In [1]:
```
# stretch Jupyter coding blocks to fit screen
from IPython.core.display import display, HTML
display(HTML("<style>.container { width:75% !important; }</style>"))
# if 100% it would fit the screen
```

In [2]:
```
! pip install lxml html5lib beautifulsoup4
```

```
Requirement already satisfied: lxml in /opt/anaconda3/lib/python3.8/site-packages (4.6.3)
Requirement already satisfied: html5lib in /opt/anaconda3/lib/python3.8/site-packages (1.1)
Requirement already satisfied: beautifulsoup4 in /opt/anaconda3/lib/python3.8/site-packages (4.9.3)
Requirement already satisfied: soupsieve>1.2 in /opt/anaconda3/lib/python3.8/site-packages (from beautifulsoup4) (2.2.1)
Requirement already satisfied: webencodings in /opt/anaconda3/lib/python3.8/site-packages (from html5lib) (0.5.1)
Requirement already satisfied: six>=1.9 in /opt/anaconda3/lib/python3.8/site-packages (from html5lib) (1.15.0)
```

PART-1

Tools and libraries

In [3]:
```
import requests # The requests library is an
# HTTP library for getting and posting content etc.

import bs4 as bs # BeautifulSoup4 is a Python library
# for pulling data out of HTML and XML code.
# We can query markup languages for specific content

import pandas as pd
import re
```

Extracting the website

In [4]:
```
url = "https://en.wikipedia.org/wiki/COVID-19_pandemic_by_country_and_territory"

data = pd.read_html(url) # downloading the website
```

In [5]:
```
covid_data = data[9] # Total cases, deaths, and death rates by country
```

In [6]:
```
covid_data
```

Out[6]:

	Country	Country.1	Deathsper million	Deaths	Cases	Unnamed: 5	Unnamed: 6	Unnamed: 7
0	NaN	World[a]	688	5422092	284530653	NaN	NaN	NaN
1	NaN	Peru	6070	202524	2279299	NaN	NaN	NaN
2	NaN	Bulgaria	4468	30819	740682	NaN	NaN	NaN
3	NaN	Bosnia and Herzegovina	4105	13397	289676	NaN	NaN	NaN
4	NaN	Hungary	4049	39009	1249694	NaN	NaN	NaN
...	...	...	...	...	...	...	...	...
213	NaN	Saint Helena, Ascension and Tristan da Cunha	—	—	4	NaN	NaN	NaN
214	NaN	Macau	—	—	78	NaN	NaN	NaN
215	NaN	Kiribati	—	—	2	NaN	NaN	NaN
216	NaN	Tonga	—	—	1	NaN	NaN	NaN
217	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...

218 rows × 8 columns

In [7]:
```
covid_data = covid_data[['Country.1', 'Deathsper million', 'Deaths', 'Cases']]
```

In [8]:
```
covid_data
```

Out[8]:

	Country.1	Deathsper million	Deaths	Cases
0	World[a]	688	5422092	284530653
1	Peru	6070	202524	2279299
2	Bulgaria	4468	30819	740682
3	Bosnia and Herzegovina	4105	13397	289676
4	Hungary	4049	39009	1249694
...	...	...	...	...
213	Saint Helena, Ascension and Tristan da Cunha	—	—	4
214	Macau	—	—	78
215	Kiribati	—	—	2
216	Tonga	—	—	1
217	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...	.mw-parser-output .reflist{font-size:90%;margi...

218 rows × 4 columns

Use string formatting to remove the square bracket information from region names (e.g. World[a], European Union[b] should be World, European Union).

In [9]:
```
# removing the squares from Country column
new_col = []
for i in covid_data['Country.1']:
    new_col.append(re.sub('\[.*?\]', '', i))
covid_data.insert(loc=0, column='COUNTRY', value=pd.Series(new_col))
```

Drop any row that does not contain country or region information. I.e. drop all the rows that do not contain numerical data.

In [10]:
```
covid_data = covid_data[covid_data.Deaths.apply(lambda x: x.isnumeric())]
```

In [11]:
```
covid_data = covid_data[covid_data.Cases.apply(lambda x: x.isnumeric())]
```

In [12]:
```
covid_data = covid_data[covid_data['Deathsper million'].apply(lambda x: x.isnumeric())]
```

In [13]:
```
#covid_data = covid_data.drop(covid_data.tail(1).index,inplace=False)
```

In [14]:
```
covid_data
```

Out[14]:

	COUNTRY	Country.1	Deathsper million	Deaths	Cases
0	World	World[a]	688	5422092	284530653
1	Peru	Peru	6070	202524	2279299
2	Bulgaria	Bulgaria	4468	30819	740682
3	Bosnia and Herzegovina	Bosnia and Herzegovina	4105	13397	289676
4	Hungary	Hungary	4049	39009	1249694
...	...	...	...	...	...
199	New Zealand	New Zealand	9	51	14057
200	Bhutan	Bhutan	3	3	2660
201	China	China[c]	3	4636	101890
202	Vanuatu	Vanuatu	3	1	7
203	Burundi	Burundi	3	38	27366

204 rows × 5 columns

Convertig the datatype of all DataFrame values from objects to integers.

