PHASE-4

PERFORMING EXPLORATORY DATA ANALYSIS

Exploratory Data Analysis (EDA) for COVID-19 vaccine analysis some steps to perform a exploratory data analysis to my dataset ,

1. Data Collection: *Gather relevant datasets on COVID-19 vaccines, including vaccine types, administration dates, locations, and demographics.*

2. Data Cleaning: *Remove missing or inconsistent data, correct data types, and handle outliers.*

3. Data Visualization: *Create various plots and charts to visualize the data. Examples include bar charts for vaccine types, time series plots for vaccination rates, and demographic breakdowns.*

4. Descriptive Statistics: *Calculate summary statistics, such as mean, median, and standard deviation, to get an overall sense of the data.*

5. Geographic Analysis: *Use maps to visualize vaccination rates by region or country.*

6. Time-Series Analysis: *Explore how vaccination rates evolve over time and identify any trends or seasonality.*

7. Demographic Analysis: *Break down the data by age groups, gender, and other demographic factors to understand vaccination distribution.*

8. Correlation Analysis: *Examine relationships between variables, like vaccine distribution and COVID-19 case rates.*

9. Hypothesis Testing: *Perform statistical tests to check for significant differences or correlations.*

10. Anomaly Detection: *Identify unusual patterns or outliers in the data.*

11. Interactive Dashboards: *Consider creating interactive dashboards using tools like Tableau or Power BI for a more user-friendly exploration.*

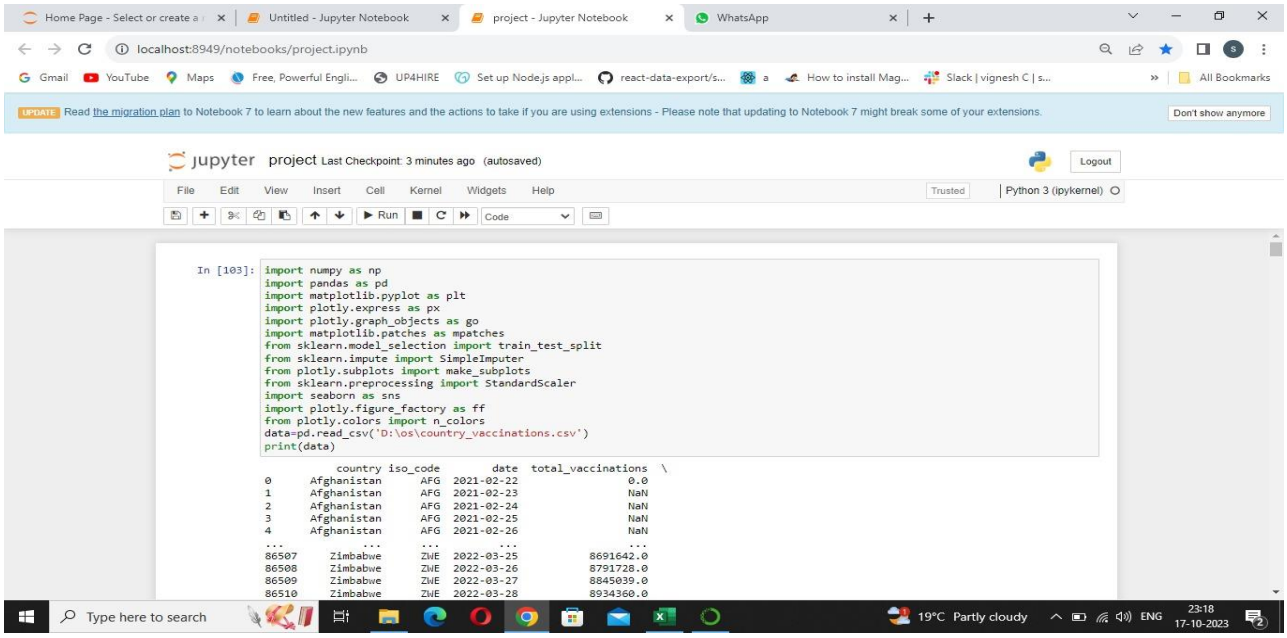
12. Communication: *Present your findings through reports, visualizations, and clear insights.*

BEGIN BUILDING THE PROJECT BY LOAD THE DATASET

To import the required libraries and read a CSV file,

data=pd.read_csv('D:\os\country_vaccinations.csv')

Print(data)



PREPROCESS DATASET

Import The Required Libraries:

import numpy as np

import pandas as pd

import matplotlib.pyplot as plt

import plotly.express as px

import plotly.graph_objects as go

import matplotlib.patches as mpatches

from sklearn.model_selection import train_test_split

from sklearn.impute import SimpleImputer

from plotly.subplots import make_subplots

from sklearn.preprocessing import StandardScaler

import seaborn as sns

import plotly.figure_factory as ff

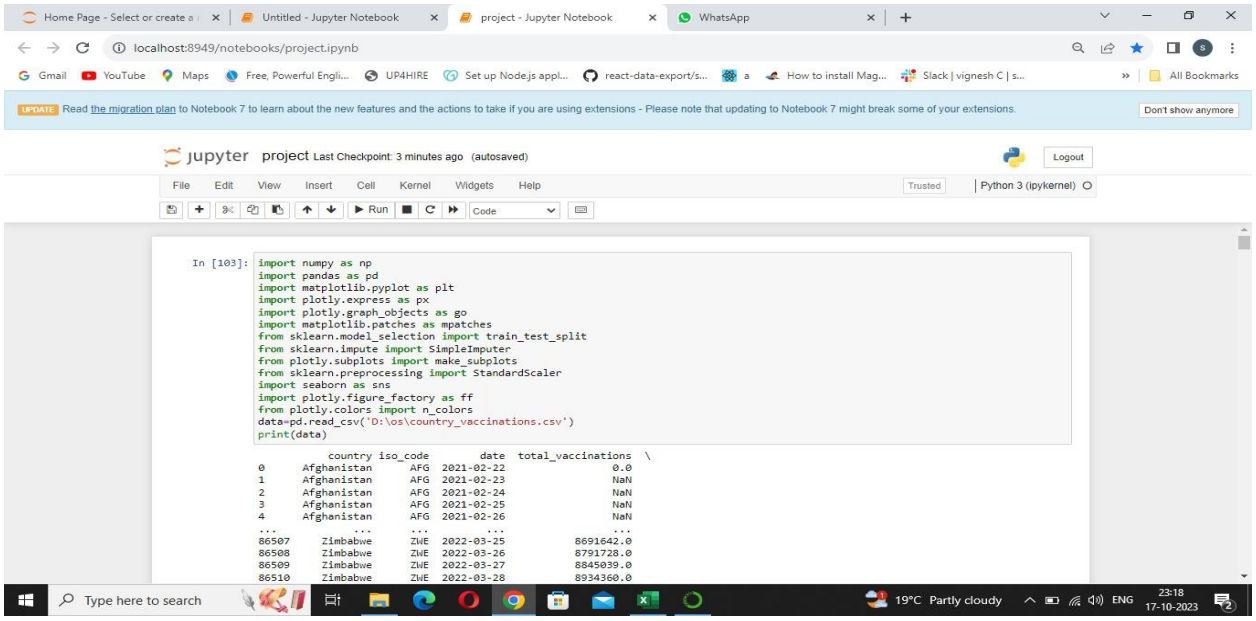
from plotly.colors import n_colors

Importing the Dataset:

- *Read Dataset,*

  data=pd.read_csv('D:\os\country_vaccinations.csv')

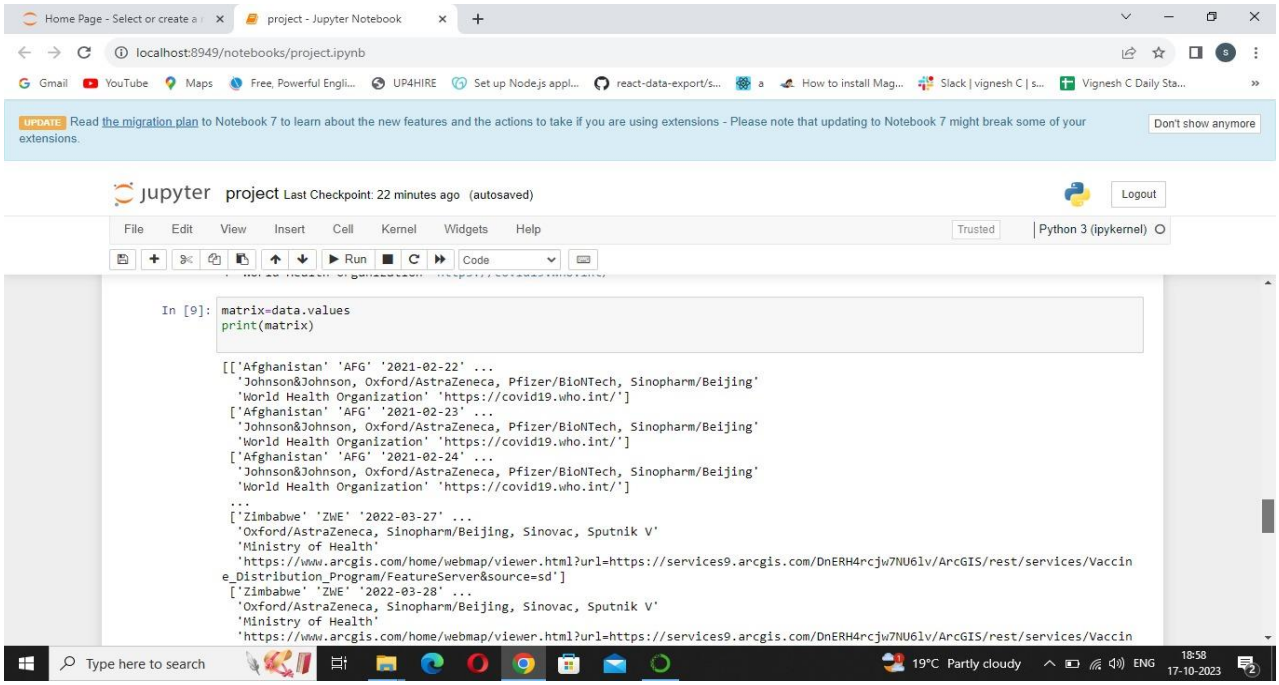
  print(data)



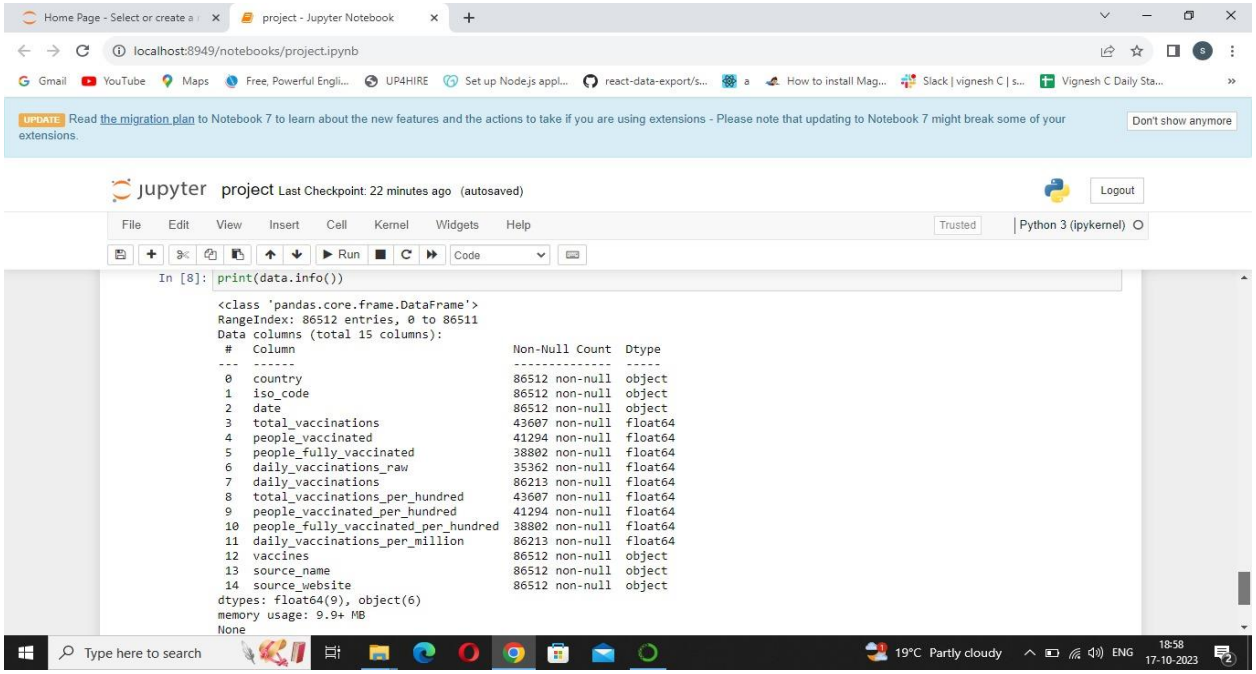
- *Create Matrix,*

matrix=data.values

print(matrix)

