```
########################import statements
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline

# pd.set_option('display.max_rows', 500)
pd.set_option('display.max_columns', 30)
pd.set_option('display.float_format', '{:,.2f}'.format)

#Load Dataset

df_vaccination = pd.read_csv('country_vaccinations.csv')

#data is from kaggle : https://www.kaggle.com/gpreda/covid-world-vaccination-progress

#Display first 5 rows

df_vaccination.head()
```

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccina
0	Afghanistan	AFG	2021-02-22	0.00	0.00	NaN	NaN	
1	Afghanistan	AFG	2021-02-23	NaN	NaN	NaN	NaN	1,:
2	Afghanistan	AFG	2021-02-24	NaN	NaN	NaN	NaN	1,:
3	Afghanistan	AFG	2021-02-25	NaN	NaN	NaN	NaN	1,:
4	Afghanistan	AFG	2021-02-26	NaN	NaN	NaN	NaN	1,:

```
##############data preprocessing
df_vaccination.info()
#Find the number or rows and columns

df_vaccination.shape

#There are 76095 rows and 15 columns
```

```
<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
```

```
#####exploratory data anaysis(EDA)
df_vaccination.nunique()
```

```
country                                 223
iso_code                                223
date                                    483
total_vaccinations                    42828
people_vaccinated                     40194
people_fully_vaccinated               37425
```

```
daily_vaccinations_raw                27692
daily_vaccinations                    40516
total_vaccinations_per_hundred        17881
people_vaccinated_per_hundred          9078
people_fully_vaccinated_per_hundred    8772
daily_vaccinations_per_million        12405
vaccines                                 84
source_name                              81
source_website                          119
dtype: int64
```

```
df_vaccination.dtypes # take a look of the data types that we dealing with; precisely the date column
```

```
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
```

```
df_vaccination['date'] = pd.to_datetime(df_vaccination['date'], format="%Y-%m-%d")
# to_datetime is a pandas method which helps to convert datetime string into pandas datetime object to make it easy when works with Timse
```

```
df_vaccination.dtypes # check our new data types after converting date(column) into datetime64[ns] by using pd.to_datetime()
```

```
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
```

```
df_vaccination.isnull().sum()

#There are no empty rows for country, iso_code or date columns.
```

```
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
```

```
# General Overview of the calculations in data

df_vaccination.describe()
```

	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinatior
count	43,607.00	41,294.00	38,802.00	35,362.00	86,213.00	
mean	45,929,644.64	17,705,077.79	14,138,299.85	270,599.58	131,305.49	
std	224,600,360.18	70,787,311.50	57,139,201.72	1,212,426.60	768,238.77	
min	0.00	0.00	1.00	0.00	0.00	
25%	526,410.00	349,464.25	243,962.25	4,668.00	900.00	
50%	3,590,096.00	2,187,310.50	1,722,140.50	25,309.00	7,343.00	
75%	17,012,303.50	9,152,519.75	7,559,869.50	123,492.50	44,098.00	

```
#drop the source_name,source_website and vaccine columns

df_vaccine_country = df_vaccination.drop(['source_name','source_website','vaccines'],axis=1)
df_vaccine_country.head()
```

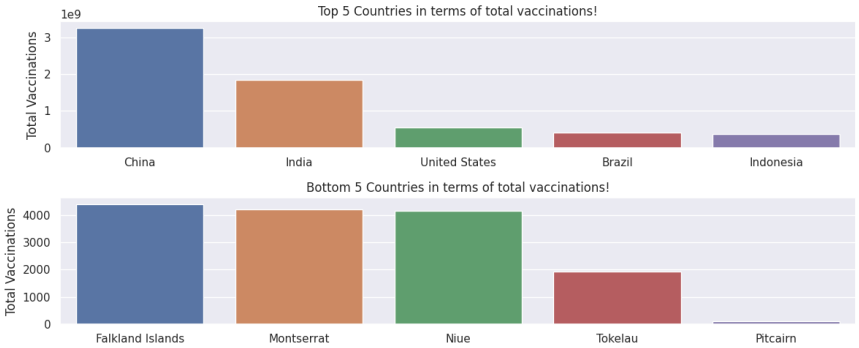
	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccina
0	Afghanistan	AFG	2021-02-22	0.00	0.00	NaN	NaN	
1	Afghanistan	AFG	2021-02-23	NaN	NaN	NaN	NaN	1,:
2	Afghanistan	AFG	2021-02-24	NaN	NaN	NaN	NaN	1,:
3	Afghanistan	AFG	2021-02-25	NaN	NaN	NaN	NaN	1,:
4	Afghanistan	AFG	2021-02-26	NaN	NaN	NaN	NaN	1,:

```
# convert Date column to date type and fill na values with 0 for calculation

df_vaccine_country["date"] = pd.to_datetime(df_vaccine_country["date"], format = '%Y-%m-%d')

df_vaccine_country = df_vaccine_country.replace([np.inf, -np.inf], np.nan)
df_vaccine_country = df_vaccine_country.fillna(0)
df_vaccine_country.isnull().sum()
```

