COVID-19 VACCINE ANALYSIS

Phase 3: Development Part 1

Topic: Start building the Covid-19 Vaccine analysis project by loading and pre-processing the dataset.

Introduction:

- The analysis of COVID-19 vaccines involves a multifaceted assessment of their development, clinical trials, regulatory approvals, safety and efficacy profiles, distribution, challenges, and broader public health impact.

- Many received Emergency Use Authorization (EUA) initially, allowing for their rapid deployment, later followed by full regulatory approval. Furthermore, the ongoing evolution of the virus necessitates continuous research, development, and adaptation.

- Developing a Covid-19 Vaccine analysis project is a data-driven process that involves harnessing the power of machine learning to analyze the data from the collected data it involves exact analysis about the present, the past and the future. This Journey begins with the fundamental steps of data loading and preprocessing the given dataset.

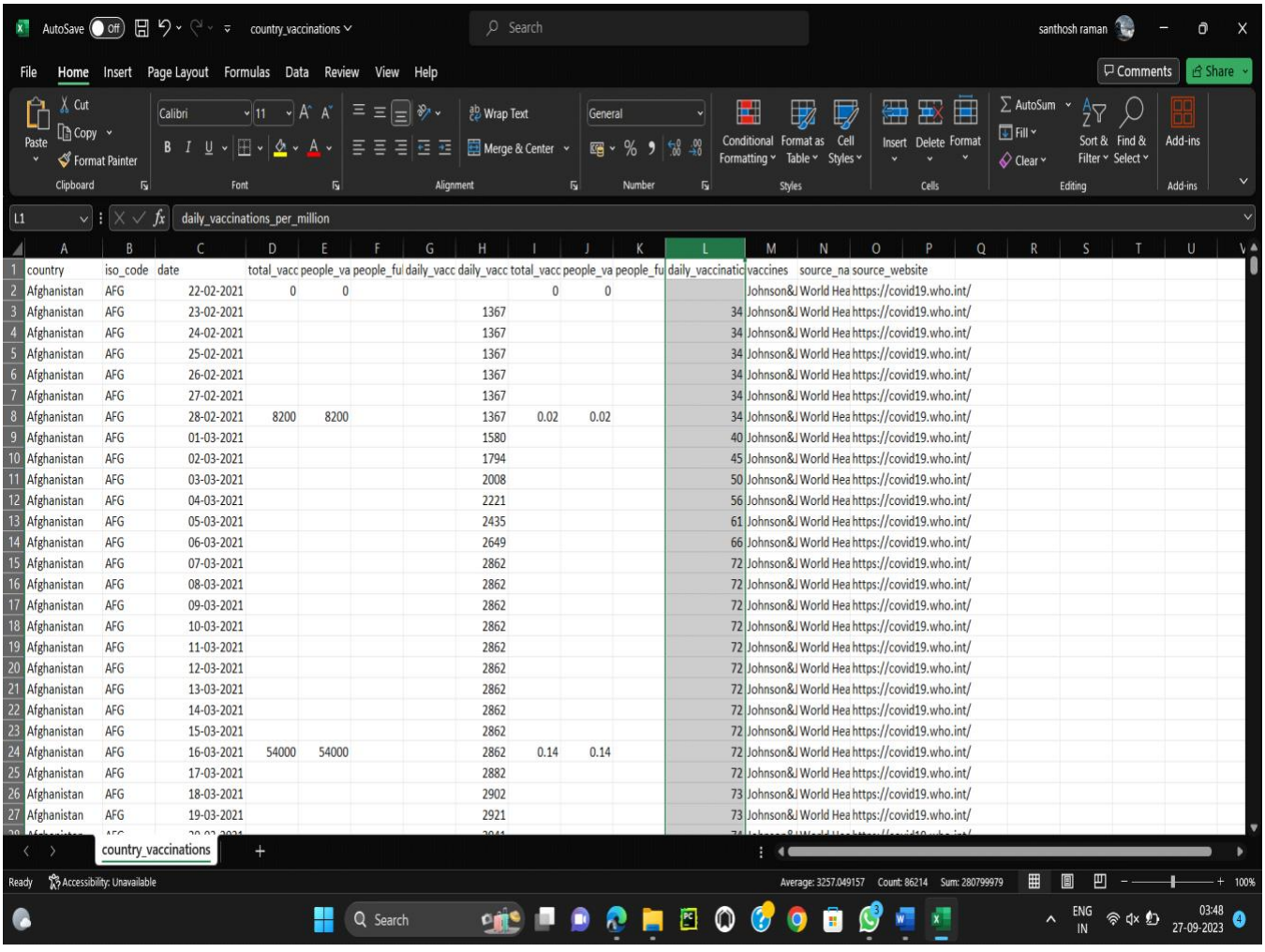
- This Introduction will guide you through the initial steps of the process. We'll explore how to import essential libraries, load the Covid-19 dataset, and perform critical preprocessing steps. Data preprocessing is crucial as it helps clean, format, and prepare the data for further analysis. This Includes handling missing values, encoding categorical variables, and clustering that the data is appropriately scaled.