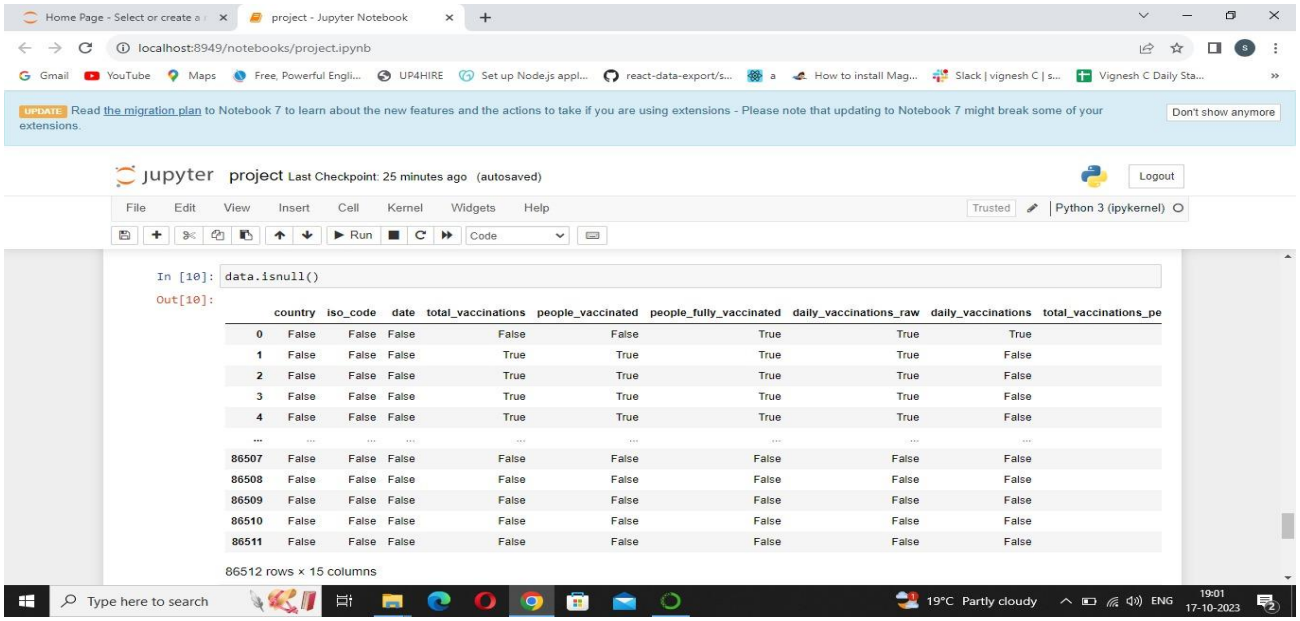


- *Other Imformation about dataset,*



Handling The Missing Data:

Before Handling the Missing data, we use isnull () to show the null values and using isnull().sum to get total number of null values.

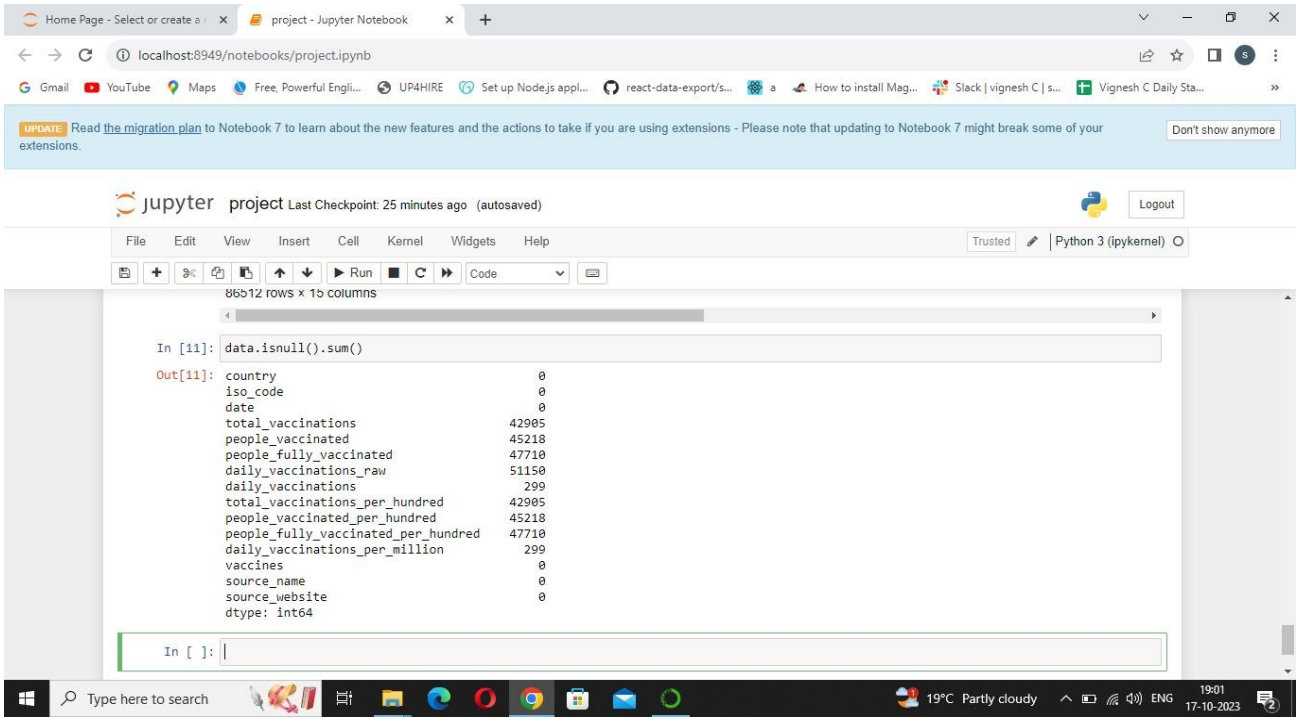


In [10]:
```
data.isnull()
```

Out[10]:

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_pe
0	False	False	False	False	False	True	True	True	
1	False	False	False	True	True	True	True	False	
2	False	False	False	True	True	True	True	False	
3	False	False	False	True	True	True	True	False	
4	False	False	False	True	True	True	True	False	
...	...	...	...	...	...	...	...	...	
86507	False	False	False	False	False	False	False	False	
86508	False	False	False	False	False	False	False	False	
86509	False	False	False	False	False	False	False	False	
86510	False	False	False	False	False	False	False	False	
86511	False	False	False	False	False	False	False	False	

