11	01/16/2021	46915418.0
12	01/17/2021	47288302.0
13	01/18/2021	47663215.0
14	01/19/2021	48040163.0
15	01/20/2021	48419151.0
16	01/21/2021	48800184.0
17	01/22/2021	49183270.0
18	01/23/2021	49568413.0
19	01/24/2021	49955619.0

In [42]:

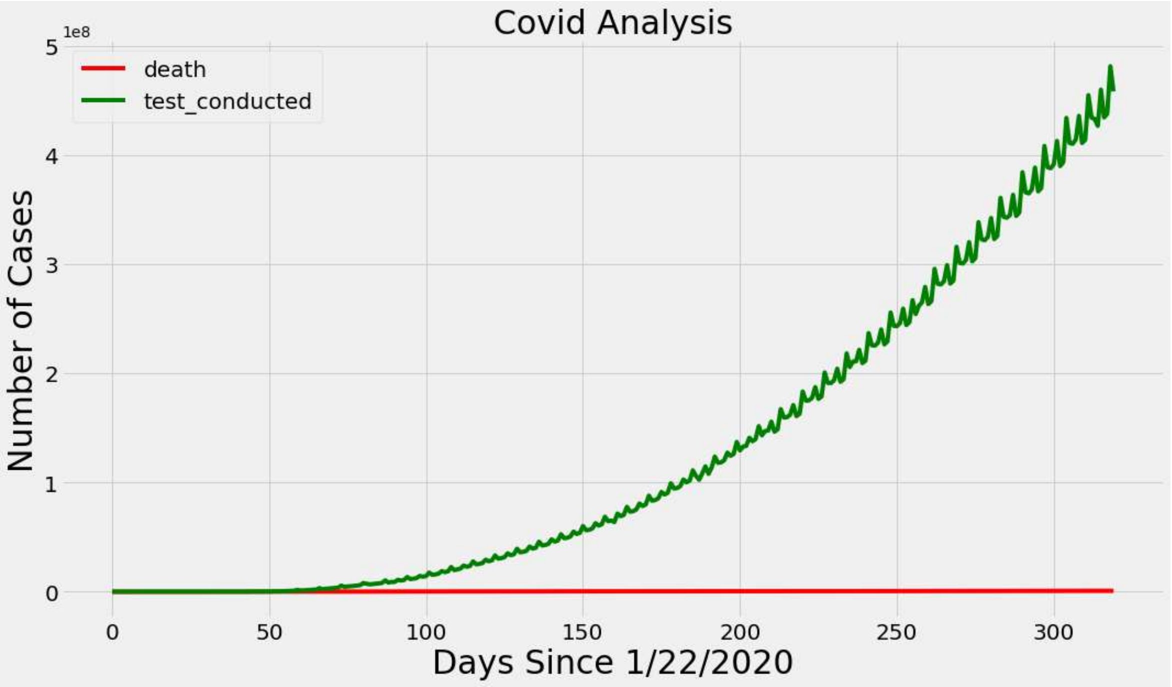
```
# Future predictions using SVM
svm_df = pd.DataFrame({'Date': future_forecast_dates[-20:], 'SVM Predicted #
svm_df
```

Out[42]:

```
          Date  SVM Predicted # of Confirmed Cases
 0  01/05/2021                          134261972.0
 1  01/06/2021                          136174565.0
 2  01/07/2021                          138109141.0
 3  01/08/2021                          140065890.0
 4  01/09/2021                          142045001.0
 5  01/10/2021                          144046665.0
 6  01/11/2021                          146071076.0
 7  01/12/2021                          148118426.0
 8  01/13/2021                          150188910.0
 9  01/14/2021                          152282723.0
10  01/15/2021                          154400061.0
11  01/16/2021                          156541123.0
12  01/17/2021                          158706107.0
13  01/18/2021                          160895213.0
14  01/19/2021                          163108642.0
15  01/20/2021                          165346597.0
16  01/21/2021                          167609280.0
17  01/22/2021                          169896896.0
18  01/23/2021                          172209650.0
19  01/24/2021                          174547749.0
```

In [43]:

```
plt.figure(figsize=(16, 9))
plt.plot(adjusted_dates, confirmed_deaths, color='r')
plt.plot(adjusted_dates, test_conducted, color='green')
plt.legend(['death', 'test_conducted'], loc='best', fontsize=20)
plt.title('Covid Analysis', size=30)
plt.xlabel('Days Since 1/22/2020', size=30)
plt.ylabel('Number of Cases', size=30)
plt.xticks(size=20)
plt.yticks(size=20)
plt.show()
```


Covid Analysis
1e8
Number of Cases
death
test_conducted
Days Since 1/22/2020