In [15]:
```
covid_data.Deaths = pd.to_numeric(covid_data.Deaths, downcast='integer')
covid_data['Deathsper million'] = pd.to_numeric(covid_data['Deathsper million'], downcast='integer')
covid_data.Cases = pd.to_numeric(covid_data.Cases, downcast='integer')
```

In [16]:
```
covid_data.dtypes
```

Out[16]:
```
COUNTRY              object
Country.1            object
Deathsper million     int16
Deaths                int32
Cases                 int32
dtype: object
```

In [17]:
```
covid_data = covid_data.drop(['Country.1'], axis=1)
```

In [18]:
```
covid_data.columns = ['country','deaths_per_million','deaths','cases']
```

In [19]:
```
covid_data
```

Out[19]:

	country	deaths_per_million	deaths	cases
0	World	688	5422092	284530653
1	Peru	6070	202524	2279299
2	Bulgaria	4468	30819	740682
3	Bosnia and Herzegovina	4105	13397	289676
4	Hungary	4049	39009	1249694
...	...	...	...	...
199	New Zealand	9	51	14057
200	Bhutan	3	3	2660
201	China	3	4636	101890
202	Vanuatu	3	1	7
203	Burundi	3	38	27366

204 rows × 4 columns

Create a new column called recovered_per_deaths and assign it the value number of recovered divided by deaths.

In [20]:
```
covid_data['cases_per_deaths'] = covid_data['cases'] // covid_data['deaths']
```

Country as index of the resulting dataframe

In [21]:
```
covid_data = covid_data.set_index('country')
```

In [22]:
```
covid_data = covid_data.sort_values('cases_per_deaths',ascending=False)
```

Final print

In [23]:
```
covid_data.head(20)
```

Out[23]:

country	deaths_per_million	deaths	cases	cases_per_deaths
Greenland	17	1	2437	2437
Bhutan	3	3	2660	886
Cayman Islands	165	11	8386	762
Burundi	3	38	27366	720
Iceland	107	37	25314	684
Faroe Islands	265	13	5548	426
Qatar	210	616	249245	404
Maldives	481	262	95420	364
United Arab Emirates	216	2160	757145	350
Singapore	151	826	278750	337
Anguilla	330	5	1674	334
Laos	48	355	108782	306
Norway	238	1305	387196	296
New Zealand	9	51	14057	275
Cyprus	708	635	157928	248
Denmark	558	3247	762299	234
Isle of Man	784	67	13487	201
Bahrain	797	1394	280876	201
Mongolia	618	2058	389089	189
Seychelles	1354	134	24546	183

COMMENT

Countries which has high value of recovered_per_deaths may indicates a few things like they have small population and less number of deaths and low value of recovered_per_deaths may indicates the opossite.

However, this is not the right way to hypothesis or extrapolate on the given information. we might required to do some normalization as there are some samples that are outliers in it.