86512 rows × 15 columns



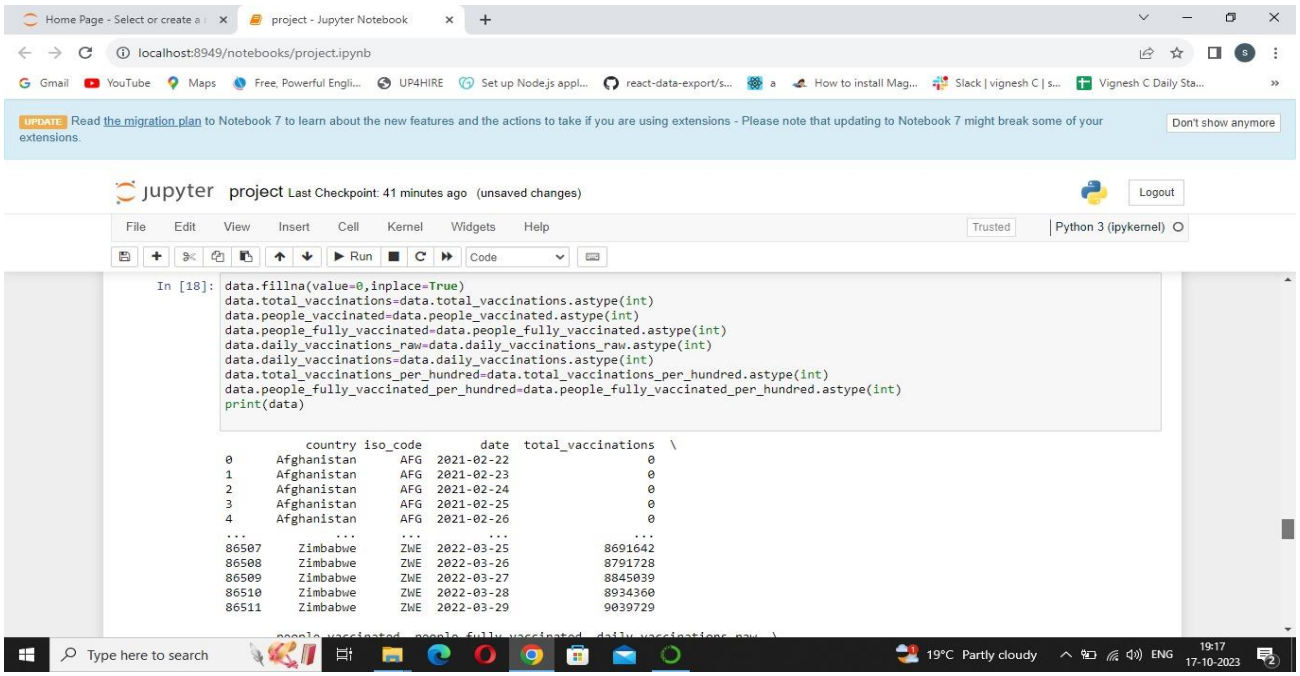
86512 rows × 15 columns

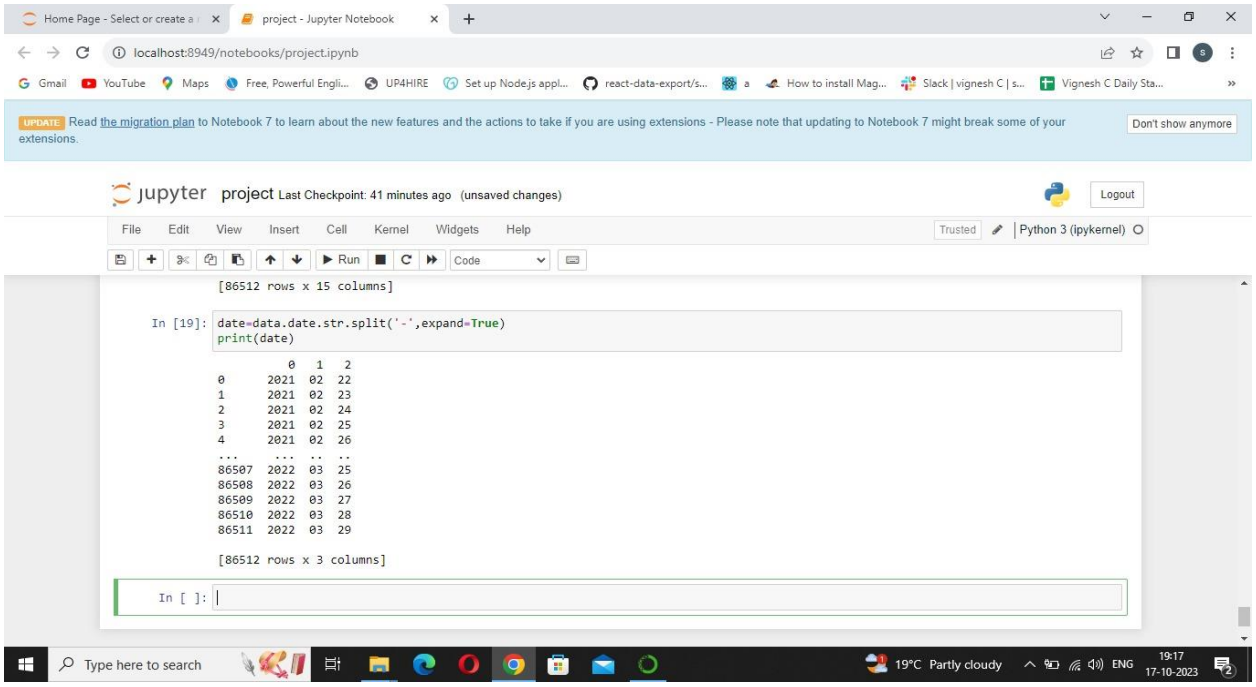
In [11]:
```
data.isnull().sum()
```

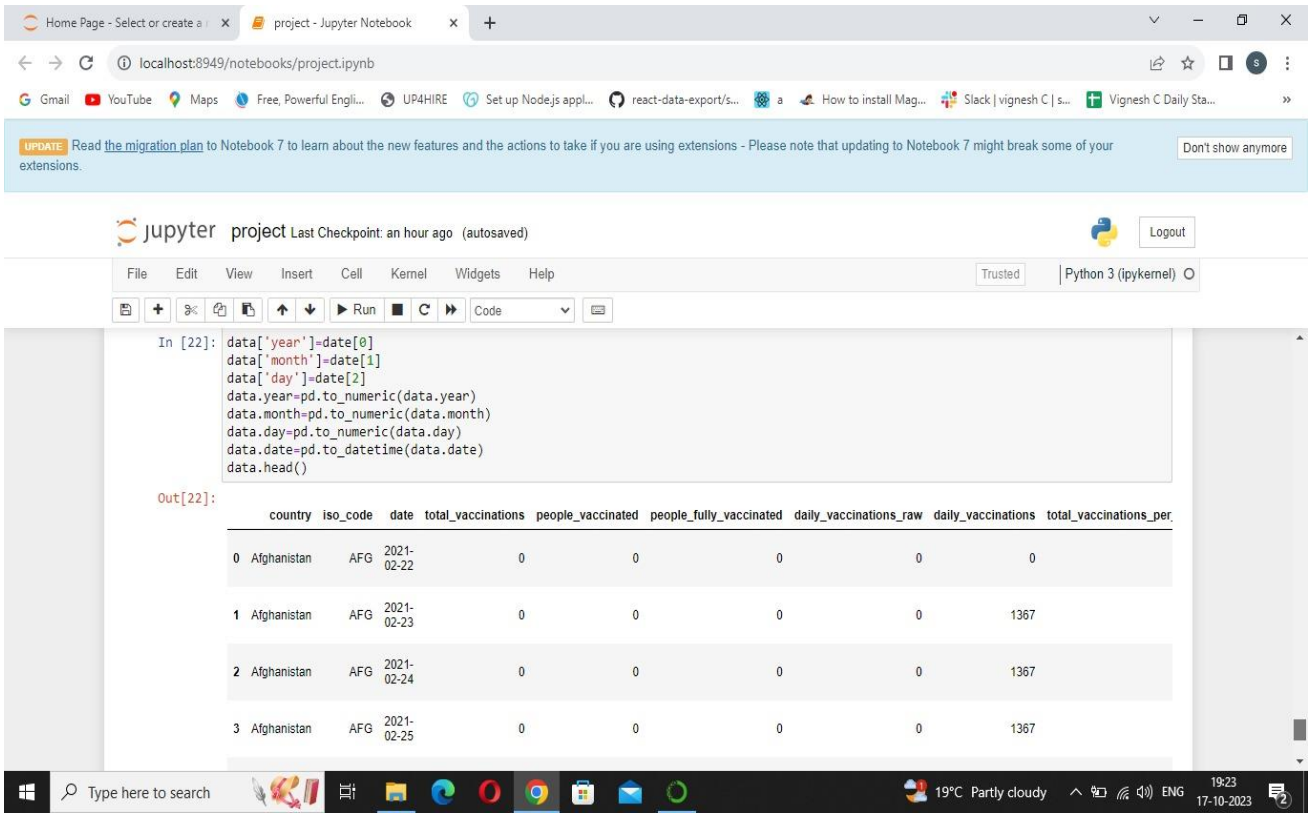
Out[11]:
```
country                          0
iso_code                         0
date                             0
total_vaccinations           42905
people_vaccinated            45218
people_fully_vaccinated      47710
daily_vaccinations_raw       51150
daily_vaccinations             299
total_vaccinations_per_hundred 42905
people_vaccinated_per_hundred 45218
people_fully_vaccinated_per_hundred 47710
daily_vaccinations_per_million 299
vaccines                         0
source_name                      0
source_website                   0
dtype: int64
```

In [ ]:

The below codein the image for all the data cleaning,



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Trusted
Python 3 (ipykernel)
Run
Code
In [22]:
data['year']=date[0]
data['month']=date[1]
data['day']=date[2]
data.year=pd.to_numeric(data.year)
data.month=pd.to_numeric(data.month)
data.day=pd.to_numeric(data.day)
data.date=pd.to_datetime(data.date)
data.head()
Out[22]:
country iso_code date total_vaccinations people_vaccinated people_fully_vaccinated daily_vaccinations_raw daily_vaccinations total_vaccinations_per
0 Afghanistan AFG 2021-02-22 0 0 0 0 0
1 Afghanistan AFG 2021-02-23 0 0 0 0 1367
2 Afghanistan AFG 2021-02-24 0 0 0 0 1367
3 Afghanistan AFG 2021-02-25 0 0 0 0 1367
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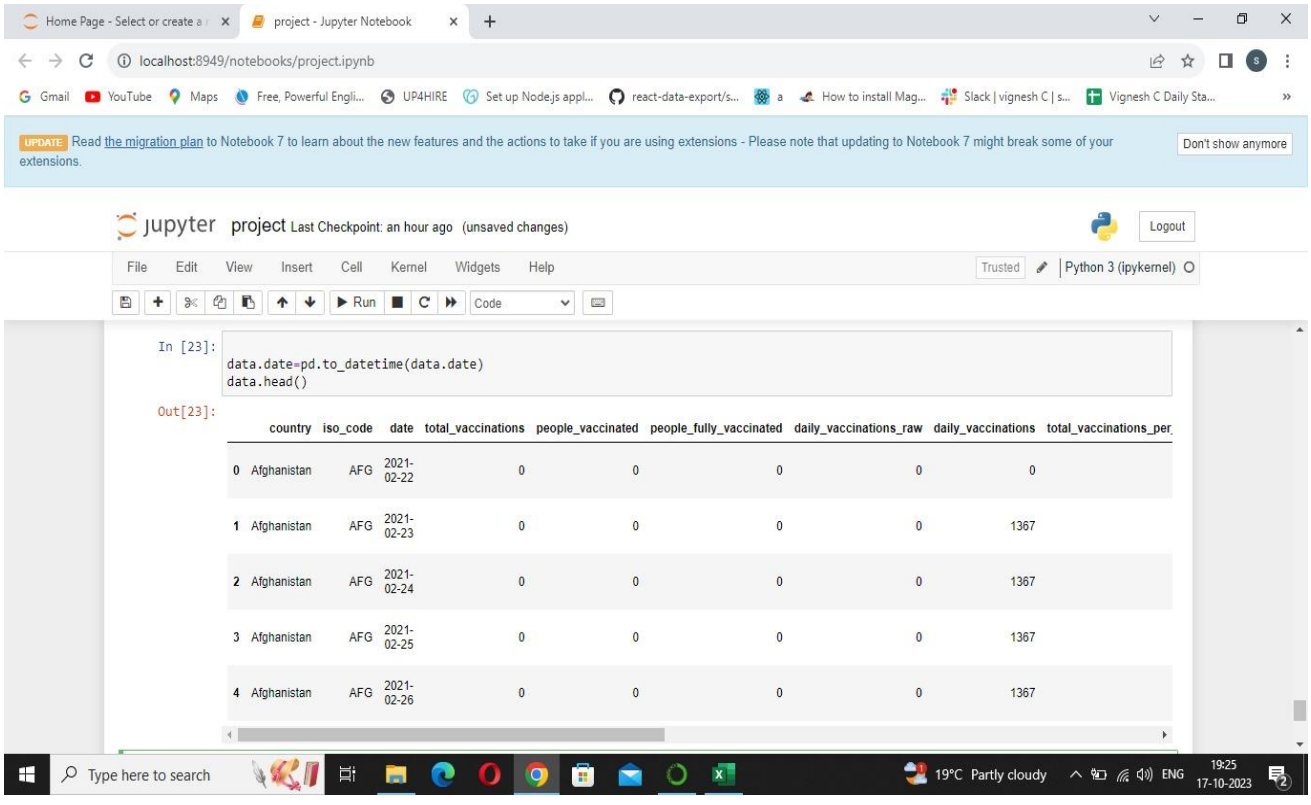
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UPDATE Read the migration plan to Notebook 7 to learn about the new features and the actions to take if you are using extensions - Please note that updating to Notebook 7 might break some of your extensions.
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Trusted
Python 3 (ipykernel)
Run
Code
In [23]:
data.date=pd.to_datetime(data.date)
data.head()
Out[23]:
country iso_code date total_vaccinations people_vaccinated people_fully_vaccinated daily_vaccinations_raw daily_vaccinations total_vaccinations_per
0 Afghanistan AFG 2021-02-22 0 0 0 0 0
1 Afghanistan AFG 2021-02-23 0 0 0 0 1367
2 Afghanistan AFG 2021-02-24 0 0 0 0 1367
3 Afghanistan AFG 2021-02-25 0 0 0 0 1367
4 Afghanistan AFG 2021-02-26 0 0 0 0 1367
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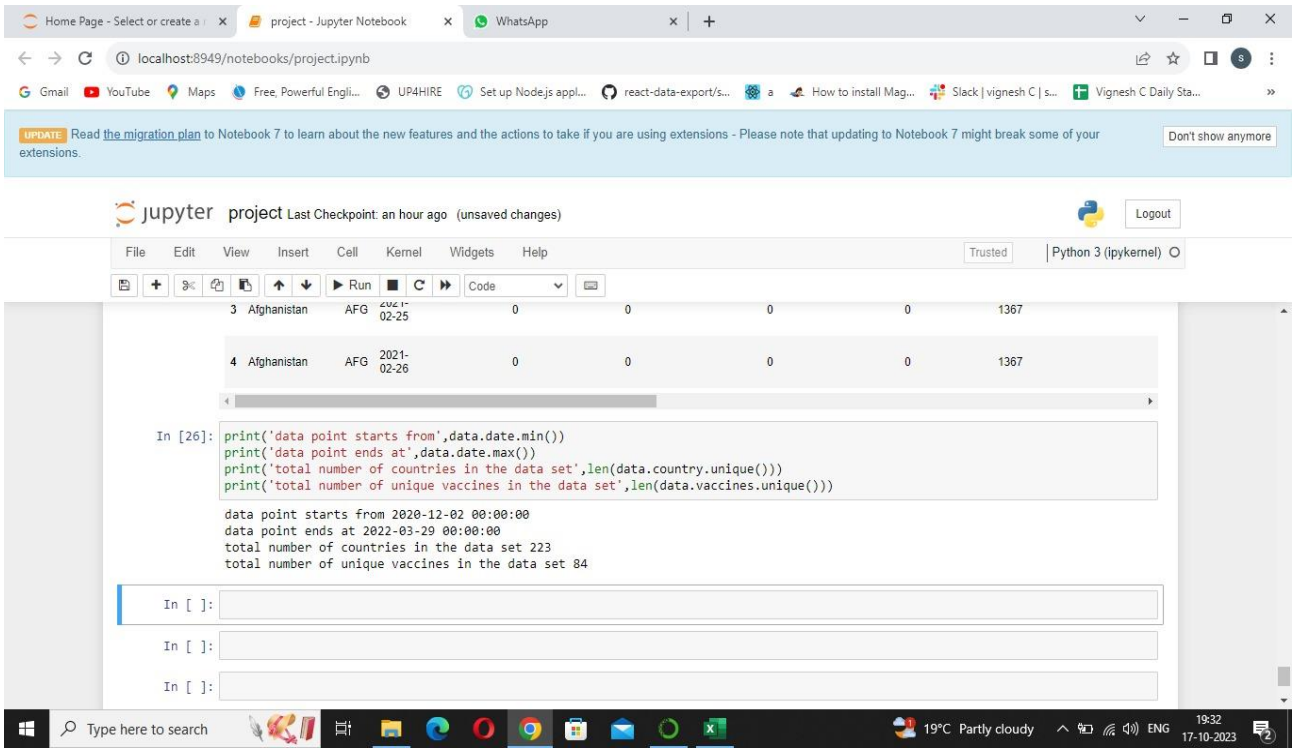
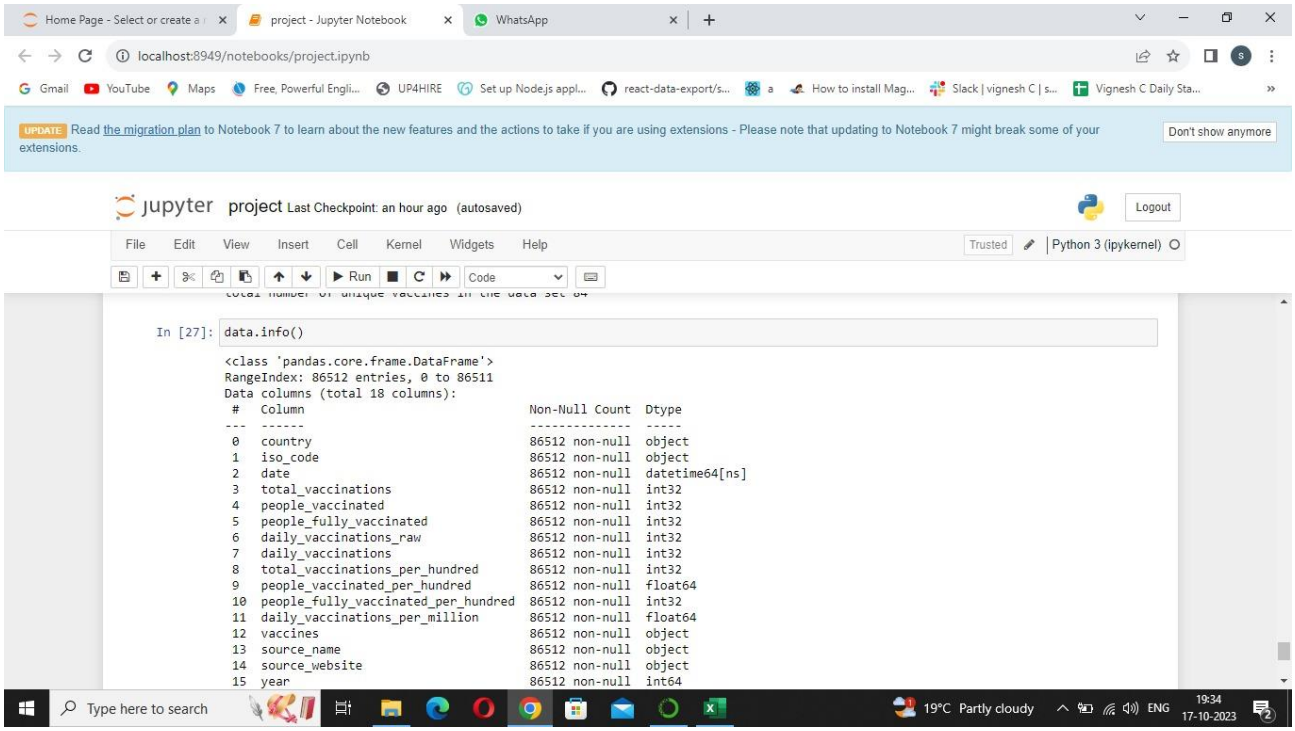
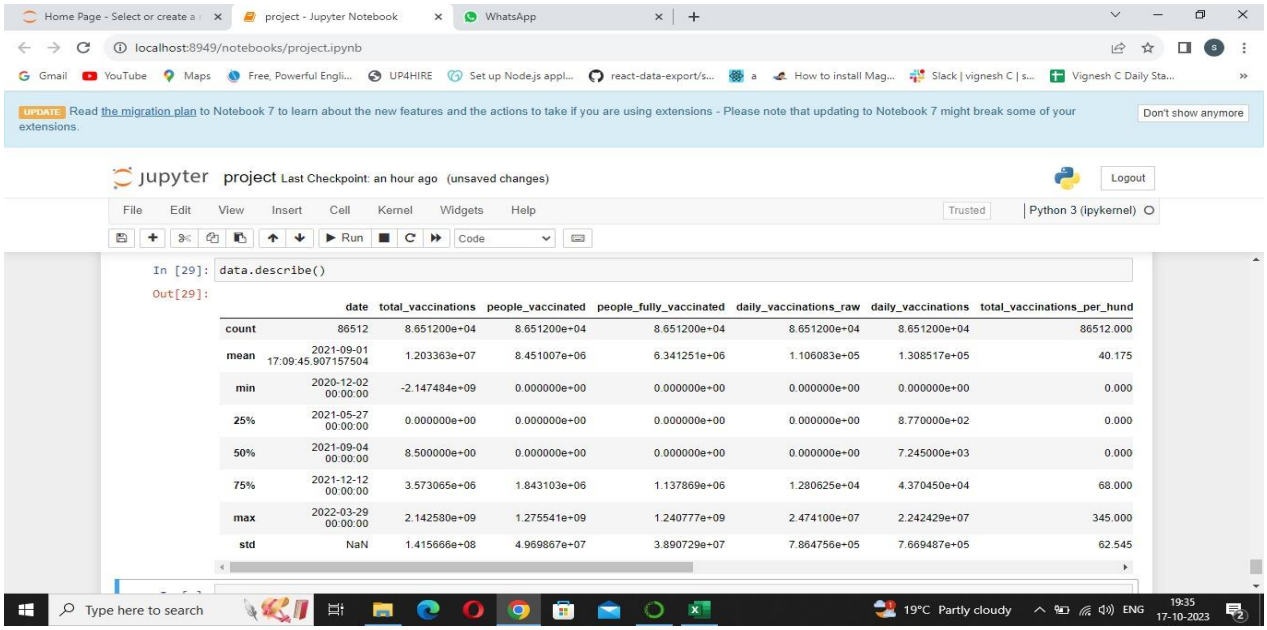
Some detailed features to specify the details using the below code,





