Part 2

Importing necessary libraries

In [39]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import matplotlib.ticker as ticker

%matplotlib inline
```

In [3]:

```
data = pd.read_csv('https://raw.githubusercontent.com/owid/covid-19-data/master/public/data/vaccinations/vaccinations.csv')
```

In [4]:

```
data.head()
```

Out[4]:

	location	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated
0	Afghanistan	AFG	2021-02-22	0.0	0.0	NaN
1	Afghanistan	AFG	2021-02-23	NaN	NaN	NaN
2	Afghanistan	AFG	2021-02-24	NaN	NaN	NaN
3	Afghanistan	AFG	2021-02-25	NaN	NaN	NaN
4	Afghanistan	AFG	2021-02-26	NaN	NaN	NaN

In [5]:

```
data.shape
```

Out[5]:

```
(156518, 16)
```

In [6]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 156518 entries, 0 to 156517
Data columns (total 16 columns):
 #   Column                               Non-Null Count   Dtype  
---  ------                               --------------   -----  
 0   location                             156518 non-null  object 
 1   iso_code                             156518 non-null  object 
 2   date                                 156518 non-null  object 
 3   total_vaccinations                   72497 non-null   float64
 4   people_vaccinated                    69398 non-null   float64
 5   people_fully_vaccinated              66744 non-null   float64
 6   total_boosters                       41255 non-null   float64
 7   daily_vaccinations_raw               60144 non-null   float64
 8   daily_vaccinations                   155416 non-null  float64
 9   total_vaccinations_per_hundred       72497 non-null   float64
 10  people_vaccinated_per_hundred        69398 non-null   float64
 11  people_fully_vaccinated_per_hundred  66744 non-null   float64
 12  total_boosters_per_hundred           41255 non-null   float64
 13  daily_vaccinations_per_million       155416 non-null  float64
 14  daily_people_vaccinated              155335 non-null  float64
 15  daily_people_vaccinated_per_hundred  155335 non-null  float64
dtypes: float64(13), object(3)
memory usage: 19.1+ MB
```

Converting the data to datetime and name and iso code to str

In [14]:

```
data['date'] = pd.to_datetime(data['date'])
```

In [15]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 156518 entries, 0 to 156517
Data columns (total 16 columns):
 #   Column                               Non-Null Count   Dtype
---  ------                               --------------   -----
 0   location                             156518 non-null  object
 1   iso_code                             156518 non-null  object
 2   date                                 156518 non-null  datetime64[ns]
 3   total_vaccinations                   72497 non-null   float64
 4   people_vaccinated                    69398 non-null   float64
 5   people_fully_vaccinated              66744 non-null   float64
 6   total_boosters                       41255 non-null   float64
 7   daily_vaccinations_raw               60144 non-null   float64
 8   daily_vaccinations                   155416 non-null  float64
 9   total_vaccinations_per_hundred       72497 non-null   float64
 10  people_vaccinated_per_hundred        69398 non-null   float64
 11  people_fully_vaccinated_per_hundred  66744 non-null   float64
 12  total_boosters_per_hundred           41255 non-null   float64
 13  daily_vaccinations_per_million       155416 non-null  float64
 14  daily_people_vaccinated              155335 non-null  float64
 15  daily_people_vaccinated_per_hundred  155335 non-null  float64
dtypes: datetime64[ns](1), float64(13), object(2)
memory usage: 19.1+ MB
```

replacing the nan with zeros

In [19]:

```
data['total_vaccinations']= data['total_vaccinations'].fillna(0)
```

grouping by date

In [20]:

```
df = data.groupby(by = ['date'])['total_vaccinations'].sum()
```

Plotting the data