In [ ]:
```

```

PART-2

In [24]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn import preprocessing, svm
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
plt.rcParams['figure.figsize'] = (20, 7)
import datetime
from   sklearn.metrics       import mean_squared_error, mean_absolute_error
import matplotlib.dates as mdates
from   sklearn.linear_model  import LinearRegression, BayesianRidge
from   sklearn.preprocessing import PolynomialFeatures
from sklearn import linear_model
```

Reading the data

In [25]:
```
covid_deaths_data = pd.read_csv("https://covid.ourworldindata.org/data/owid-covid-data.csv")
```

In [26]:
```
# Converting to Pandas datetime object
covid_deaths_data['date'] = pd.to_datetime(covid_deaths_data['date'])
```

In [27]:
```
# Filling NaN values with 0
covid_deaths_data = covid_deaths_data.fillna(0)
```

In [28]:
```
covid_deaths_data
```

Out[28]:

	iso_code	continent	location	date	total_cases	new_cases	new_cases_smoothed	total_deaths	new_deaths	new_deaths_smoothed	...	female_smoke
0	AFG	Asia	Afghanistan	2020-02-24	5.0	5.0	0.000	0.0	0.0	0.000	...	0
1	AFG	Asia	Afghanistan	2020-02-25	5.0	0.0	0.000	0.0	0.0	0.000	...	0
2	AFG	Asia	Afghanistan	2020-02-26	5.0	0.0	0.000	0.0	0.0	0.000	...	0
3	AFG	Asia	Afghanistan	2020-02-27	5.0	0.0	0.000	0.0	0.0	0.000	...	0
4	AFG	Asia	Afghanistan	2020-02-28	5.0	0.0	0.000	0.0	0.0	0.000	...	0
...	...	...	...	...	...	...	...	...	...	...	...	...
150852	ZWE	Africa	Zimbabwe	2021-12-25	203746.0	1010.0	2025.571	4885.0	14.0	15.143	...	1
150853	ZWE	Africa	Zimbabwe	2021-12-26	204351.0	605.0	1811.143	4891.0	6.0	15.571	...	1
150854	ZWE	Africa	Zimbabwe	2021-12-27	205449.0	1098.0	1481.429	4908.0	17.0	14.714	...	1
