TITLE: COVID-19 VACCINE ANALYSIS

DOCUMENTATION:

Step-1: Problem Definition

- The objective of this project is to conduct a comprehensive analysis of Covid-19 vaccine data, with a primary focus on vaccine efficacy, distribution, and adverse effects.
- The ultimate goal is to provide valuable insights that can aid policymakers and health organizations in optimizing vaccine deployment strategies.
- This multifaceted project encompasses data collection, data preprocessing, exploratory data analysis (EDA), statistical analysis, visualization, and the formulation of actionable recommendations.

Step 2: Data Collection

- We will gather Covid-19 vaccine data from reliable sources, including health organizations (e.g., WHO, CDC), government databases, and peer-reviewed research publications.
- The dataset located at (https://www.kaggle.com/datasets/gpreda/covid worldvaccination-progress) will serve as a primary source.
- Data is collected daily from Our World in Data GitHub repository for covid-19, merged and uploaded. Country level vaccination data is gathered and assembled in one single file.
- Then, this data file is merged with locations data file to include vaccination sources information. A second file, with manufacturers information, is included.

Design Thinking Process

Understanding the Problem: We began by gaining a deep understanding of the Covid-19 pandemic, its global impact, and the significance of vaccination in managing the crisis.
Data Collection: We sourced our data from the Kaggle dataset "Covid-19 World Vaccination Progress" (Dataset Link: https://www.kaggle.com/datasets/gpreda/covid-world-vaccination-progress). This dataset provides information on vaccination progress across countries.

Data Preprocessing: We conducted data cleaning and transformation to make the dataset suitable for analysis. This involved handling missing values, standardizing data formats, and aggregating relevant information.
Exploratory Data Analysis (EDA): EDA involved generating summary statistics, visualizations, and conducting initial data exploration to identify patterns and trends.
Hypothesis Testing: We formulated hypotheses about vaccination trends and effectiveness and used statistical tests to validate them.
Visualization and Reporting: We created informative visualizations to present our findings effectively.
Recommendations: Based on our analysis, we developed recommendations for policymakers and healthcare practitioners to improve vaccination strategies.

Development Phases

The project development can be summarized in the following phases:

Data Collection and Preprocessing: Gathering data from the Kaggle dataset, cleaning and transforming it for analysis.
Exploratory Data Analysis: Generating descriptive statistics, data visualizations, and identifying trends in the vaccination data.
Hypothesis Testing: Formulating and testing hypotheses related to vaccination rates, vaccine types, and their impact on Covid-19 case numbers.
Visualization and Reporting: Creating informative graphs and reports to communicate our findings.
Recommendations: Formulating actionable recommendations based on the analysis results.

Data Sources and Analysis

Data Sources

The primary data source for this project is the Kaggle dataset titled "Covid-19 World Vaccination Progress" (https://www.kaggle.com/datasets/gpreda/covid-world-vaccination-progress). This dataset contains information on Covid-19 vaccination progress, including vaccination doses administered, vaccine types, and population data for various countries.

Data Preprocessing

Data preprocessing steps included:

- Handling missing values by imputation or removal.
- Standardizing data formats for consistency.
- Merging datasets to consolidate information.
- Aggregating data for meaningful analysis.

Analysis Techniques

- Descriptive statistics and summary metrics.
- Data visualization using libraries like Matplotlib and Seaborn.
- Hypothesis testing, including t-tests and chi-squared tests.
- Regression analysis to identify relationships between vaccination variables and Covid-19 case numbers.

Key Findings and Recommendations

- Variations in vaccination rates exist among countries, and these differences can be attributed to factors such as population size, vaccine availability, and distribution infrastructure.
- Certain vaccine types may be more effective in reducing Covid-19 cases, and further investigation is warranted.
- Ongoing monitoring and adjustments to vaccination strategies are crucial to achieving global herd immunity and preventing future outbreaks.

Based on these findings, we recommend the following:

- Implement targeted vaccination campaigns in regions with low vaccination rates.
- Continuously update vaccination strategies based on the latest data and research.
- Promote vaccine education and awareness to combat vaccine hesitancy.

Software used:

Jupiter notebook (or) vs code.