Dataset:

The dataset for the given Covid-19 Project can be downloaded from the link given below.

“ https://www.kaggle.com/datasets/gpreda/covid-world-vaccination-progress ”

The given dataset is picturized as below:



country	iso_code	date	total_vacc	people_va	people_fu	daily_vacc	daily_vacc	total_vacc	people_va	people_fu	daily_vaccinatic	vaccines	source_na	source_website
Afghanistan	AFG	22-02-2021	0	0				0	0			Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	23-02-2021					1367				34	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	24-02-2021					1367				34	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	25-02-2021					1367				34	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	26-02-2021					1367				34	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	27-02-2021					1367				34	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	28-02-2021	8200	8200			1367	0.02	0.02		34	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	01-03-2021					1580				40	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	02-03-2021					1794				45	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	03-03-2021					2008				50	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	04-03-2021					2221				56	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	05-03-2021					2435				61	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	06-03-2021					2649				66	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	07-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	08-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	09-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	10-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	11-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	12-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	13-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	14-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	15-03-2021					2862				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	16-03-2021	54000	54000			2862	0.14	0.14		72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	17-03-2021					2882				72	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	18-03-2021					2902				73	Johnson&J	World Hea	https://covid19.who.int/
Afghanistan	AFG	19-03-2021					2921				73	Johnson&J	World Hea	https://covid19.who.int/

Loading and Preprocessing of dataset:

Loading and preprocessing the dataset is an important first step in building up any machine learning model. By loading and preprocessing the dataset, we can ensure the machine learning algorithm is able to learn from the data effectively and accurately.

1.Loading the dataset:

To load a dataset in Python, we make use of various libraries, such as Pandas, NumPy, and scikit-learn, depending on the dataset's format and our specific requirements. The term "dataset" is quite broad, so the method that we use may vary depending on whether we have a CSV file, Excel file, SQL database, or some other format. Since we are given a csv file, we make use of the read_csv() method to read the given dataset file.

PROGRAM:

Since we are given two datasets, we are going to load both of these datasets separately.

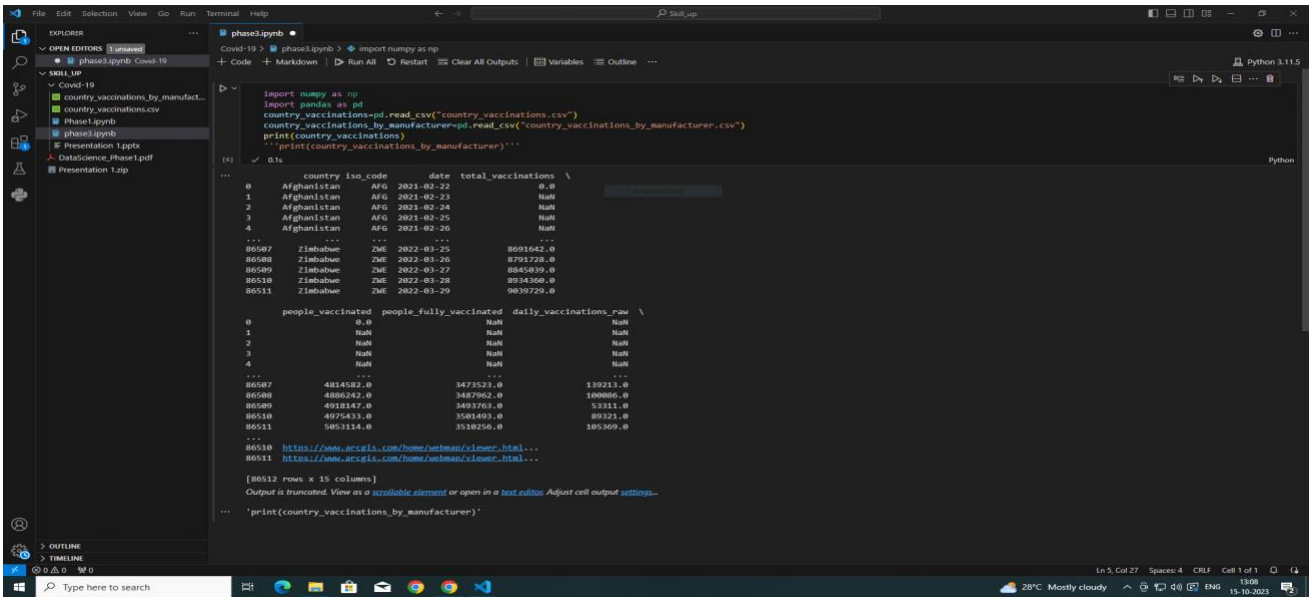
1.Dataset named country_vaccinations:

```
import numpy as np
import pandas as pd
country_vaccinations=pd.read_csv("country_vaccinations.csv")
print(country_vaccinations)
```