150855	ZWE	Africa	Zimbabwe	2021-12-28	207548.0	2099.0	1397.143	4940.0	32.0	17.286	...	1
150856	ZWE	Africa	Zimbabwe	2021-12-29	207548.0	0.0	0.000	4940.0	0.0	0.000	...	1

150857 rows × 67 columns

In [29]:
```
covid_deaths_data = covid_deaths_data.groupby(['date']).sum('total_deaths')
```

In [30]:
```
covid_deaths_data
```

Out[30]:

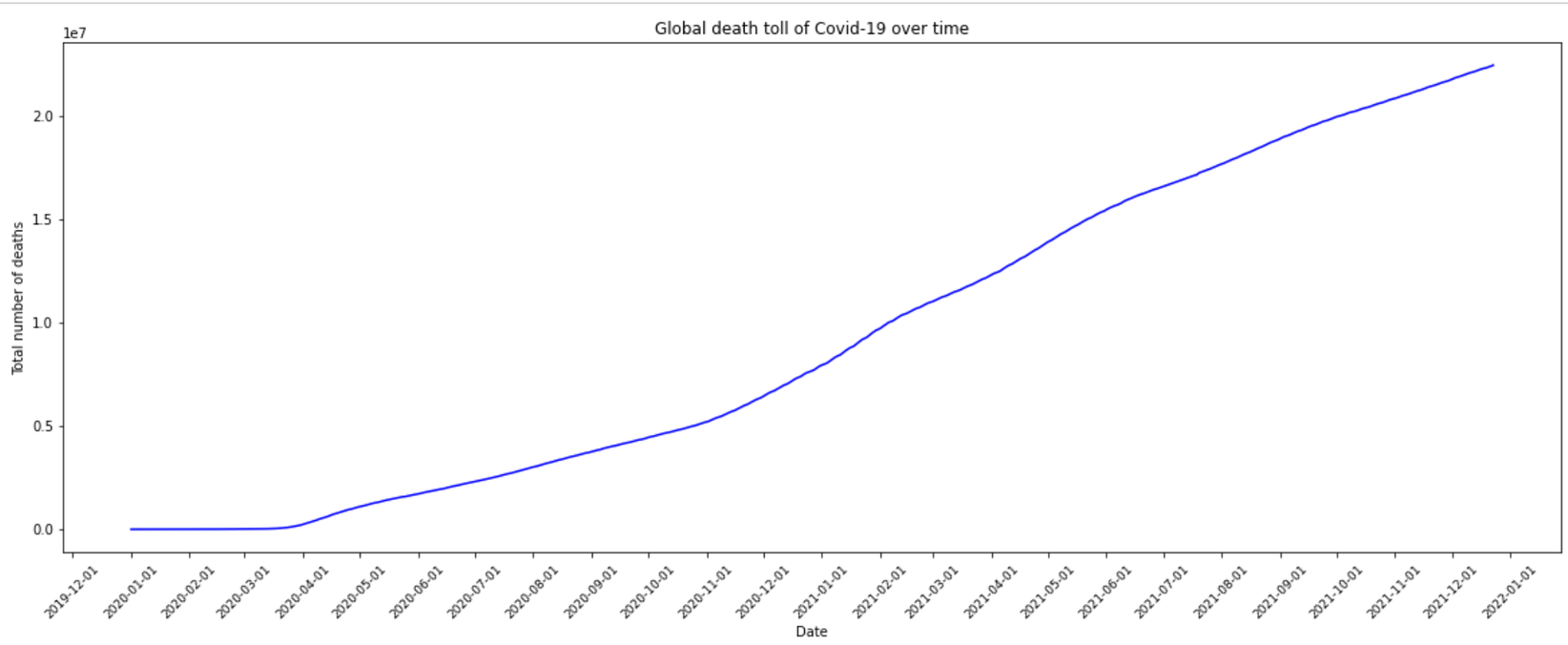
date	total_cases	new_cases	new_cases_smoothed	total_deaths	new_deaths	new_deaths_smoothed	total_cases_per_million	new_cases_per_million	new_cases
2020-01-01	0.000000e+00	0.0	0.000	0.0	0.0	0.000	0.000000e+00	0.000	
2020-01-02	0.000000e+00	0.0	0.000	0.0	0.0	0.000	0.000000e+00	0.000	
2020-01-03	0.000000e+00	0.0	0.000	0.0	0.0	0.000	0.000000e+00	0.000	
2020-01-04	0.000000e+00	0.0	0.000	0.0	0.0	0.000	0.000000e+00	0.000	
2020-01-05	0.000000e+00	0.0	0.000	0.0	0.0	0.000	0.000000e+00	0.000	
...	...	...	...	...	...	...	...	...	
2021-12-25	1.171230e+09	2330249.0	3267345.716	22481198.0	17730.0	28074.719	1.427776e+07	37634.150	
2021-12-26	1.173227e+09	1996343.0	3260119.432	22495425.0	14227.0	27573.575	1.430085e+07	23097.082	
2021-12-27	1.179602e+09	6375465.0	3709598.282	22523510.0	28085.0	27399.151	1.438961e+07	88756.494	
2021-12-28	1.185392e+09	5790000.0	4037545.566	22554723.0	31213.0	27190.721	1.447083e+07	81224.424	
2021-12-29	1.192987e+09	7594311.0	4538410.570	22588839.0	34116.0	26950.151	1.458038e+07	109549.147	

729 rows × 62 columns

Use Matplotlib or Pandas to plot the total number of deaths over time globally from the 1st of Jan 2020 until the 23rd of Dec 2021,

In [31]:
```
covid_deaths_data.drop(covid_deaths_data.tail(6).index,inplace=True) # drop last n rows
```

In [32]:
```
covid_deaths_data.index = pd.date_range(start='1/1/2020', end='23/12/2021')