Using Data visualization we are going to draw some visuals to get insights from dataset,

Describe () function is used to get the statistics of each feature in dataset to get count, min, max, standard deviation, median, etc.,

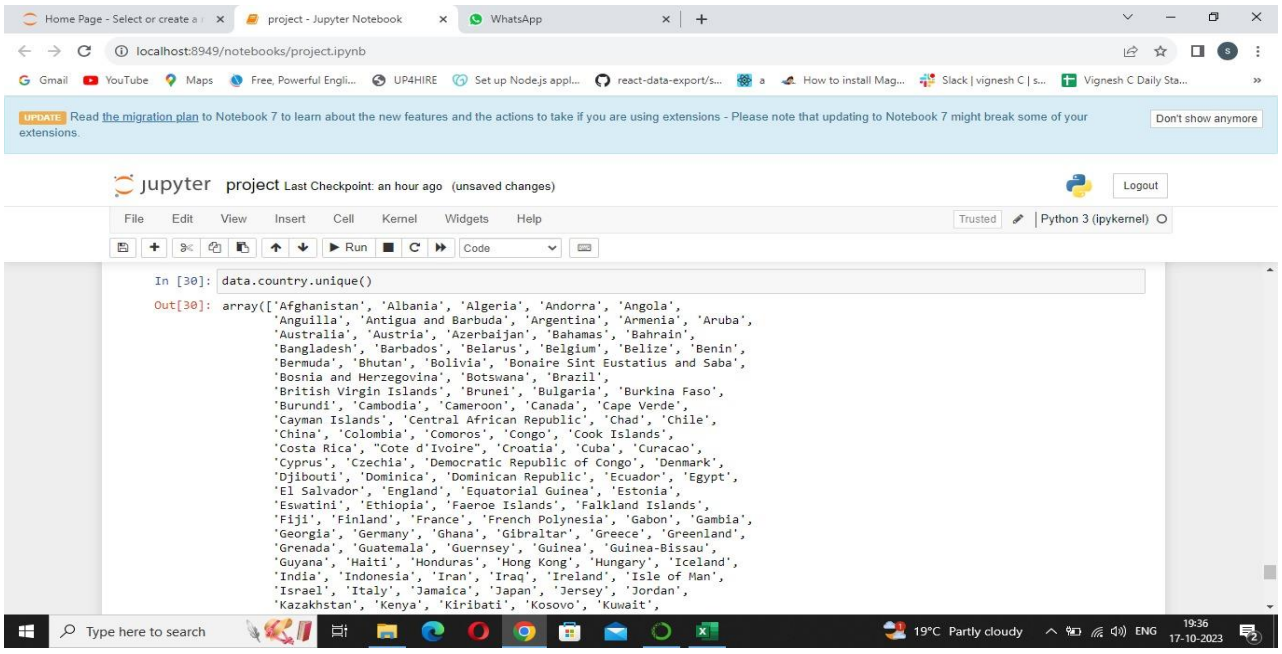


```
In [29]: data.describe()
```

Out[29]:

	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hund
count	86512	8.651200e+04	8.651200e+04	8.651200e+04	8.651200e+04	8.651200e+04	86512.000
mean	2021-09-01 17:09:45.907157504	1.203363e+07	8.451007e+06	6.341251e+06	1.106083e+05	1.308517e+05	40.175
min	2020-12-02 00:00:00	-2.147484e+09	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	0.000
25%	2021-05-27 00:00:00	0.000000e+00	0.000000e+00	0.000000e+00	0.000000e+00	8.770000e+02	0.000
50%	2021-09-04 00:00:00	8.500000e+00	0.000000e+00	0.000000e+00	0.000000e+00	7.245000e+03	0.000
75%	2021-12-12 00:00:00	3.573065e+06	1.843103e+06	1.137869e+06	1.280625e+04	4.370450e+04	68.000
max	2022-03-29 00:00:00	2.142580e+09	1.275541e+09	1.240777e+09	2.474100e+07	2.242429e+07	345.000
std	NaN	1.415666e+08	4.969867e+07	3.890729e+07	7.864756e+05	7.669487e+05	62.545

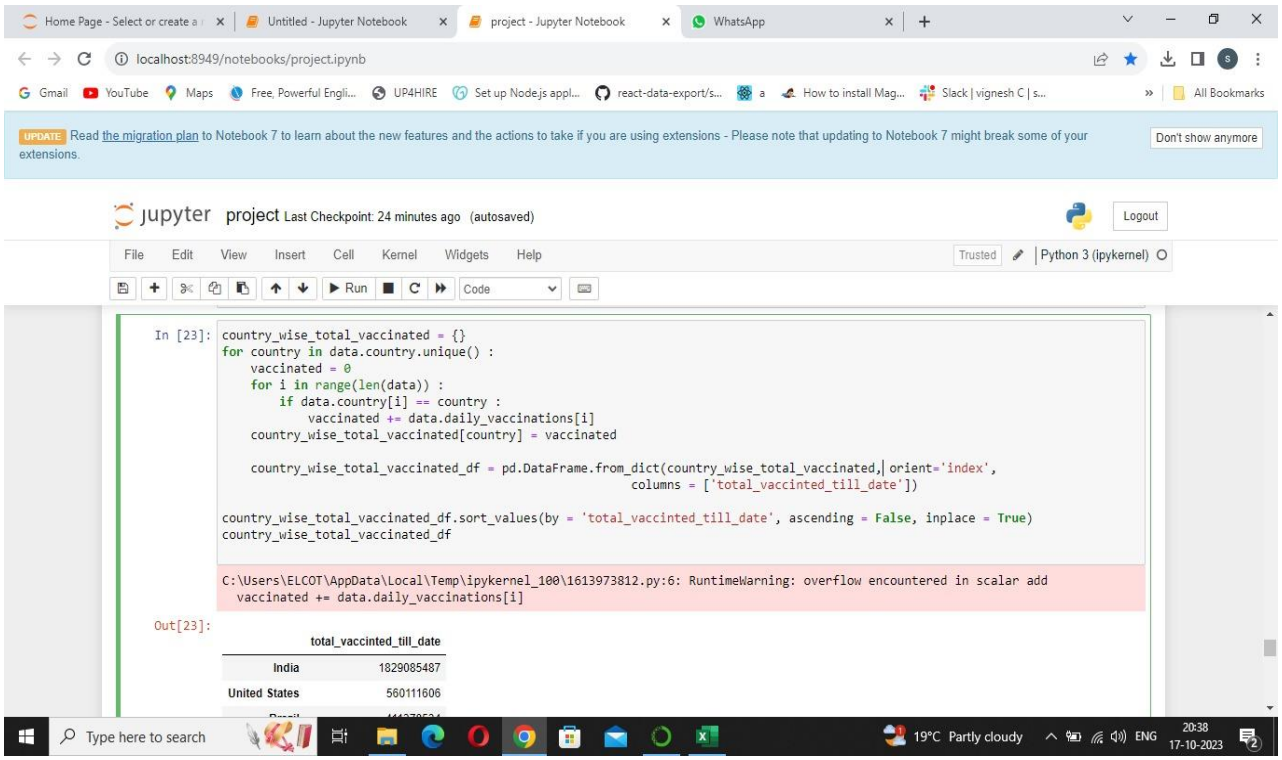
Unique () function helps to get unique values,



```
In [30]: data.country.unique()
```

Out[30]:
```
array(['Afghanistan', 'Albania', 'Algeria', 'Andorra', 'Angola',
       'Anguilla', 'Antigua and Barbuda', 'Argentina', 'Armenia', 'Aruba',
       'Australia', 'Austria', 'Azerbaijan', 'Bahamas', 'Bahrain',
       'Bangladesh', 'Barbados', 'Belarus', 'Belgium', 'Belize', 'Benin',
       'Bermuda', 'Bhutan', 'Bolivia', 'Bonaire Sint Eustatius and Saba',
       'Bosnia and Herzegovina', 'Botswana', 'Brazil',
       'British Virgin Islands', 'Brunei', 'Bulgaria', 'Burkina Faso',
       'Burundi', 'Cambodia', 'Cameroon', 'Canada', 'Cape Verde',
       'Cayman Islands', 'Central African Republic', 'Chad', 'Chile',
       'China', 'Colombia', 'Comoros', 'Congo', 'Cook Islands',
       'Costa Rica', "Cote d'Ivoire", 'Croatia', 'Cuba', 'Curacao',
       'Cyprus', 'Czechia', 'Democratic Republic of Congo', 'Denmark',
       'Djibouti', 'Dominica', 'Dominican Republic', 'Ecuador', 'Egypt',
       'El Salvador', 'England', 'Equatorial Guinea', 'Estonia',
       'Eswatini', 'Ethiopia', 'Faeroe Islands', 'Falkland Islands',
       'Fiji', 'Finland', 'France', 'French Polynesia', 'Gabon', 'Gambia',
       'Georgia', 'Germany', 'Ghana', 'Gibraltar', 'Greece', 'Greenland',
       'Grenada', 'Guatemala', 'Guernsey', 'Guinea', 'Guinea-Bissau',
       'Guyana', 'Haiti', 'Honduras', 'Hong Kong', 'Hungary', 'Iceland',
       'India', 'Indonesia', 'Iran', 'Iraq', 'Ireland', 'Isle of Man',
       'Israel', 'Italy', 'Jamaica', 'Japan', 'Jersey', 'Jordan',
       'Kazakhstan', 'Kenya', 'Kiribati', 'Kosovo', 'Kuwait',
```

To see how many total vaccines have been used in each country using the code below,