2. Dataset named country_vaccinatioins_by_manufacturer:

```
import numpy as np
import pandas as pd
country_vaccinations_by_manufacturer=pd.read_csv("country_vaccina
tions_by_manufacturer.csv")
print(country_vaccinations_by_manufacturer)
```

OUTPUT:



```
import numpy as np
import pandas as pd
country_vaccinations=pd.read_csv("country_vaccinations.csv")
country_vaccinations_by_manufacturer=pd.read_csv("country_vaccinations_by_manufacturer.csv")
print(country_vaccinations)
'''print(country_vaccinations_by_manufacturer)'''
```

```
         country iso_code        date  total_vaccinations  \
0      Afghanistan      AFG  2021-02-22                 0.0
1      Afghanistan      AFG  2021-02-23                 NaN
2      Afghanistan      AFG  2021-02-24                 NaN
3      Afghanistan      AFG  2021-02-25                 NaN
4      Afghanistan      AFG  2021-02-26                 NaN
...            ...      ...         ...                 ...
86507     Zimbabwe      ZWE  2022-03-25           8691642.0
86508     Zimbabwe      ZWE  2022-03-26           8791728.0
86509     Zimbabwe      ZWE  2022-03-27           8845039.0
86510     Zimbabwe      ZWE  2022-03-28           8934360.0
86511     Zimbabwe      ZWE  2022-03-29           9039729.0

       people_vaccinated  people_fully_vaccinated  daily_vaccinations_raw  \
0                    0.0                      NaN                     NaN
1                    NaN                      NaN                     NaN
2                    NaN                      NaN                     NaN
3                    NaN                      NaN                     NaN
4                    NaN                      NaN                     NaN
...                  ...                      ...                     ...
86507          4814582.0                3473523.0                139213.0
86508          4886242.0                3487962.0                100086.0
86509          4918147.0                3493763.0                 53311.0
86510          4975433.0                3501493.0                 89321.0
86511          5053114.0                3510256.0                105369.0
...
86510  https://www.arcgis.com/home/webmap/viewer.html...
86511  https://www.arcgis.com/home/webmap/viewer.html...

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'print(country_vaccinations_by_manufacturer)'
```
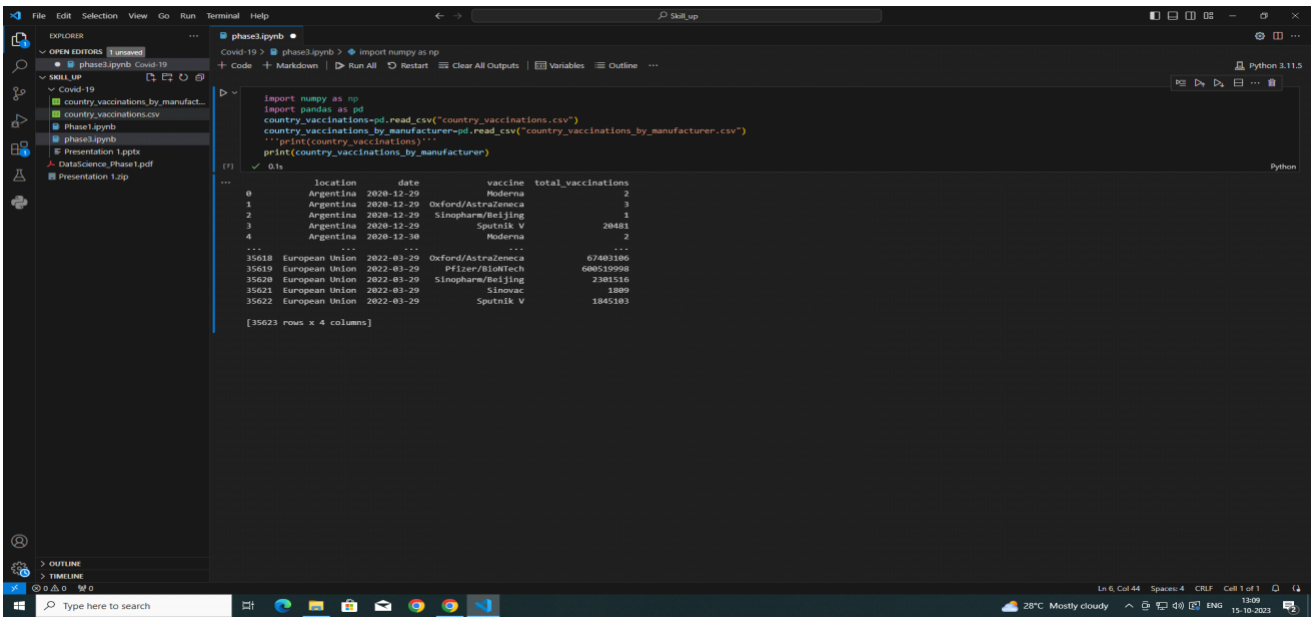



```
import numpy as np
import pandas as pd
country_vaccinations=pd.read_csv("country_vaccinations.csv")
country_vaccinations_by_manufacturer=pd.read_csv("country_vaccinations_by_manufacturer.csv")
'''print(country_vaccinations)'''
print(country_vaccinations_by_manufacturer)
```

```
          location        date            vaccine  total_vaccinations
0        Argentina  2020-12-29            Moderna                   2
1        Argentina  2020-12-29  Oxford/AstraZeneca                   3
2        Argentina  2020-12-29   Sinopharm/Beijing                   1
3        Argentina  2020-12-29          Sputnik V                20481
4        Argentina  2020-12-30            Moderna                   2
...            ...         ...                ...                 ...
35618  European Union  2022-03-29  Oxford/AstraZeneca            67403106
35619  European Union  2022-03-29     Pfizer/BioNTech           600519998
35620  European Union  2022-03-29   Sinopharm/Beijing             2301516
35621  European Union  2022-03-29             Sinovac                1809
35622  European Union  2022-03-29          Sputnik V             1845103

[35623 rows x 4 columns]
```