x_axis = covid_deaths_data.index
y_axis = covid_deaths_data['total_deaths']

fig, ax = plt.subplots()
# naming the x axis
plt.xlabel('Date')
# naming the y axis
plt.ylabel('Total number of deaths')

# giving a title to my graph
plt.title('Global death toll of Covid-19 over time')

ax.xaxis.set_major_locator(mdates.MonthLocator(bymonth= None,interval=1, tz=None))
ax.xaxis.set_major_formatter(mdates.DateFormatter("%Y-%m-%d"))
ax.plot(x_axis,y_axis,color='blue')
plt.xticks(rotation=45, size=9)

plt.show()
```



Use scikit-learn to train a Simple Linear Regression model predicting the number of global coronavirus deaths over the time period of when the first death occurred until the 23rd of Dec 2021

In [33]:
```
X = np.array(covid_deaths_data.index.to_julian_date()).reshape(covid_deaths_data.shape[0],1)
y = np.array(covid_deaths_data['total_deaths']).reshape(-1,1)
```

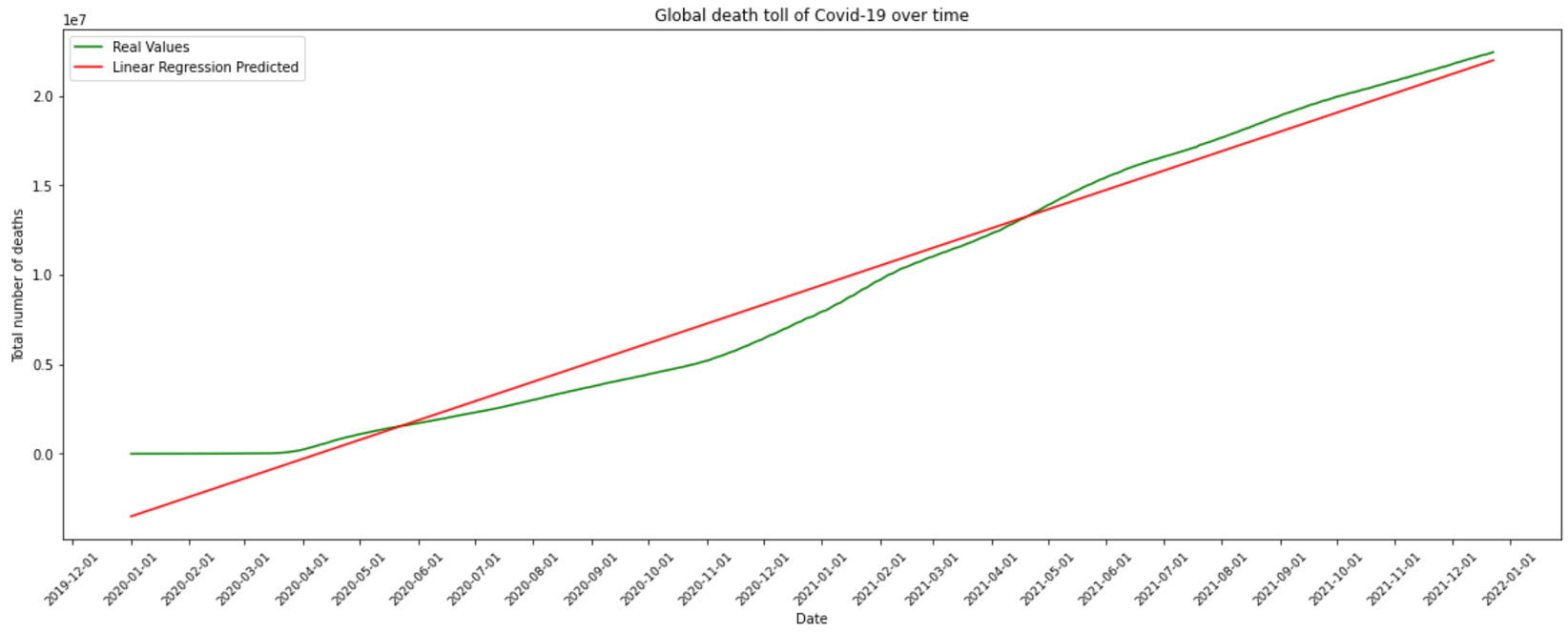
In [34]:
```
''' Fitting the model '''
regr = LinearRegression()

regr.fit(X, y)
```

Out[34]:
```
LinearRegression()
```

In [35]:
```
''' Predicting the values'''
y_pred = regr.predict(X)
```

In [36]:
```
xx_axis = covid_deaths_data.index
yy_axis = y_pred
```

In [37]:
```
''' Plotting the Graphs of REAL versus Predicted Values'''
fig, ax = plt.subplots()
# naming the x axis
plt.xlabel('Date')
# naming the y axis
plt.ylabel('Total number of deaths')

# giving a title to my graph
plt.title('Global death toll of Covid-19 over time')

ax.xaxis.set_major_locator(mdates.MonthLocator(bymonth= None,interval=1, tz=None))
ax.xaxis.set_major_formatter(mdates.DateFormatter("%Y-%m-%d"))
ax.plot(x_axis,y_axis,color='green')
ax.plot(xx_axis, yy_axis, color='red')
plt.xticks(rotation=45, size=9)
plt.legend(["Real Values", "Linear Regression Predicted"], loc ="upper left")

plt.show()
```



Print the mean squared error of your Linear Regression model (as compared to the real values in the model training data for the whole time period).

In [38]:
```
#y_pred = regr.predict(X_test)
print('MSE:', mean_squared_error  (y_pred,X))
```