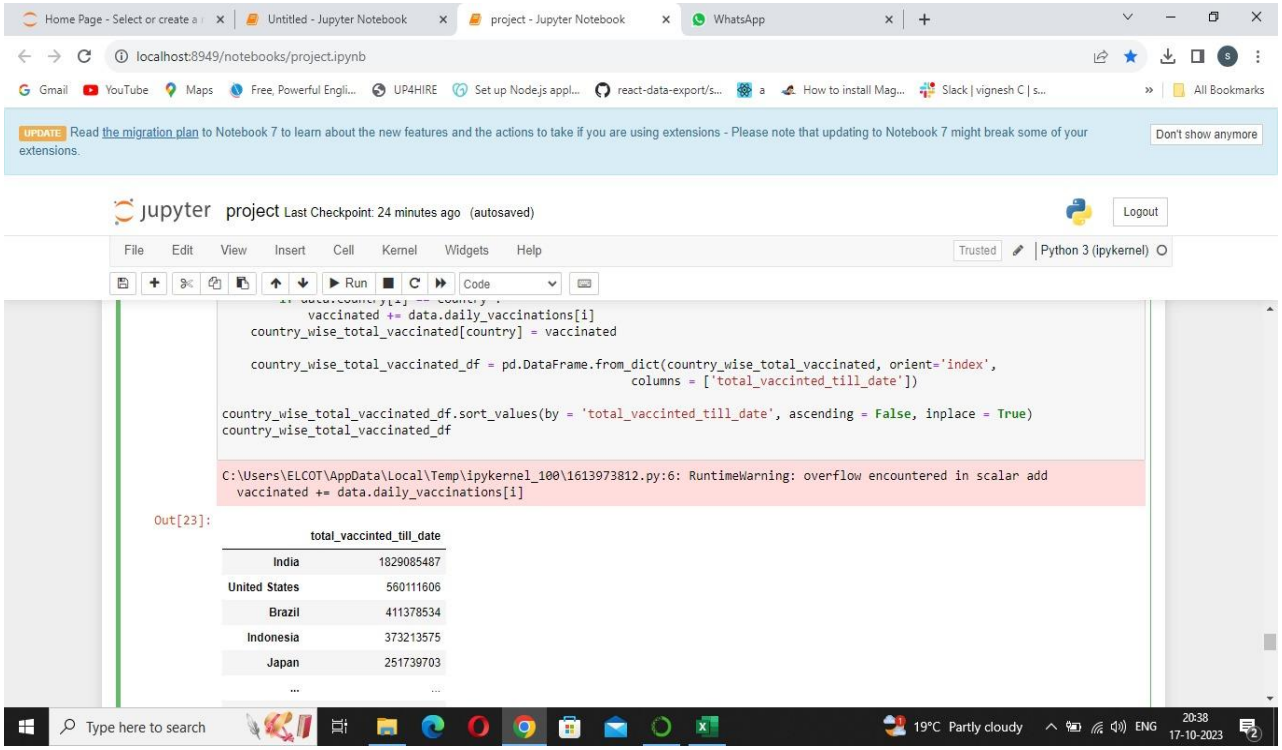


```
country_wise_total_vaccinated = {}
for country in data.country.unique() :
    vaccinated = 0
    for i in range(len(data)) :
        if data.country[i] == country :
            vaccinated += data.daily_vaccinations[i]
    country_wise_total_vaccinated[country] = vaccinated

    country_wise_total_vaccinated_df = pd.DataFrame.from_dict(country_wise_total_vaccinated, orient='index',
                                                              columns = ['total_vaccinted_till_date'])

country_wise_total_vaccinated_df.sort_values(by = 'total_vaccinted_till_date', ascending = False, inplace = True)
country_wise_total_vaccinated_df
```

```
C:\Users\ELCOT\AppData\Local\Temp\ipykernel_100\1613973812.py:6: RuntimeWarning: overflow encountered in scalar add
  vaccinated += data.daily_vaccinations[i]
```

Out[23]:

	total_vaccinted_till_date
India	1829085487
United States	560111606



```
            vaccinated += data.daily_vaccinations[i]
    country_wise_total_vaccinated[country] = vaccinated

    country_wise_total_vaccinated_df = pd.DataFrame.from_dict(country_wise_total_vaccinated, orient='index',
                                                              columns = ['total_vaccinted_till_date'])

country_wise_total_vaccinated_df.sort_values(by = 'total_vaccinted_till_date', ascending = False, inplace = True)
country_wise_total_vaccinated_df
```

```
C:\Users\ELCOT\AppData\Local\Temp\ipykernel_100\1613973812.py:6: RuntimeWarning: overflow encountered in scalar add
  vaccinated += data.daily_vaccinations[i]
```

Out[23]:

	total_vaccinted_till_date
India	1829085487
United States	560111606
Brazil	411378534
Indonesia	373213575
Japan	251739703
...	...

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Run Code

In [24]:
```
fig = px.bar(country_wise_total_vaccinated_df,
             y = 'total_vaccinted_till_date',
             x = country_wise_total_vaccinated_df.index,
             color = 'total_vaccinted_till_date',
             color_discrete_sequence= px.colors.sequential.Viridis_r
            )
fig.update_layout(
    title={
            'text' : "Vaccination till date in various countries",
           'y':0.95,
           'x':0.5
        },
    xaxis_title="Countries",
    yaxis_title="Total vaccinated",
    legend_title="Total vaccinated"
)
fig.show()
```

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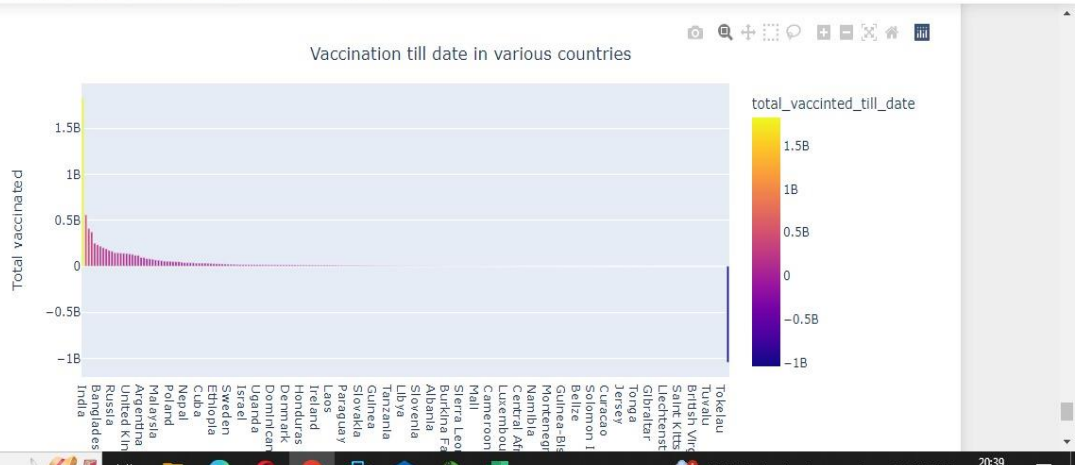
Run Code



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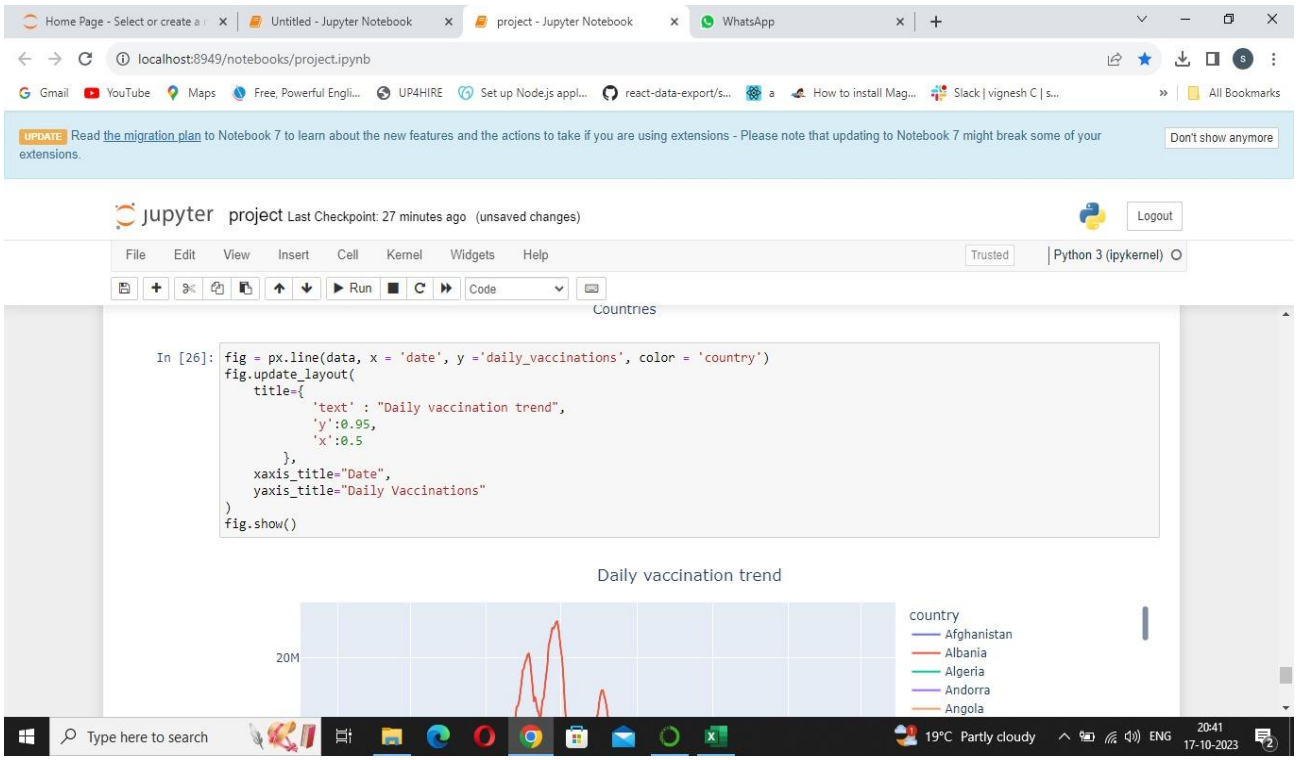
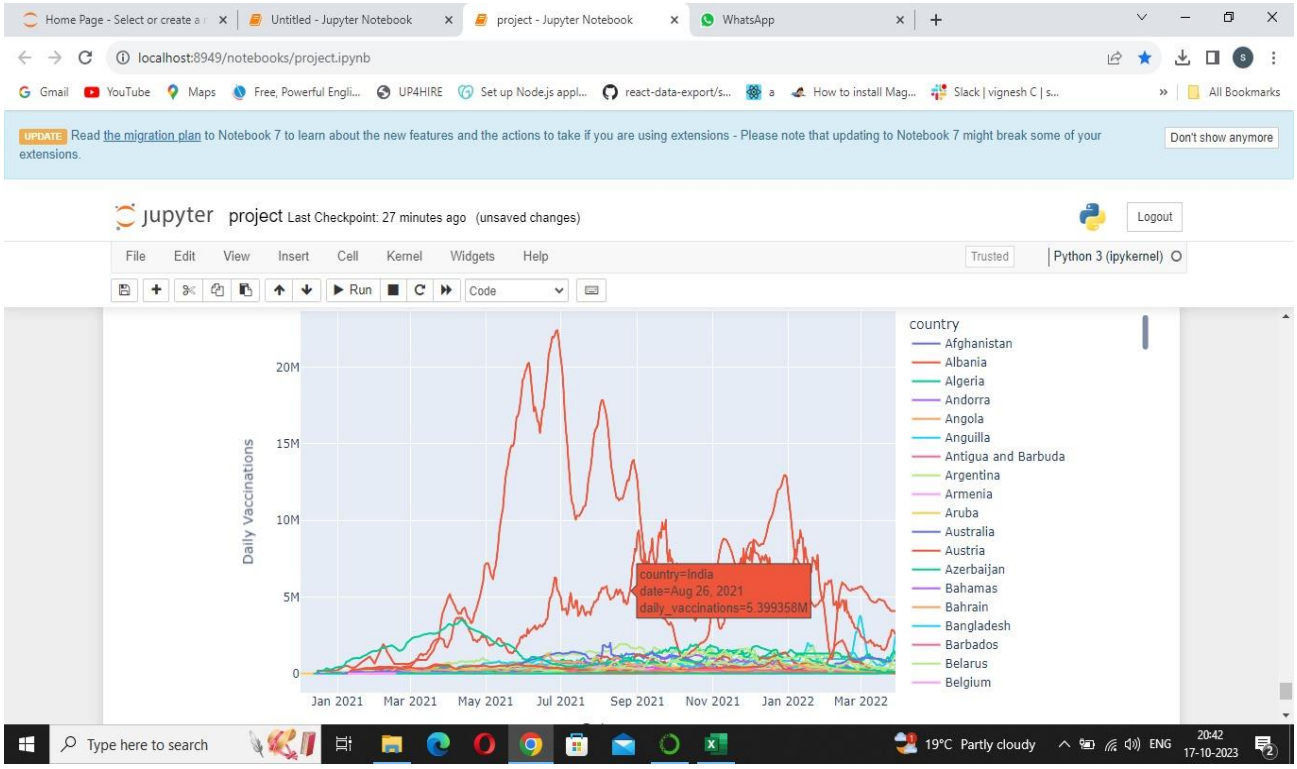
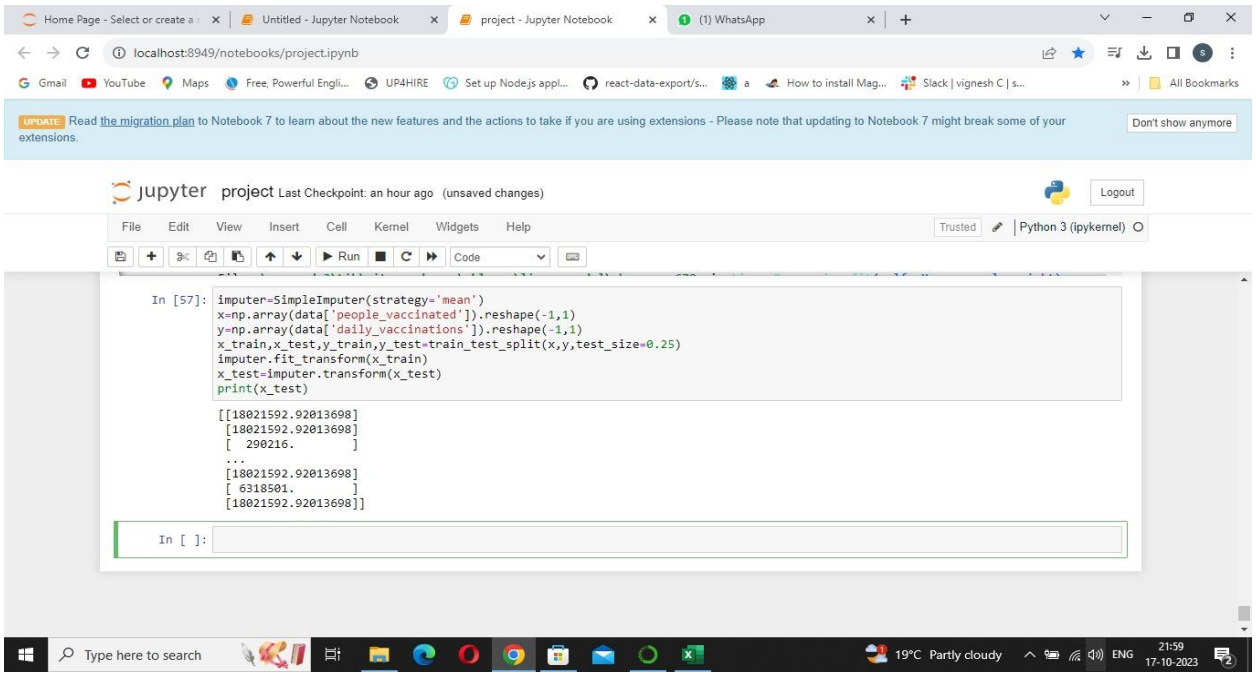
To draw a line plot where x-axis is Date and the y-axis is daily_vaccination using the in the image,