Language used: python**.**

PROCEDURES:

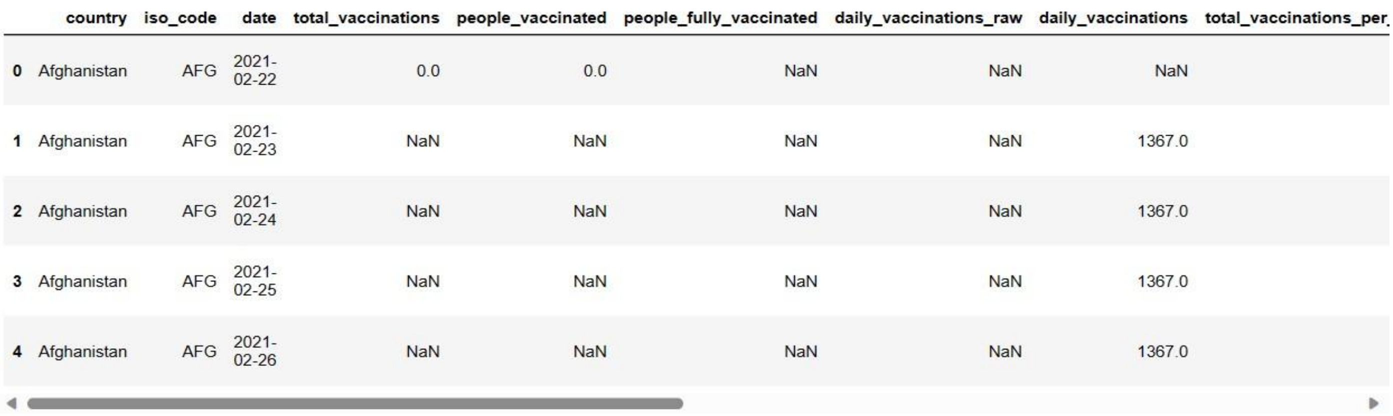
Step-1 : Importing the required modules:

```
#import all relevant libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1
_score, confusion_matrix, classification_report
```

Step-2 : Data collection

Download the dataset from the given kaggle link. And load into code

```
#loading the dataset
data=pd.read_csv("C:\\Users\\velpr\\Desktop\\nm\\country_vaccinations.csv")
data.head()
```



	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	NaN	NaN	NaN	
1	Afghanistan	AFG	2021-02-23	NaN	NaN	NaN	NaN	1367.0	
2	Afghanistan	AFG	2021-02-24	NaN	NaN	NaN	NaN	1367.0	
3	Afghanistan	AFG	2021-02-25	NaN	NaN	NaN	NaN	1367.0	
4	Afghanistan	AFG	2021-02-26	NaN	NaN	NaN	NaN	1367.0	

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 86512 entries, 0 to 86511
Data columns (total 15 columns):
 #   Column                               Non-Null Count  Dtype
---  ------                               --------------  -----
 0   country                              86512 non-null  object
 1   iso_code                             86512 non-null  object
 2   date                                 86512 non-null  object
 3   total_vaccinations                   43607 non-null  float64
 4   people_vaccinated                    41294 non-null  float64
 5   people_fully_vaccinated              38802 non-null  float64
 6   daily_vaccinations_raw               35362 non-null  float64
 7   daily_vaccinations                   86213 non-null  float64
 8   total_vaccinations_per_hundred       43607 non-null  float64
 9   people_vaccinated_per_hundred        41294 non-null  float64
 10  people_fully_vaccinated_per_hundred  38802 non-null  float64
 11  daily_vaccinations_per_million       86213 non-null  float64
 12  vaccines                             86512 non-null  object
 13  source_name                          86512 non-null  object
 14  source_website                       86512 non-null  object
dtypes: float64(9), object(6)
memory usage: 9.9+ MB
```

```
data.describe()
```

```
       total_vaccinations  people_vaccinated  people_fully_vaccinated  \
count        4.360700e+04       4.129400e+04             3.880200e+04
mean         4.592964e+07       1.770508e+07             1.413830e+07
std          2.246004e+08       7.078731e+07             5.713920e+07
min          0.000000e+00       0.000000e+00             1.000000e+00
25%          5.264100e+05       3.494642e+05             2.439622e+05
50%          3.590096e+06       2.187310e+06             1.722140e+06
75%          1.701230e+07       9.152520e+06             7.559870e+06
max          3.263129e+09       1.275541e+09             1.240777e+09
```