```
MSE: 100250846745254.47
```

Train any Regression model of your choice on the number of COVID19 deaths in South Korea.

In [39]:
```
korea_data = pd.read_csv("https://covid.ourworldindata.org/data/owid-covid-data.csv")
```

In [40]:
```
# Filling NaN values with 0
korea_data = korea_data.fillna(0)
```

In [41]:
```
korea_data = korea_data[korea_data['iso_code'] == 'KOR']
```

In [42]:
```
korea_data
```

Out[42]:

	iso_code	continent	location	date	total_cases	new_cases	new_cases_smoothed	total_deaths	new_deaths	new_deaths_smoothed	...	female_smokers
126449	KOR	Asia	South Korea	2020-01-21	0.0	0.0	0.000	0.0	0.0	0.000	...	6.2
126450	KOR	Asia	South Korea	2020-01-22	1.0	0.0	0.000	0.0	0.0	0.000	...	6.2
126451	KOR	Asia	South Korea	2020-01-23	1.0	0.0	0.000	0.0	0.0	0.000	...	6.2
126452	KOR	Asia	South Korea	2020-01-24	2.0	1.0	0.000	0.0	0.0	0.000	...	6.2
126453	KOR	Asia	South Korea	2020-01-25	2.0	0.0	0.000	0.0	0.0	0.000	...	6.2
...	...	...	...	...	...	...	...	...	...	...	...	...
127153	KOR	Asia	South Korea	2021-12-25	607463.0	5418.0	6052.143	5245.0	69.0	74.714	...	6.2
127154	KOR	Asia	South Korea	2021-12-26	611670.0	4207.0	5893.714	5300.0	55.0	74.857	...	6.2
127155	KOR	Asia	South Korea	2021-12-27	615532.0	3862.0	5702.429	5346.0	46.0	74.000	...	6.2
127156	KOR	Asia	South Korea	2021-12-28	620938.0	5406.0	5410.429	5382.0	36.0	68.000	...	6.2
127157	KOR	Asia	South Korea	2021-12-29	625967.0	5029.0	5141.286	5455.0	73.0	62.857	...	6.2

709 rows × 67 columns

In [43]:
```
# Training dataset
korea_data_train = korea_data[korea_data['date'] >= '2021-09-01']
```

In [44]:
```
korea_data_train = korea_data_train[korea_data_train['date'] <= '2021-11-22']
```

In [45]:
```
korea_data_train = korea_data_train.drop(['iso_code','continent','location'], axis=1)
```

In [46]:
```
korea_data_train = korea_data_train.groupby(['date']).sum('total_deaths')
```

In [47]:
```
# Testing dataset
korea_data_test = korea_data[korea_data['date'] >= '2021-11-23']
```

In [48]:
```
korea_data_test = korea_data_test[korea_data_test['date'] <= '2021-11-29']
```

In [49]:
```
korea_data_test = korea_data_test.drop(['iso_code','continent','location'], axis=1)
```

In [50]:
```
korea_data_test = korea_data_test.groupby(['date']).sum('total_deaths')
```

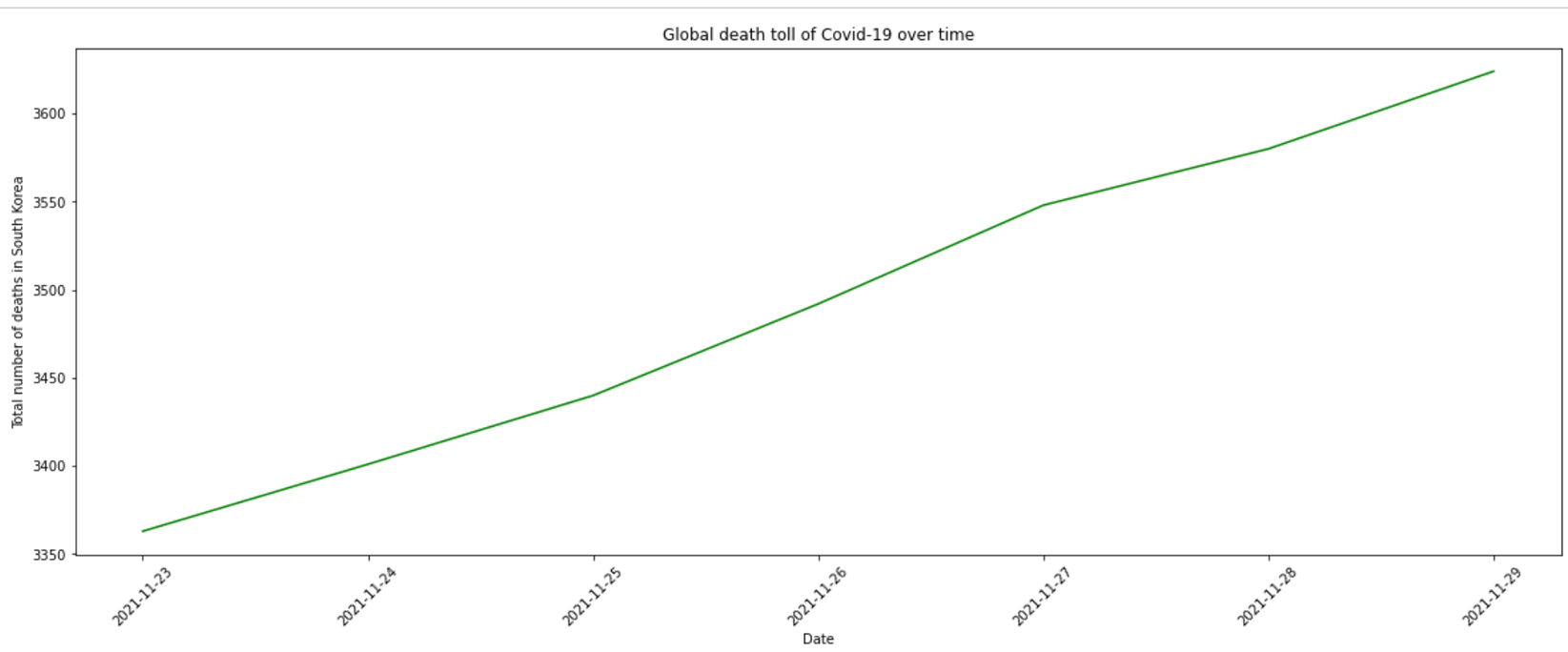
In [51]:
```
korea_data_test
```

Out[51]:

date	total_cases	new_cases	new_cases_smoothed	total_deaths	new_deaths	new_deaths_smoothed	total_cases_per_million	new_cases_per_million	new_cases_s
2021-11-23	425065.0	4115.0	3184.286	3363.0	35.0	29.286	8285.030	80.206	
2021-11-24	429002.0	3937.0	3276.714	3401.0	38.0	30.571	8361.767	76.737	
2021-11-25	432901.0	3899.0	3400.286	3440.0	39.0	32.143	8437.763	75.996	
2021-11-26	436968.0	4067.0	3522.429	3492.0	52.0	35.429	8517.034	79.271	
2021-11-27	440896.0	3928.0	3638.714	3548.0	56.0	39.143	8593.596	76.561	
2021-11-28	444200.0	3304.0	3706.857	3580.0	32.0	40.286	8657.994	64.399	
2021-11-29	447230.0	3030.0	3754.286	3624.0	44.0	42.286	8717.053	59.058	

7 rows × 62 columns

In [52]:
```
korea_data_test.index = pd.date_range(start='23/11/2021', end='29/11/2021')