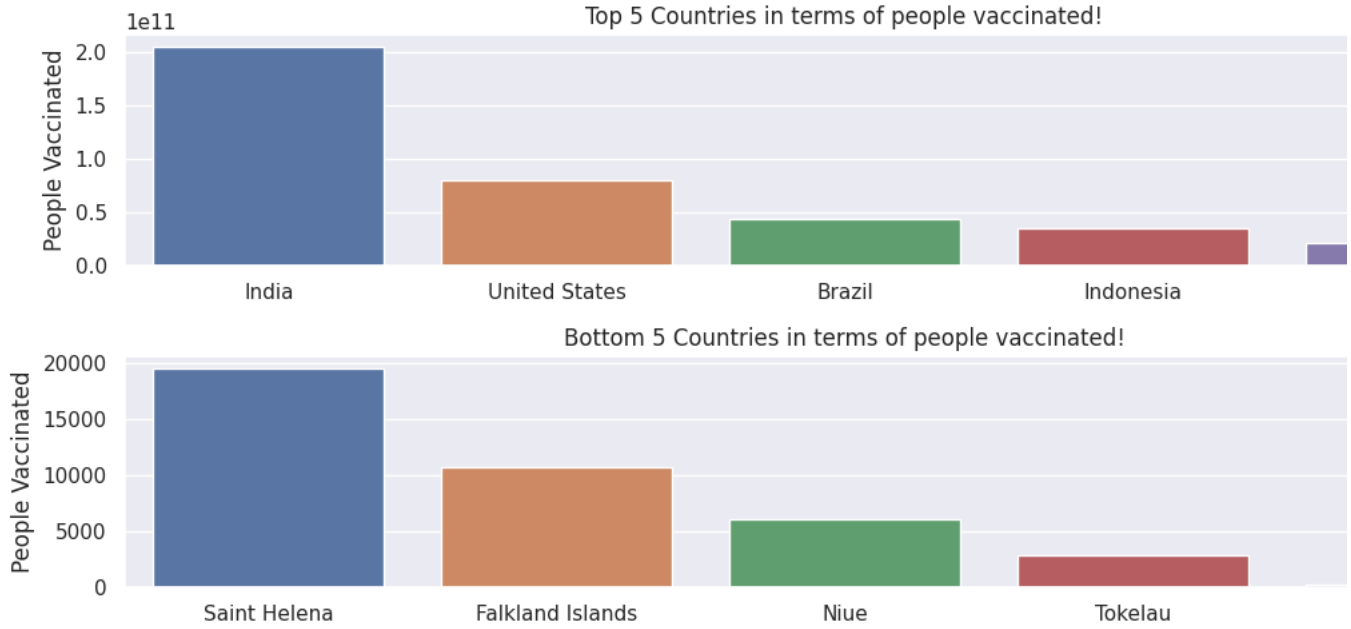
```
country                              0
iso_code                             0
date                                 0
total_vaccinations                   0
people_vaccinated                    0
people_fully_vaccinated              0
daily_vaccinations_raw               0
daily_vaccinations     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

```
#Function to find total, avergae, maximum  and minimum of different vaccinations status by country
#STATISTICAL ANALYSIS
def vaccination_country(col_name,func_name):

    '''
    Function that requires vaccination column name, and sum/mean/max/min function name as string arguments.
    '''
    if func_name == 'sum':

        return  (df_vaccine_country[['country',col_name]].groupby(by='country')
                                .sum()
                                .sort_values(by=col_name,ascending= False)
                                .reset_index()
                            )

    elif func_name == 'mean':

        return  (df_vaccine_country[['country',col_name]].groupby(by='country')
                                .mean()
                                .sort_values(by=col_name,ascending= False)
                                .reset_index()
                               )
    elif func_name == 'max':

        return  (df_vaccine_country[['country',col_name]].groupby(by='country')
```

```
                                .max()
                                .sort_values(by=col_name,ascending= False)
                                .reset_index()
                               )
    elif func_name == 'min':

        return  (df_vaccine_country[['country',col_name]].groupby(by='country')
                                .min()
                                .sort_values(by=col_name,ascending= False)
                                .reset_index()
                               )


# Calculating different vaccinations for visualizations
max_total_vaccinations = vaccination_country('total_vaccinations','max')

sum_people_vaccinated = vaccination_country('people_vaccinated','sum')
sum_people_fully_vaccinated = vaccination_country('people_fully_vaccinated','sum')

avg_total_vaccinations = vaccination_country('total_vaccinations_per_hundred','mean')
avg_people_vaccinated = vaccination_country('people_vaccinated_per_hundred','mean')
avg_people_fully_vaccinated = vaccination_country('people_fully_vaccinated_per_hundred','mean')
avg_daily_vaccinations = vaccination_country('daily_vaccinations_per_million','mean')