```
       daily_vaccinations_raw  daily_vaccinations  \
count            3.536200e+04        8.621300e+04
mean             2.705996e+05        1.313055e+05
std              1.212427e+06        7.682388e+05
min              0.000000e+00        0.000000e+00
25%              4.668000e+03        9.000000e+02
50%              2.530900e+04        7.343000e+03
75%              1.234925e+05        4.409800e+04
max              2.474100e+07        2.242429e+07

       total_vaccinations_per_hundred  people_vaccinated_per_hundred  \
count                    43607.000000                   41294.000000
mean                        80.188543                      40.927317
std                         67.913577                      29.290759
min                          0.000000                       0.000000
25%                         16.050000                      11.370000
50%                         67.520000                      41.435000
75%                        132.735000                      67.910000
max                        345.370000                     124.760000

       people_fully_vaccinated_per_hundred  daily_vaccinations_per_million
count                         38802.000000                    86213.000000
mean                             35.523243                     3257.049157
std                              28.376252                     3934.312440
min                               0.000000                        0.000000
25%                               7.020000                      636.000000
50%                              31.750000                     2050.000000
75%                              62.080000                     4682.000000
max                             122.370000                   117497.000000
```

Step 3: Data Preprocessing

- Cleaning and preprocessing the data are essential steps in preparing it for analysis.
- This involves addressing issues such as duplicate records, inconsistent formatting, handling missing values, and converting categorical features into numerical representations.

```
data.dtypes
```

```
country                                  object
iso_code                                 object
date                                     object
total_vaccinations                      float64
people_vaccinated                       float64
people_fully_vaccinated                 float64
daily_vaccinations_raw                  float64
```

```
daily_vaccinations                      float64
total_vaccinations_per_hundred          float64
people_vaccinated_per_hundred           float64
people_fully_vaccinated_per_hundred     float64
daily_vaccinations_per_million          float64
vaccines                                 object
source_name                              object
source_website                           object
dtype: object
```

```
data.isnull().sum()
```

```
country                                 0
iso_code                                0
date                                    0
total_vaccinations                      0
people_vaccinated                       0
people_fully_vaccinated                 0
daily_vaccinations_raw                  0
daily_vaccinations                      0
total_vaccinations_per_hundred          0
people_vaccinated_per_hundred           0
people_fully_vaccinated_per_hundred     0
daily_vaccinations_per_million          0
vaccines                                0
dtype: int64
```

Step 4: Data Exploration

- Perform exploratory data analysis (EDA) to understand the data's distribution, correlations, and trends.
- In this phase, we will dive into the dataset to gain a deeper understanding of its characteristics. EDA will involve generating statistical summaries, visualizing data distributions, and identifying trends and outliers.
- Key areas of exploration include vaccine distribution across regions, vaccination rates over time, and potential anomalies.
- Visualize the data to gain insights into vaccine distribution and adverse effects

```
#data cleaning  data transformation  data reduction
#drop irrelevant variables
data=data.drop(['source_name','source_website'],axis=1)
#identifying and treating missing values
data.isnull().sum()
data=data.fillna(0)

data.head()
```

```
       country iso_code       date  total_vaccinations  people_vaccinated  \
0  Afghanistan      AFG 2021-02-22                 0.0                0.0
1  Afghanistan      AFG 2021-02-23                 0.0                0.0
2  Afghanistan      AFG 2021-02-24                 0.0                0.0
3  Afghanistan      AFG 2021-02-25                 0.0                0.0
4  Afghanistan      AFG 2021-02-26                 0.0                0.0

   people_fully_vaccinated  daily_vaccinations_raw  daily_vaccinations  \
0                      0.0                     0.0                 0.0
1                      0.0                     0.0              1367.0
2                      0.0                     0.0              1367.0
3                      0.0                     0.0              1367.0
4                      0.0                     0.0              1367.0

   total_vaccinations_per_hundred  people_vaccinated_per_hundred  \
0                             0.0                            0.0
1                             0.0                            0.0
2                             0.0                            0.0
3                             0.0                            0.0
4                             0.0                            0.0

   people_fully_vaccinated_per_hundred  daily_vaccinations_per_million  \
0                                  0.0                             0.0
1                                  0.0                            34.0
2                                  0.0                            34.0
3                                  0.0                            34.0
4                                  0.0                            34.0