x_axis = korea_data_test.index
y_axis = korea_data_test['total_deaths']

fig, ax = plt.subplots()
# naming the x axis
plt.xlabel('Date')
# naming the y axis
plt.ylabel('Total number of deaths in South Korea')

# giving a title to my graph
plt.title('Global death toll of Covid-19 over time')

ax.xaxis.set_major_locator(mdates.DayLocator(bymonthday=None,interval=1, tz=None))
ax.xaxis.set_major_formatter(mdates.DateFormatter("%Y-%m-%d"))
ax.plot(x_axis,y_axis,color='green')
plt.xticks(rotation=45, size=10)

plt.show()
```



Creating the model

In [53]:
```
y_train = np.array(korea_data_train['total_deaths']).reshape(-1,1)
X_train = np.array(korea_data_train.drop(['total_deaths'], axis=1))

y_test = np.array(korea_data_test['total_deaths']).reshape(-1,1)
X_test = np.array(korea_data_test.drop(['total_deaths'], axis=1))
```

In [54]:
```
X_train
```

Out[54]:
```
array([[255401.   ,   1956.   ,   1726.286, ...,      0.   ,      0.   ,
             0.   ],
       [257110.   ,   1709.   ,   1707.429, ...,      0.   ,      0.   ,
             0.   ],
       [258913.   ,   1803.   ,   1708.857, ...,      0.   ,      0.   ,
             0.   ],
       ...,
       [415425.   ,   3114.   ,   2852.143, ...,      0.   ,      0.   ,
             0.   ],
       [418252.   ,   2827.   ,   2969.429, ...,      0.   ,      0.   ,
             0.   ],
       [420950.   ,   2698.   ,   3051.286, ...,      0.   ,      0.   ,
             0.   ]])
```

In [55]:
```
y_test
```

Out[55]:
```
array([[3363.],
       [3401.],
       [3440.],
       [3492.],
       [3548.],
       [3580.],
       [3624.]])
```

In [56]:
```
# LINEAR MODEL
lm=linear_model.Ridge(alpha=0.3)
```

In [57]:
```
# Fitting the model
lm.fit(X_train, y_train)
```