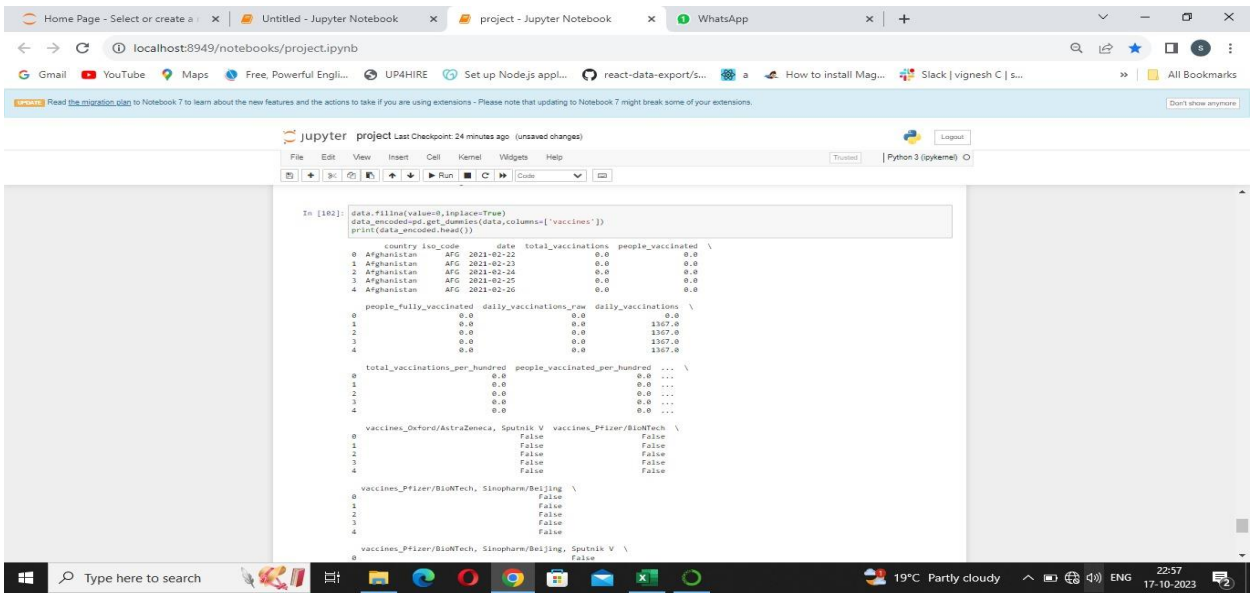


Now, using the sklearn.preprocessing library contains class called imputer, helps in missing data by using the below:



Encoding categorical data(one-hot encoding)

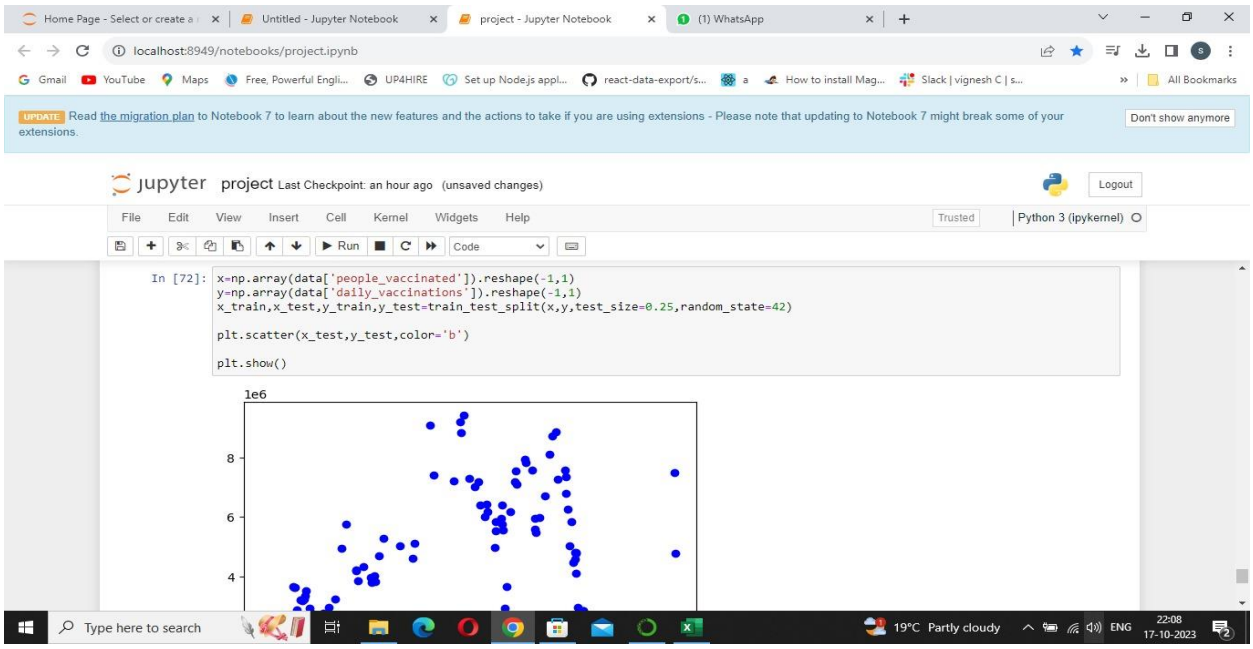
One-hot encoding is a technique used to convert categorical data into a numerical format that machine learning algorithms can work with. Here's how you can perform one-hot encoding in Python, assuming you have a dataset with categorical variables:



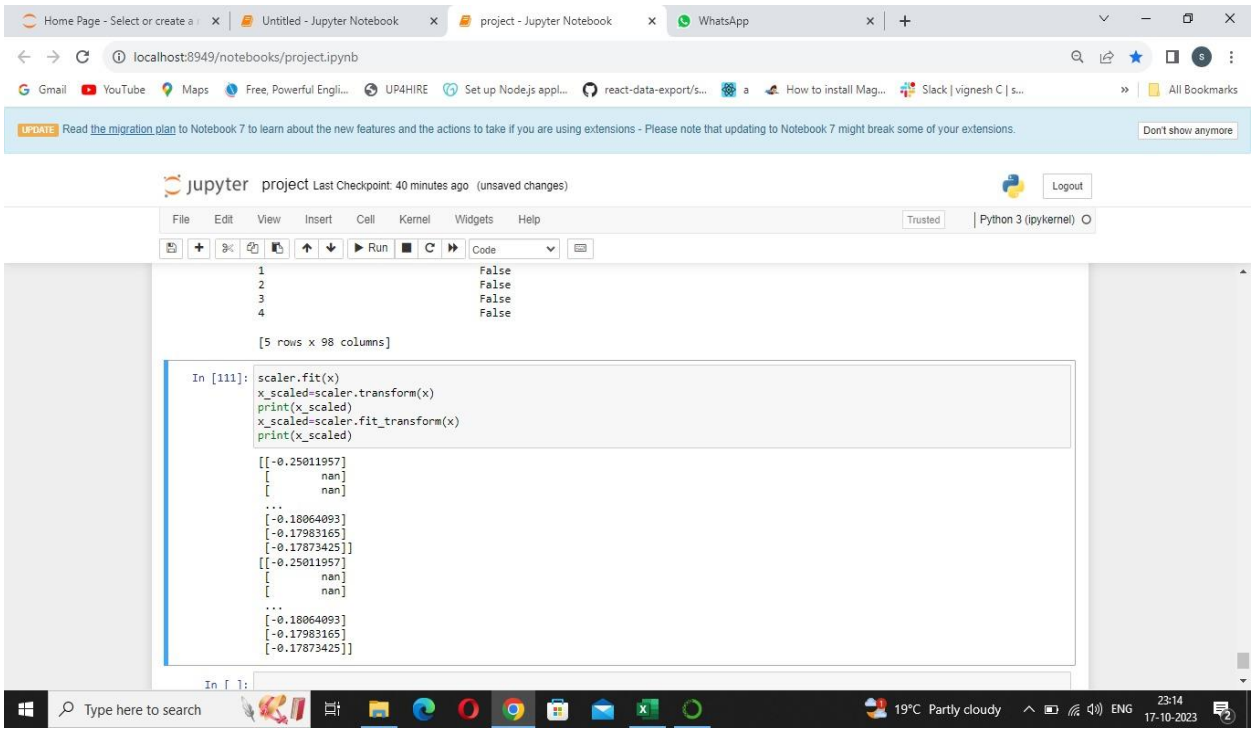
Splitting the data set into test set and training set

By using,

Import train_test_split



Feature Scaling



STATISTICAL ANALYSIS

Statistical analysis for COVID-19 vaccine analysis data can provide more in-depth insights and support decision-making. Here are some statistical techniques and analyses you can perform:

1. Descriptive Statistics: *Calculate summary statistics (mean, median, standard deviation) for key vaccine-related variables, such as vaccination rates, doses administered, and adverse events.*

2. Hypothesis Testing: *Use statistical tests like t-tests or ANOVA to compare vaccination rates or outcomes between different groups (e.g., regions, age groups, vaccine types).*

3. Correlation Analysis: *Determine the strength and direction of relationships between variables, such as vaccine coverage and COVID-19 case rates, using correlation coefficients (e.g., Pearson, Spearman).*

4. Regression Analysis: *Perform regression analysis to model and predict vaccination rates or other outcomes based on various factors like time, demographics, and vaccine supply.*

5. Time Series Analysis: *Utilize time series methods like ARIMA or Exponential Smoothing to forecast vaccination trends and assess their impact on COVID-19 cases.*

6. Spatial Analysis: *Employ spatial statistics and geographic information systems (GIS) to analyze the spatial distribution of vaccination rates and identify hotspots.*

7. Survival Analysis: *If relevant, conduct survival analysis to study the time to vaccination completion or the duration of vaccine effectiveness.*

8. Chi-Square Analysis: *Use chi-square tests to analyze categorical data, such as adverse events or vaccine preference by age group.*

9. Cluster Analysis: *Apply clustering algorithms to group areas or individuals with similar vaccination patterns.*

10. Bayesian Analysis: *Employ Bayesian methods to model vaccine efficacy, taking into account prior information and updating as new data becomes available.*

11. Machine Learning: *Utilize machine learning techniques for classification or prediction tasks related to vaccine distribution, efficacy, or adverse events.*

12. A/B Testing: *If applicable, conduct A/B testing to compare the impact of different vaccine distribution strategies or communication approaches.*

13. Meta-Analysis: *If multiple studies are available, perform a meta-analysis to synthesize findings from different sources.*

14. Statistical Significance: *Ensure results are statistically significant by setting appropriate significance levels (e.g., $p < 0.05$) and adjusting for multiple comparisons if needed.*

15. Data Visualization: *Visualize statistical results using charts, plots, and graphs to make the findings more accessible.*

DESCRIPTIVE STATISTICS

Descriptive statistics provide a summary of your data, including measures like mean, median, and standard deviation.