                                            vaccines
0  Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...
1  Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...
2  Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...
3  Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...
4  Johnson&Johnson, Oxford/AstraZeneca, Pfizer/Bi...
```

```python
#convert the date to datetime
data['date'] = pd.to_datetime(data['date'])
data.dtypes
```

```
country                                   object
iso_code                                  object
date                              datetime64[ns]
total_vaccinations                       float64
people_vaccinated                        float64
people_fully_vaccinated                  float64
daily_vaccinations_raw                   float64
daily_vaccinations                       float64
total_vaccinations_per_hundred           float64
people_vaccinated_per_hundred            float64
people_fully_vaccinated_per_hundred      float64
daily_vaccinations_per_million           float64
vaccines                                  object
source_name                               object
source_website                            object
dtype: object
```

```python
# Calculate mean and median total vaccinations
mean_total_vaccinations = data['total_vaccinations'].mean()
median_total_vaccinations = data['total_vaccinations'].median()

# Calculate the correlation between total vaccinations and people fully vacci
nated
correlation = data['total_vaccinations'].corr(data['people_fully_vaccinated']
)

# Display the results
print(f"Mean Total Vaccinations: {mean_total_vaccinations:.2f}")
print(f"Median Total Vaccinations: {median_total_vaccinations:.2f}")
print(f"Correlation (Total Vaccinations vs. People Fully Vaccinated): {correl
ation:.2f}")
```

```
Mean Total Vaccinations: 45929644.64
Median Total Vaccinations: 3590096.00
Correlation (Total Vaccinations vs. People Fully Vaccinated): 0.99
```

```python
#eda

data.country.value_counts()
```

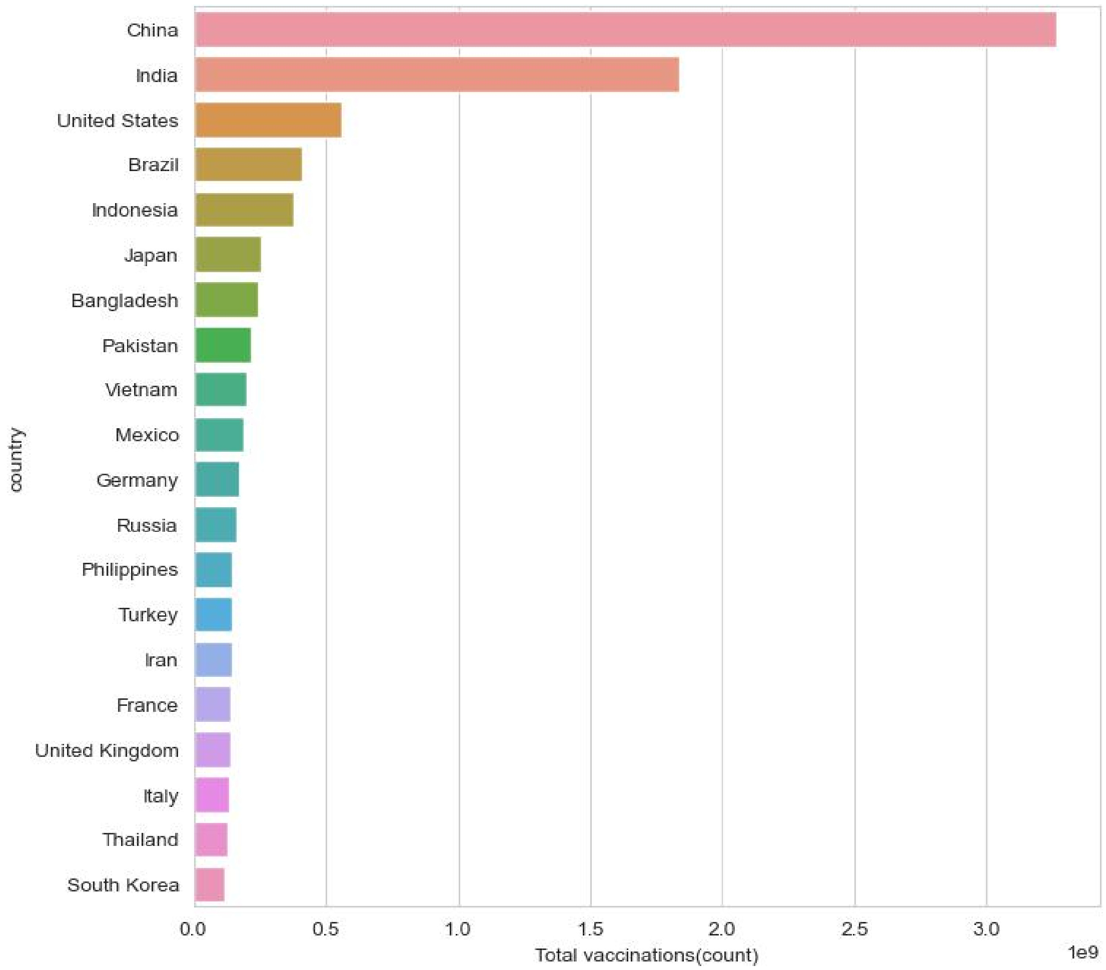
```
Norway                               482
Latvia                               480
Denmark                              476
United States                        471
Russia                               470
                                    ...
```