```
/opt/anaconda3/lib/python3.8/site-packages/sklearn/linear_model/_ridge.py:147: LinAlgWarning: Ill-conditioned matrix (rc
ond=1.09354e-17): result may not be accurate.
  return linalg.solve(A, Xy, sym_pos=True,
```

Out[57]:
```
Ridge(alpha=0.3)
```

In [58]:
```
# Prediction
y_pred = lm.predict(X_test)
```

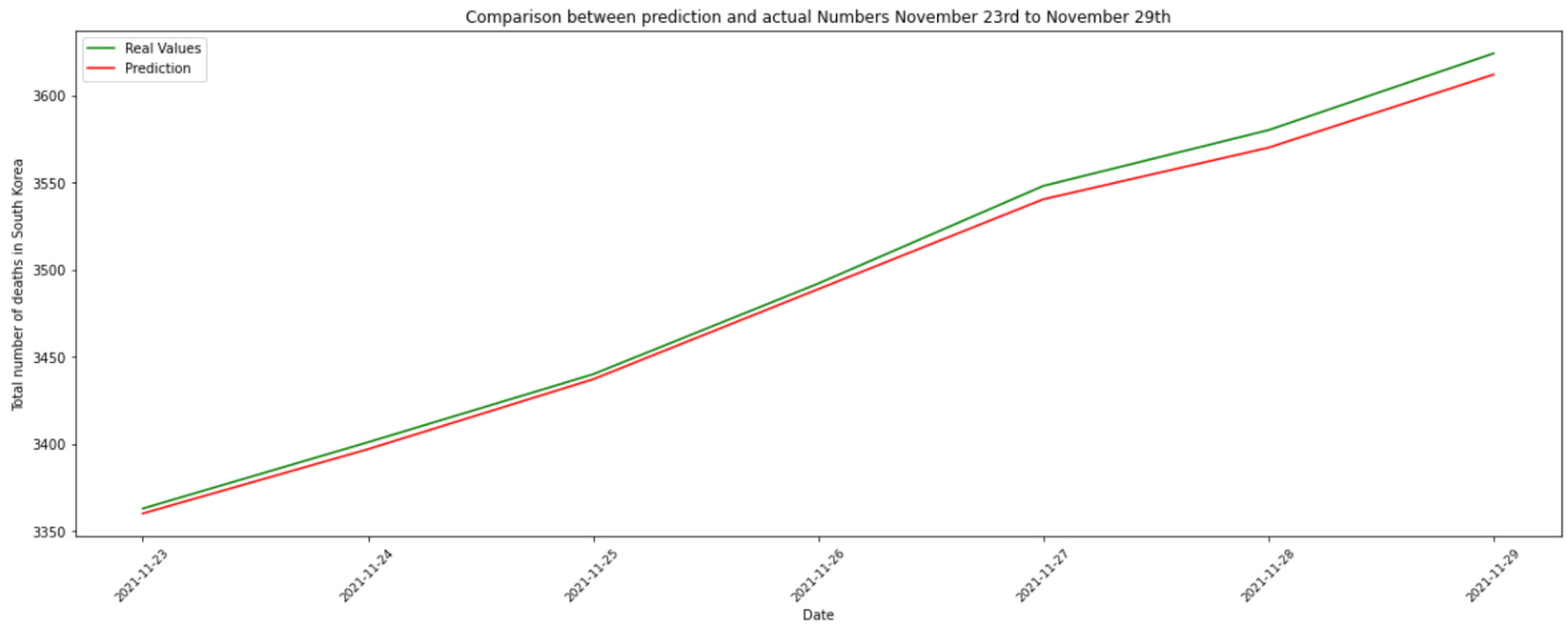
In [59]:
```
# Predicted values
y_pred
```

Out[59]:
```
array([[3360.16845664],
       [3397.03699601],
       [3437.11948568],
       [3488.78584689],
       [3540.33877683],
       [3569.94058089],
       [3611.88845891]])
```

In [60]:
```
# Graph's axis
xx_axis = korea_data_test.index
yy_axis = y_pred
```

Final Plot

In [61]:
```
''' Plotting the Graphs of REAL versus Predicted Values'''
fig, ax = plt.subplots()
# naming the x axis
plt.xlabel('Date')
# naming the y axis
plt.ylabel('Total number of deaths in South Korea')

# giving a title to my graph
plt.title('Comparison between prediction and actual Numbers November 23rd to November 29th')

ax.xaxis.set_major_locator(mdates.DayLocator(bymonthday=None,interval=1, tz=None))
ax.xaxis.set_major_formatter(mdates.DateFormatter("%Y-%m-%d"))
ax.plot(x_axis,y_axis,color='green')
ax.plot(xx_axis, yy_axis, color='red')
plt.xticks(rotation=45, size=9)
plt.legend(["Real Values", "Prediction"], loc ="upper left")

plt.show()
```



MSE

In [62]:
```
#y_pred = regr.predict(X_test)
print('MSE:', mean_squared_error  (y_test,y_pred))
```

```
MSE: 49.84669460744557
```

In [ ]:
```

```