- *mean_vaccination = data['total_vaccinations'].mean()*

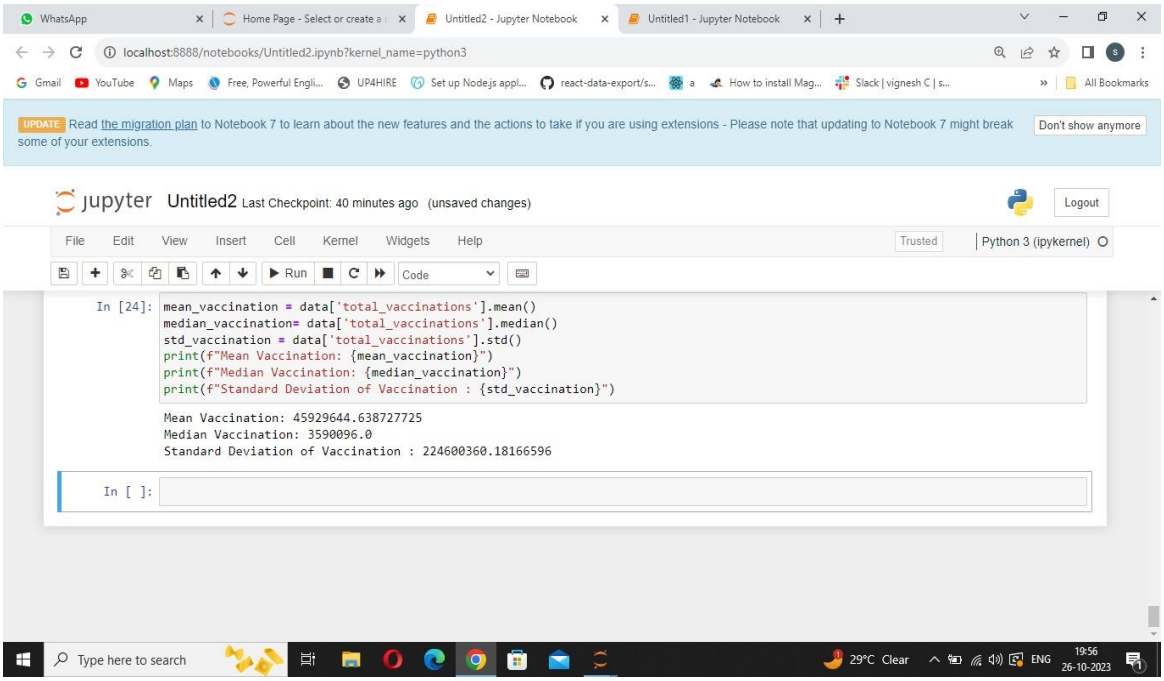
  median_vaccination= data['total_vaccinations'].median()

  std_vaccination = data['total_vaccinations'].std()

  print(f"Mean Vaccination: {mean_vaccination}")

  print(f"Median Vaccination: {median_vaccination}")

  print(f"Standard Deviation of Vaccination : {std_vaccination}")



- *mean_vaccination = data['people_vaccinated'].mean()*

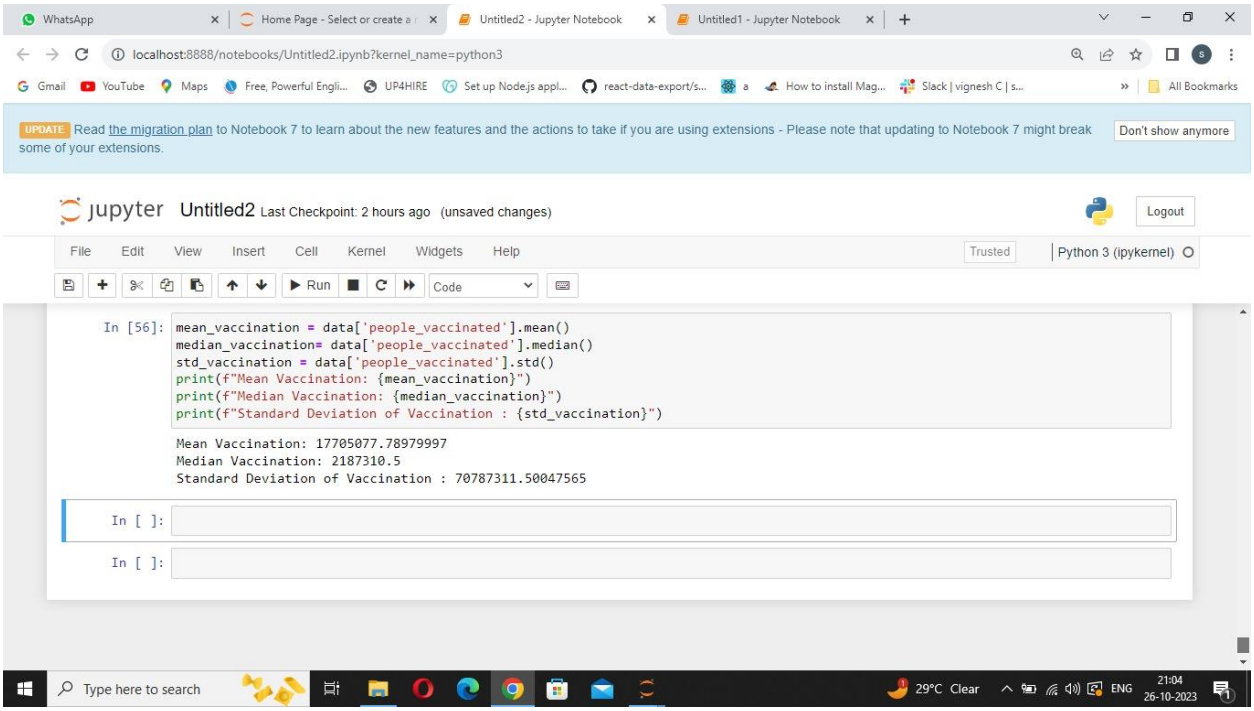
  median_vaccination= data['people_vaccinated'].median()

  std_vaccination = data['people_vaccinated'].std()

  print(f"Mean Vaccination: {mean_vaccination}")

  print(f"Median Vaccination: {median_vaccination}")

  print(f"Standard Deviation of Vaccination : {std_vaccination}")



- *mean_vaccination = data['daily_vaccinations'].mean()*

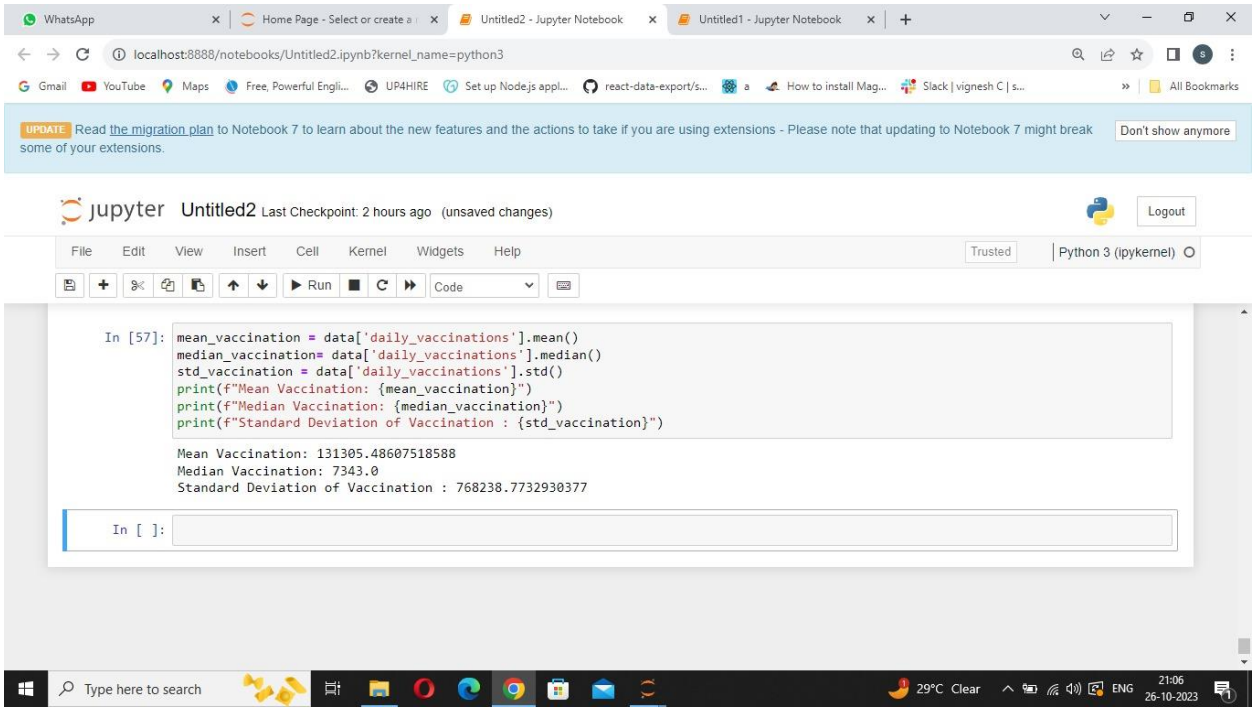
  median_vaccination= data['daily_vaccinations'].median()

  std_vaccination = data['daily_vaccinations'].std()

  print(f"Mean Vaccination: {mean_vaccination}")

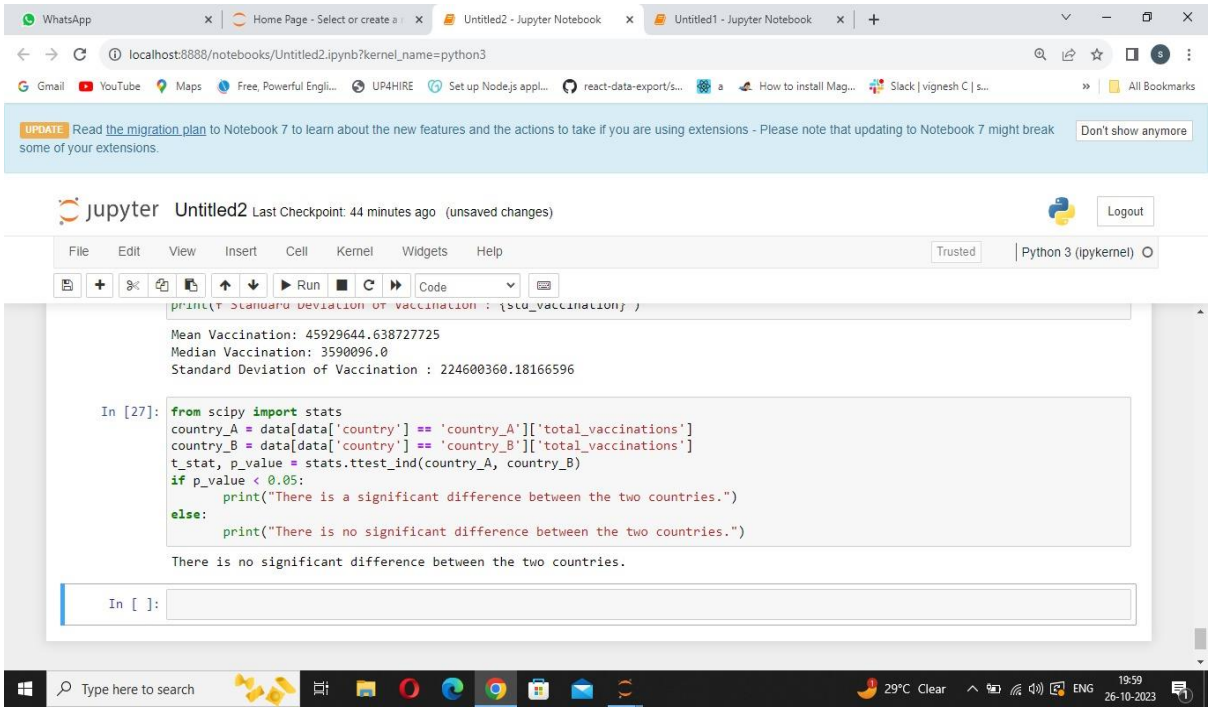
  print(f"Median Vaccination: {median_vaccination}")

  print(f"Standard Deviation of Vaccination : {std_vaccination}")



HYPOTHESIS TESTING

```
from scipy import stats
country_A = data[data['country'] == 'country_A']['total_vaccinations']
country_B = data[data['country'] == 'country_B']['total_vaccinations']
t_stat, p_value = stats.ttest_ind(country_A, country_B)
if p_value < 0.05:
    print("There is a significant difference between the two countries.")
else:
        print("There is no significant difference between the two countries.")
```



VISUALISATION

Visualizations play a crucial role in understanding and presenting COVID-19 vaccine analysis. Here are some types of visualizations you can use:

***1. Bar Charts:** Show the distribution of different vaccine types administered in a region or over time.*

***2. Line Charts:** Display trends in vaccination rates over time, including first and second doses administered.*

***3. Area Charts:** Visualize the cumulative number of vaccines administered over time to track progress.*

***4. Stacked Bar Charts:** Illustrate the breakdown of vaccine distribution by age group or gender.*

***5. Heatmaps:** Depict vaccination rates across regions or countries using color gradients.*

6. Choropleth Maps: *Show vaccination coverage by shading areas on a map, with darker colors indicating higher coverage.*

7. Scatter Plots: *Explore correlations between vaccination rates and variables like COVID-19 cases, GDP, or healthcare infrastructure.*

8. Histograms: *Examine the distribution of adverse events or vaccine side effects.*

9. Box Plots: *Display the distribution of vaccination rates or efficacy scores, showing median, quartiles, and outliers.*

10. Sankey Diagrams: *Visualize the flow of vaccines from manufacturers to distribution points.*

11. Network Diagrams: *Illustrate the connections between different stakeholders in the vaccine supply chain.*

12. Venn Diagrams: *Compare the overlap or differences between vaccinated populations by age, region, or other factors.*

13. Pareto Charts: *Identify the most significant contributors to vaccine distribution or adverse events.*

14. Pie Charts: *Show the proportion of the population that has received different vaccine types.*

15. Radar Charts: *Compare multiple attributes of different vaccines, such as efficacy, side effects, and cost.*

16. Dashboard: *Create an interactive dashboard with multiple visualizations for a comprehensive view of vaccine-related data.*

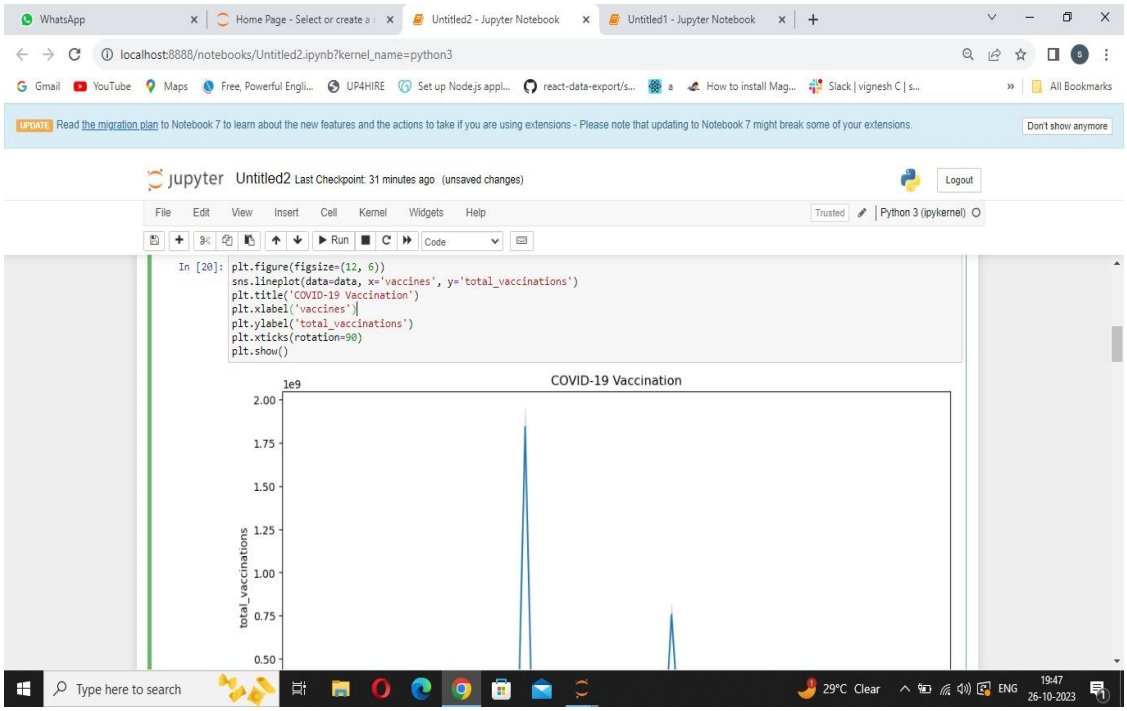
17. Bubble Charts: *Represent data in a scatter plot format with bubbles of different sizes to show relationships between multiple variables.*

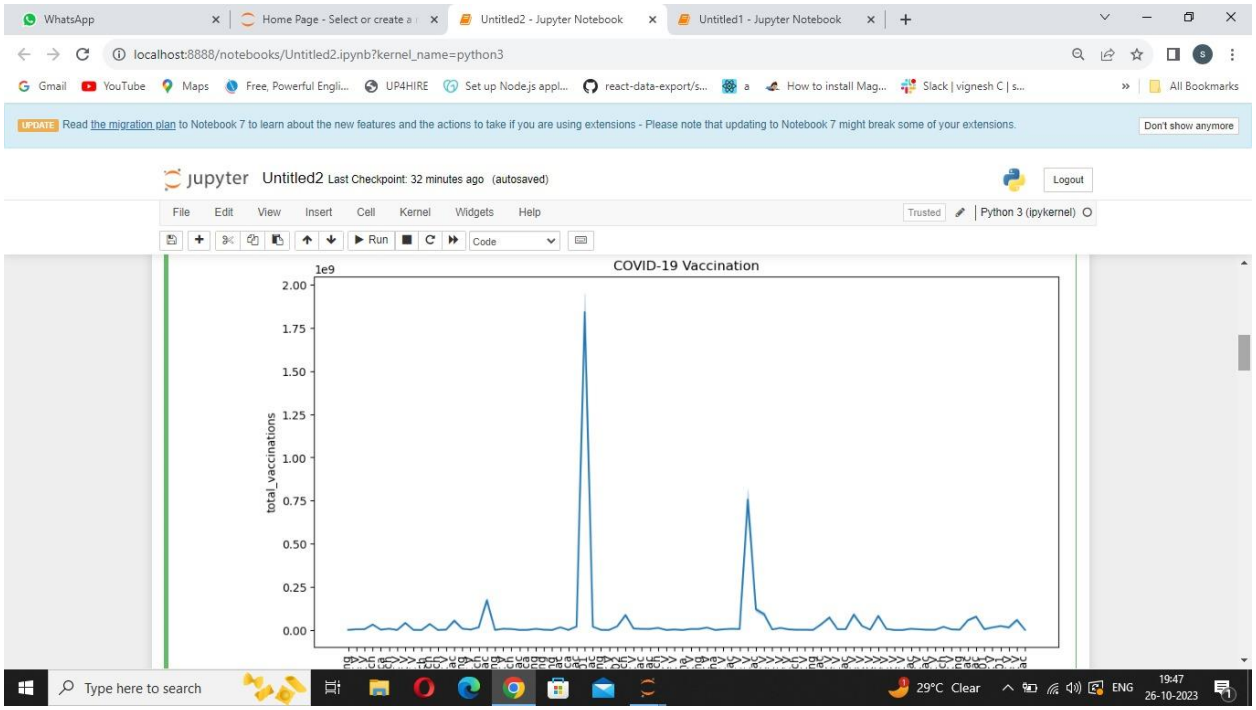
18. Word Clouds: *Summarize public sentiment or discussions about vaccines on social media or news articles.*

19. Time Series Plots: *Analyze how vaccination rates change over time, including variations in different regions or age groups.*

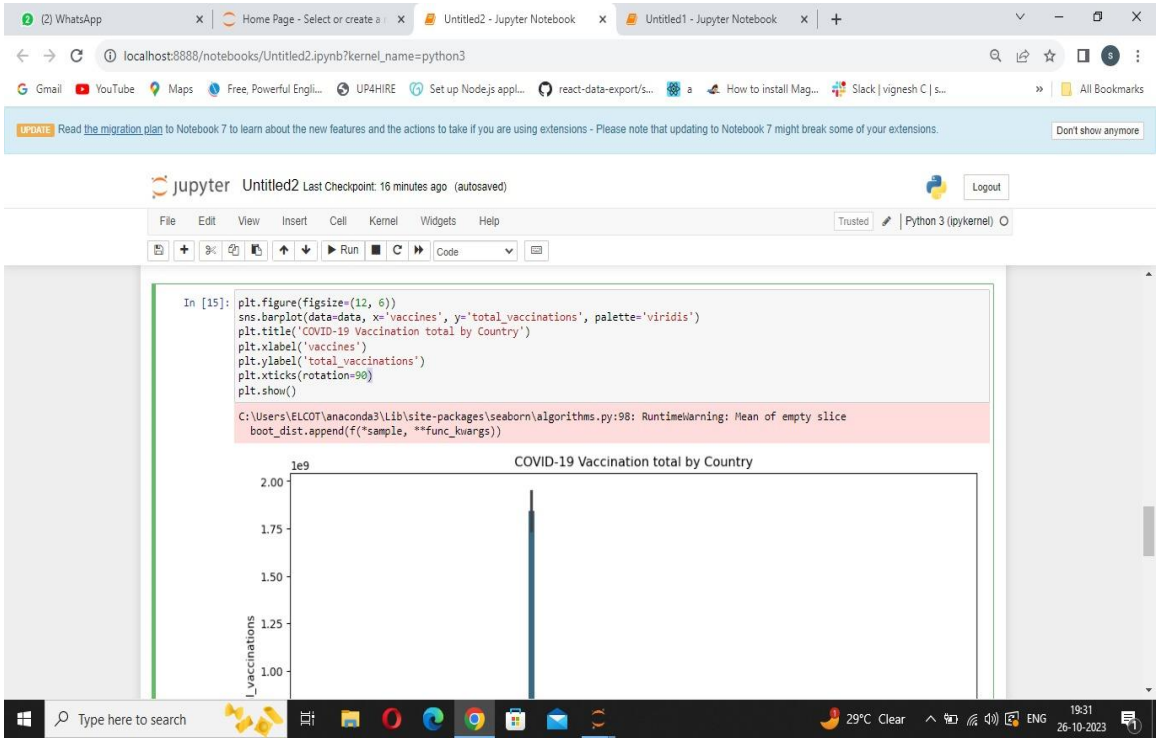
20. Comparative Charts: *Compare vaccine distribution and coverage across different countries or regions.*

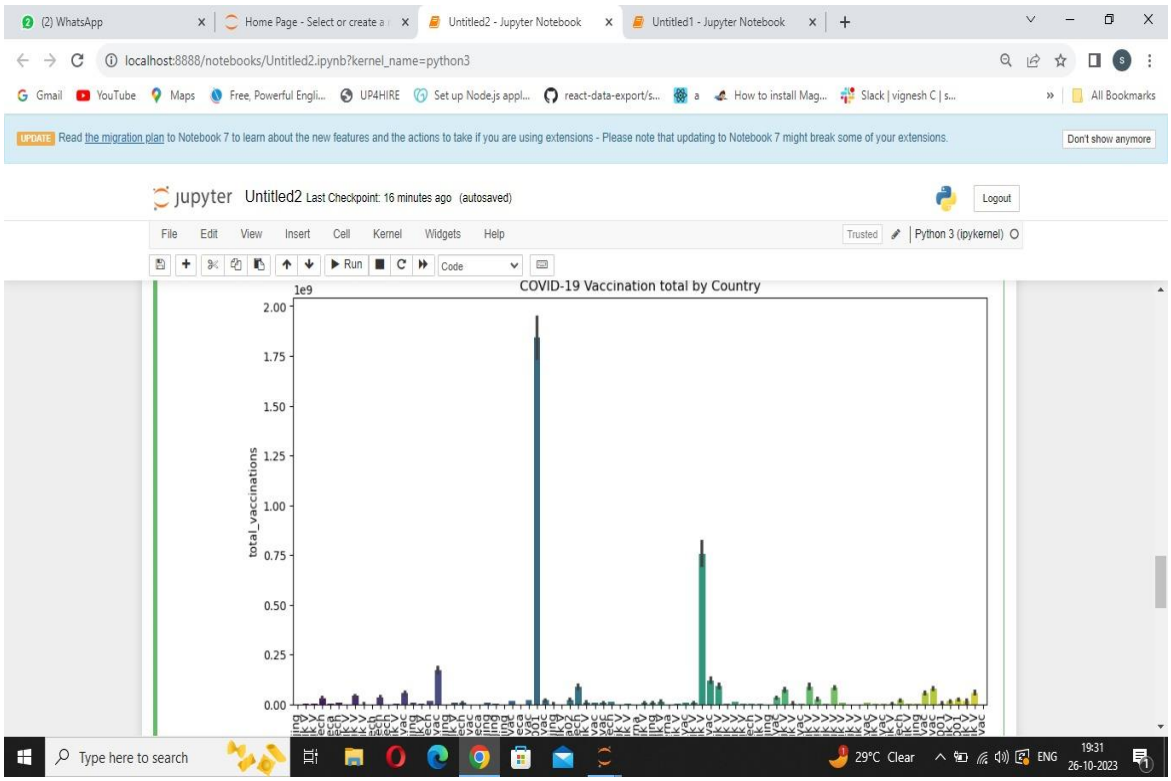
- *create a line chart to utilize the progress of vaccination*





- ***create a bar chart between total by country and total_vaccination***





- ***Create a pie chart to show the distribution of vaccine types***