#Function for Country with maximum and minimum daily vaccinations
def daily_vaccination_country(col_name,func_name):

    '''
    A function that requires daily_vaccination column and max/min function name as string arguments.
    '''

    daily_vaccination = (df_vaccine_country
                                .pivot_table(index='country',columns='date',values=col_name)
                                   )
    if func_name == 'max':

        daily_vaccination['Highest Daily Vaccination'] = daily_vaccination.max(axis=1)
        daily_vaccination['Date - Highest Daily Vaccination'] = daily_vaccination.idxmax(axis=1)
        daily_vaccination.sort_values(by='Highest Daily Vaccination',ascending=False,inplace=True)
        daily_vaccination.rename_axis('',axis=1,inplace=True)

        return daily_vaccination[['Highest Daily Vaccination','Date - Highest Daily Vaccination']].reset_index()

    elif func_name == 'min':

        daily_vaccination.replace(0.00,np.nan,inplace=True)
        daily_vaccination['Lowest Daily Vaccination'] = daily_vaccination.min(axis=1)
        daily_vaccination['Date - Lowest Daily Vaccination'] = daily_vaccination.idxmin(axis=1)
        daily_vaccination.sort_values(by='Lowest Daily Vaccination',ascending=False,inplace=True)
        daily_vaccination.rename_axis('',axis=1,inplace=True)

        return daily_vaccination[['Lowest Daily Vaccination','Date - Lowest Daily Vaccination']].reset_index()



#Calculating highest and lowest daily vaccination and the respective dates.
highest_daily_vaccination = daily_vaccination_country('daily_vaccinations','max')
lowest_daily_vaccination = daily_vaccination_country('daily_vaccinations','min')


#Set sns theme and default figsize for all the sns visualizations.
####################VISUALISATION#############
sns.set_theme(style='whitegrid')
sns.set(rc={'figure.figsize' : (12,5)})

fig, axes  = plt.subplots(2,1)

sns.barplot(x='country',y='total_vaccinations',data=max_total_vaccinations.head(),ax=axes[0])
axes[0].set(xlabel = '', ylabel = 'Total Vaccinations', title ='Top 5 Countries in terms of total vaccinations!')

sns.barplot(x='country',y='total_vaccinations',data=max_total_vaccinations.tail(),ax=axes[1])
axes[1].set(xlabel = '', ylabel = 'Total Vaccinations', title ='Bottom 5 Countries in terms of total vaccinations!')


fig.tight_layout()
plt.show()
```




```
fig, axes = plt.subplots(2,1)

sns.barplot(x='country',y='people_vaccinated',data=sum_people_vaccinated.head(),ax=axes[0])
axes[0].set(xlabel = '', ylabel = 'People Vaccinated', title ='Top 5 Countries in terms of people vaccinated!')

sns.barplot(x='country', y='people_vaccinated',data=sum_people_vaccinated.tail(),ax=axes[1])
axes[1].set(xlabel = '', ylabel = 'People Vaccinated', title ='Bottom 5 Countries in terms of people vaccinated!')


fig.tight_layout()
plt.show()
```




```
#Plotting scatterplot matrix using Seaborn
#create dataframe with important features.
df_vaccination['total_vacc'] = np.log10(df_vaccination['total_vaccinations'])
df_vaccination['people_vacc'] = np.log10(df_vaccination['people_vaccinated'])
df_vaccination['people_fully_vacc'] = np.log10(df_vaccination['people_fully_vaccinated'])
df_vaccination['daily_vacc'] = np.log10(df_vaccination['daily_vaccinations'])

#drop the original nontransformed columns
df_vaccination = df_vaccination.drop(columns = ['total_vaccinations','people_vaccinated','people_fully_vaccinated', 'daily_vaccinations']


covid_features = df_vaccination[['date', 'total_vacc', 'people_vacc' , 'people_fully_vacc' , 'daily_vacc']]
sns.set_theme(style="ticks")
sns.pairplot(covid_features)
```

```
/usr/local/lib/python3.10/dist-packages/pandas/core/arraylike.py:402: RuntimeWarning: divide by zero encountered in log10
  result = getattr(ufunc, method)(*inputs, **kwargs)
/usr/local/lib/python3.10/dist-packages/pandas/core/arraylike.py:402: RuntimeWarning: divide by zero encountered in log10
  result = getattr(ufunc, method)(*inputs, **kwargs)
/usr/local/lib/python3.10/dist-packages/pandas/core/arraylike.py:402: RuntimeWarning: divide by zero encountered in log10
  result = getattr(ufunc, method)(*inputs, **kwargs)
<seaborn.axisgrid.PairGrid at 0x7f048cd95270>
```