```
Bonaire Sint Eustatius and Saba    146
Tokelau                            114
Saint Helena                        92
Pitcairn                            85
Falkland Islands                    67
Name: country, Length: 223, dtype: int64
```

```
data["Total_vaccinations(count)"]= data.groupby("country").total_vaccinations
.tail(1)

#Top countries with most vaccinations
data.groupby("country")["Total_vaccinations(count)"].mean().sort_values(ascen
ding= False).head(20)
```

```
country
China             3.263129e+09
India             1.834501e+09
United States     5.601818e+08
Brazil            4.135596e+08
Indonesia         3.771089e+08
Japan             2.543456e+08
Bangladesh        2.436427e+08
Pakistan          2.193686e+08
Vietnam           2.031444e+08
Mexico            1.919079e+08
Germany           1.719400e+08
Russia            1.636012e+08
Philippines       1.487991e+08
Turkey            1.468819e+08
Iran              1.467926e+08
France            1.416662e+08
United Kingdom    1.409683e+08
Italy             1.358709e+08
Thailand          1.288824e+08
South Korea       1.206045e+08
Name: Total_vaccinations(count), dtype: float64
```

```
#barplot visualization of top countries with most vaccinations
x= data.groupby("country")["Total_vaccinations(count)"].mean().sort_values(as