```
In [31]:
```

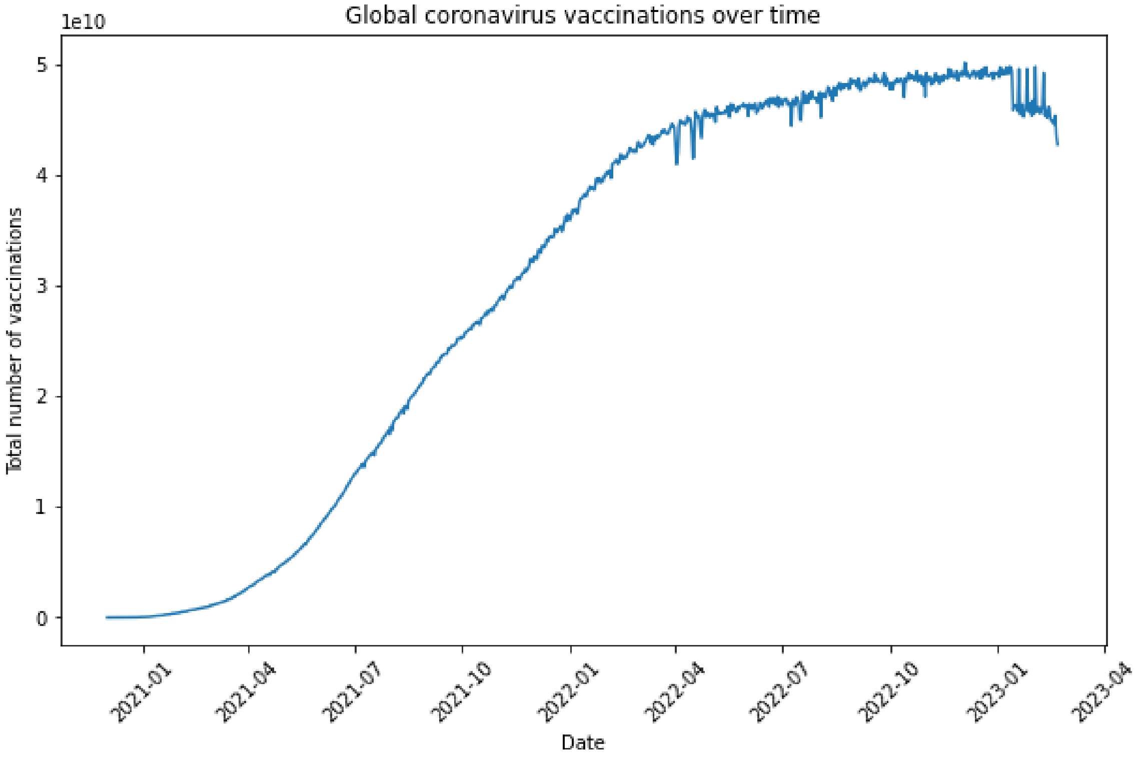
```
df
```

```
Out[31]:
```

```
date
2020-12-02    0.000000e+00
2020-12-03    0.000000e+00
2020-12-04    5.000000e+00
2020-12-05    4.000000e+00
2020-12-06    4.000000e+00
                  ...     
2023-02-17    4.490975e+10
2023-02-18    4.462018e+10
2023-02-19    4.535745e+10
2023-02-20    4.352706e+10
2023-02-21    4.277068e+10
Name: total_vaccinations, Length: 812, dtype: float64
```

```
In [46]:
```

```
figure = plt.figure(figsize = (10,6))
plt.plot(df)
plt.xlabel('Date')
plt.ylabel('Total number of vaccinations')
plt.xticks(rotation=45)
plt.title('Global coronavirus vaccinations over time');
```



Regression Analysis:

For the regression model, i will first label encode the date column since it is an ordinal data.

In [51]:

```
df = pd.DataFrame(df)
df = df.reset_index()
```

label encoding the date column

In [65]:

```
first_date = df.iloc[0]['date']
```

In [66]:

```
df['days'] = df['date'] - first_date
```

In [67]:

```
df['days'] = df['days'].apply(lambda x : int(str(x).split()[0]))
```

Creating the train and test data

In [96]:

```
X = df['days']
y = df['total_vaccinations']
```

In [74]:

```
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
```

In [75]:

```
X_train,X_test,y_train,y_test = train_test_split(X,y,train_size= 0.75, random_state = 4
2)
```

In the question it was asked to fit the whole data to the model. So rather than the train data I am giving the whole data to the mdoel.

In [79]:

```
model1 = LinearRegression()
```

In [98]:

```
X = np.array(X).reshape(812,-1)
y = np.array(y).reshape(812,-1)
```

In [99]:

```
model1.fit(X,y)
```

Out[99]:

```
LinearRegression()
```

In [100]:

```
y_pred = model1.predict(X)
```

Mean Square Error:

In [106]:

```
from sklearn.metrics import mean_squared_error, r2_score
```

In [107]:

```
mse = mean_squared_error(y,y_pred)
r2  = r2_score(y,y_pred)
```

In [110]:

```
print(f'The root mean square error of our regression is: {np.sqrt(mse)}')
print(f"the R2 score of the model is: {r2}")
```