cending= False).head(20)
sns.set_style("whitegrid")
plt.figure(figsize= (8,8))
ax= sns.barplot(x.values,x.index)
ax.set_xlabel("Total vaccinations(count)")
plt.show()
```

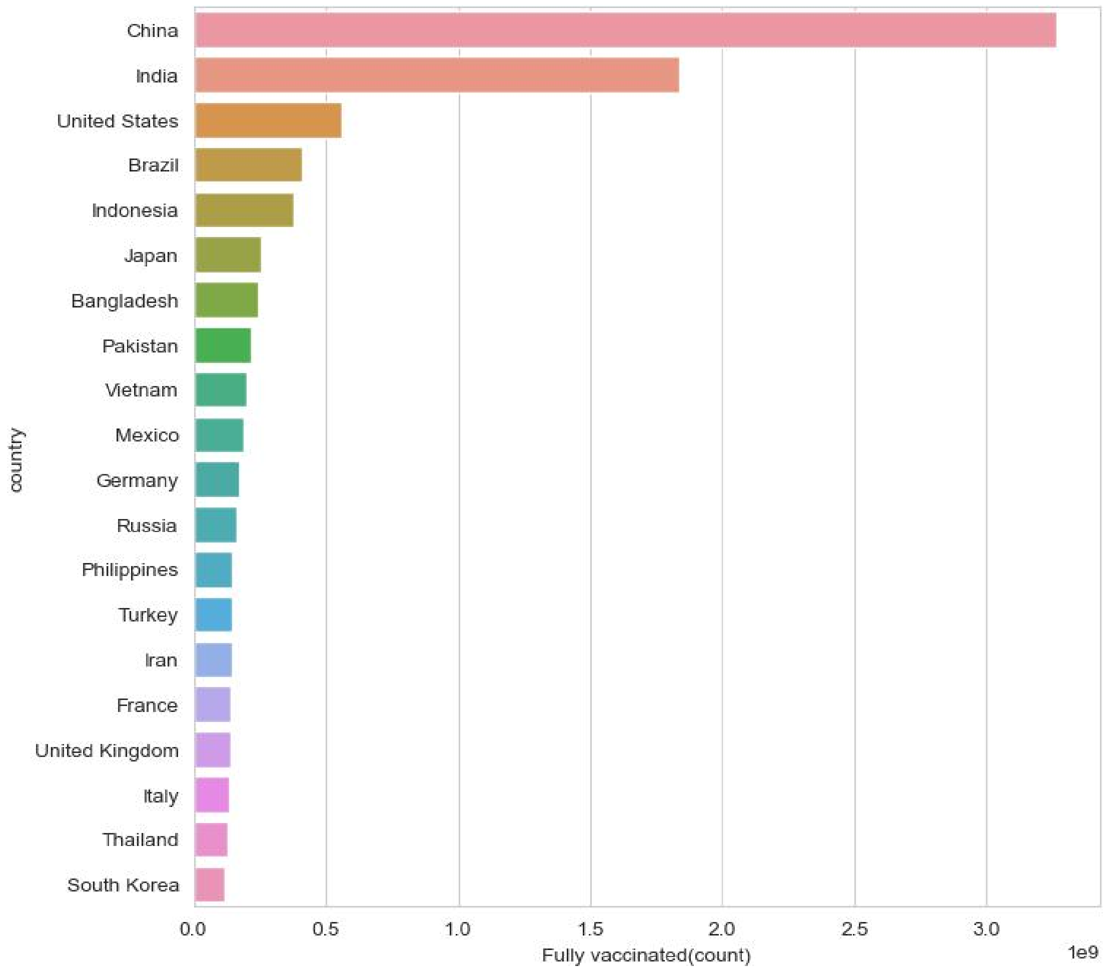


```
#Top countries with fully  vaccinated peoples
data["Full_vaccinations(count)"]= data.groupby("country").people_fully_vaccin
ated.tail(1)

data.groupby("country")["Full_vaccinations(count)"].mean().sort_values(ascend
ing= False).head(20)
```

```
country
India                828229455.0
United States        217498967.0
Brazil               160272858.0
Indonesia            158830466.0
Bangladesh           107712737.0
Pakistan             101881176.0
Japan                100633737.0
Mexico                79711762.0
Vietnam               77754108.0
Russia                72841232.0
Philippines           65804988.0
Germany               63142649.0
```

```
Iran                  56810058.0
Turkey                52968985.0
France                52438706.0
Thailand              50159803.0
United Kingdom        49404026.0
Italy                 47817555.0
South Korea           44482876.0
England               41501690.0
Name: Full_vaccinations(count), dtype: float64
```

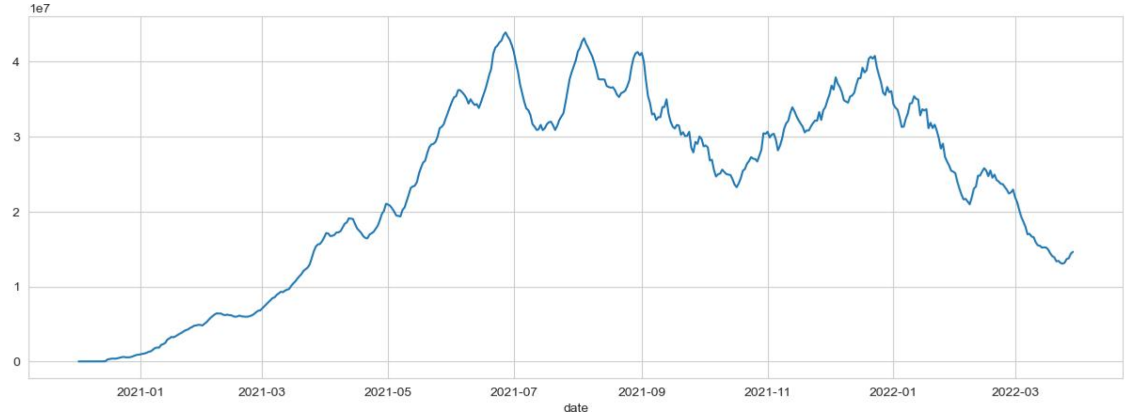
```
#barplot visualization of top countries with most full vaccinations

sns.set_style("whitegrid")
plt.figure(figsize= (8,8))
ax= sns.barplot(x.values,x.index)
ax.set_xlabel("Fully vaccinated(count)")
plt.show()
```



```
#most common vaccines
data.vaccines.value_counts()
```

```
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech
7608
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech
6263
Oxford/AstraZeneca
6022
Oxford/AstraZeneca, Pfizer/BioNTech
4629
Johnson&Johnson, Moderna, Novavax, Oxford/AstraZeneca, Pfizer/BioNTech
3564

...
Johnson&Johnson, Oxford/AstraZeneca, Sinovac
312
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V
311
Johnson&Johnson, Moderna
251
Johnson&Johnson, Pfizer/BioNTech, Sinopharm/Beijing
228
EpiVacCorona, Oxford/AstraZeneca, QazVac, Sinopharm/Beijing, Sputnik V, ZF200
1     190
Name: vaccines, Length: 84, dtype: int64
```

```
#daily vaccinations
x= data.groupby("date").daily_vaccinations.sum()
plt.figure(figsize= (15,5))
sns.lineplot(x.index,x.values)
plt.show()
```



```
#preferred vaccine in India
x= data[data["country"]=="India"]
z= x.vaccines.value_counts()
c= list(z.index)
c
```

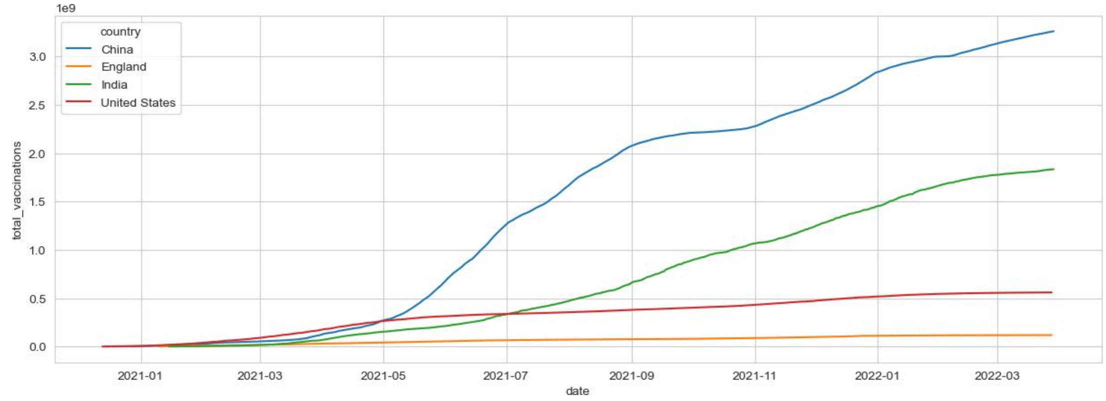
```
['Covaxin, Oxford/AstraZeneca, Sputnik V']
```

```
#COMPARING TOP 5 COUNTRIES WITH MOST VACCINATIONS

data.groupby("country")["Total_vaccinations(count)"].mean().sort_values(ascen
ding= False).head()
```

```
country
China            3.263129e+09
India            1.834501e+09
United States    5.601818e+08
Brazil           4.135596e+08
Indonesia        3.771089e+08
Name: Total_vaccinations(count), dtype: float64
```

```
#creating dataframe for top 5 vaccinated countries
x= data.loc[(data.country== "United States") | (data.country== "China")| (dat
a.country== "India")| (data.country== "Unted Kingdom")|(data.country== "Engla
nd")]
```

```
#total vaccination comparison
plt.figure(figsize= (15,5))
sns.lineplot(x= "date",y= "total_vaccinations" ,data= x,hue= "country")
plt.show()
```


1e9
country
China
England
India
United States
total_vaccinations
date