```
The root mean square error of our regression is: 5763831183.782436
the R2 score of the model is: 0.9021182108442227
```

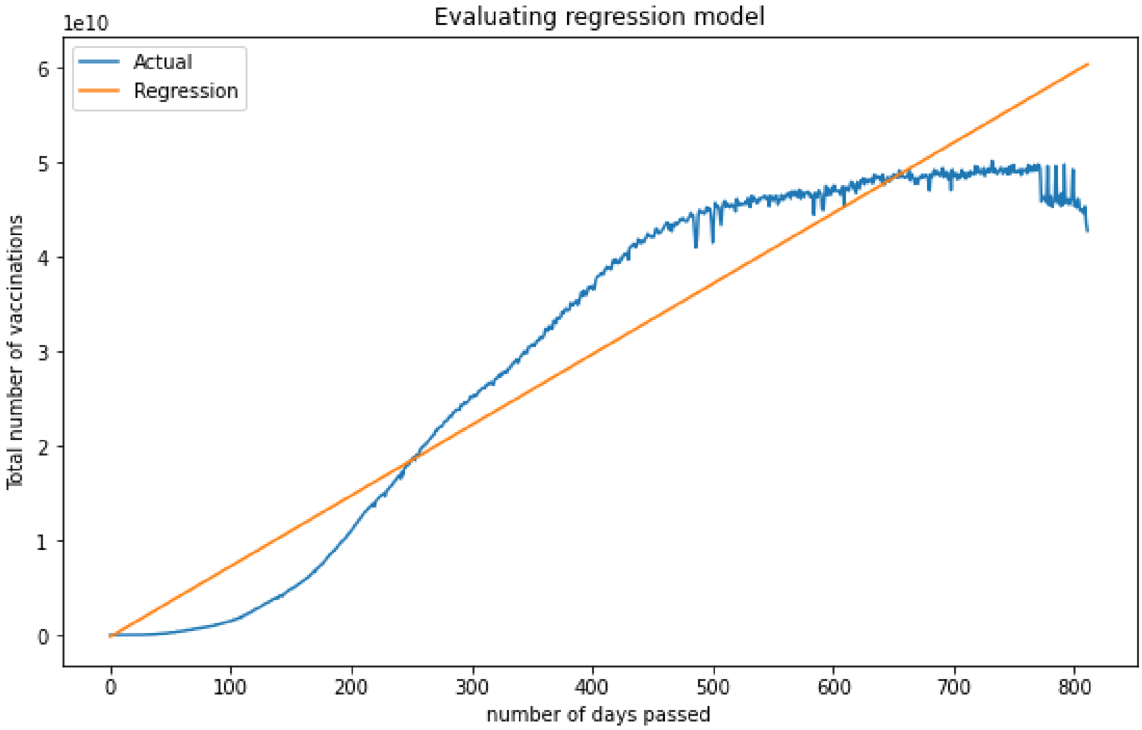
plotting the predicted vs actual data

In [105]:

```python
figure = plt.figure(figsize = (10,6))
plt.plot(y)
plt.plot(y_pred)
plt.xlabel('number of days passed')
plt.ylabel('Total number of vaccinations')
plt.title('Evaluating regression model')
plt.legend(['Actual','Regression'])
```

Out[105]:

```
<matplotlib.legend.Legend at 0x7efd9dc2aca0>
```



South Korea:

In [137]:

```python
sk = data[(data.location == 'South Korea') & (data.date.between(pd.to_datetime('2021-08-01'),pd.to_datetime('2021-10-08')))][['date','total_vaccinations']]
```

In [138]:

```python
sk = sk.reset_index(drop = True)
```

In [139]:

```python
sk['day'] = sk ['date'] - first_date
```

In [140]:

```python
sk['day'] = sk['day'].apply(lambda x : int(str(x).split()[0]))
```

In [147]:

```
#train and test data:
train  = sk[['day','total_vaccinations']].iloc[:-8,:]
test   = sk[['day','total_vaccinations']].iloc[-8:,:]
```

In [148]:

```
train.shape
```

Out[148]:

```
(61, 2)
```

In [149]:

```
model2 = LinearRegression()
```

In [153]:

```
x_train = np.array(train['day']).reshape(61,-1)
x_test = np.array(test['day']).reshape(-1,1)
```

In [155]:

```
y_train = train['total_vaccinations']
y_test  = test['total_vaccinations']
```

In [156]:

```
model2.fit(x_train,y_train)
```

Out[156]:

```
LinearRegression()
```

In [158]:

```
y_pred = model2.predict(x_test)
```

In [163]:

```
#predicting the mean squared error
mse = mean_squared_error(y_pred,y_test)
rmse = np.sqrt(mse)
```

In [168]:

```
print(f'The RMSE is : {rmse}')
print(f'The difference to the given threshold is (rmse - 750000):{rmse - 750000}')
print(f'R2 score is : {r2_score(y_pred,y_test)}')
```

```
The RMSE is : 745358.0723030564
The difference to the given threshold is (rmse - 750000):-4641.92769694363
2
R2 score is : 0.7676087442259245
```

As we can see my model perfomrs better than the set threshold