2.Preprocessing the dataset:

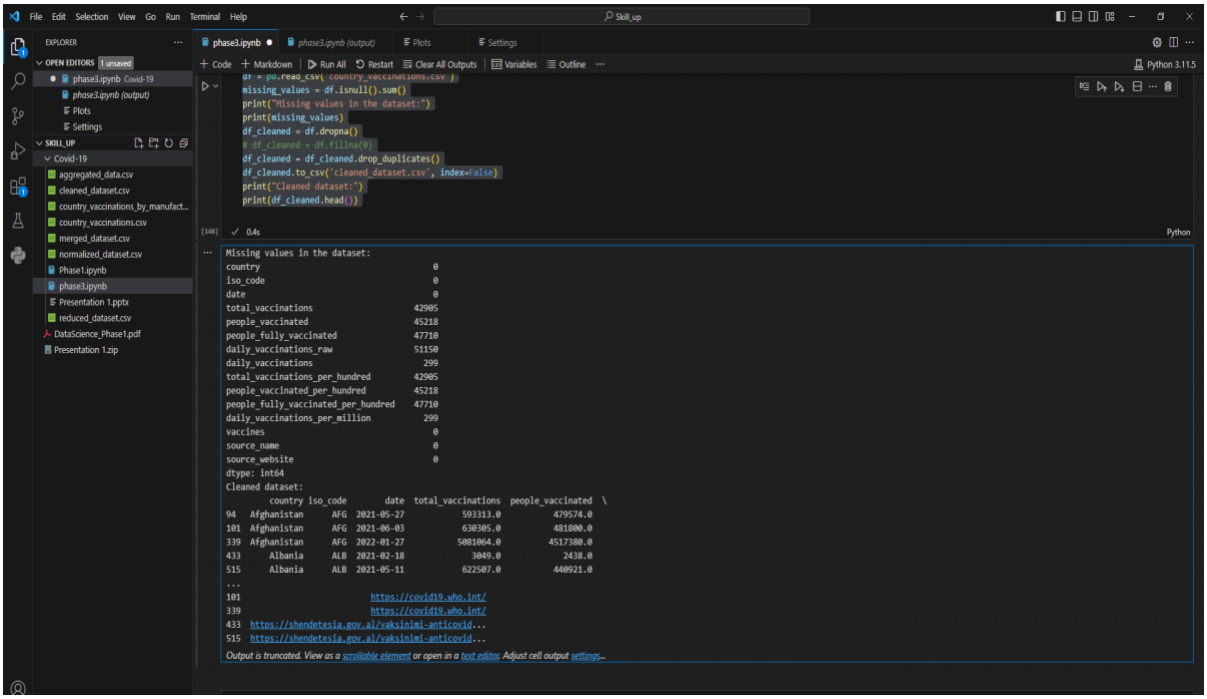
- Data preprocessing is the process of cleaning, transforming, and integrating the data in order to make it ready for analysis.
- This may involve removing errors and inconsistencies, handling missing values, transforming the data into a consistent format, and scaling the data to a suitable range.

2.1Data Cleansing:

1) Data cleansing for the dataset country_vaccinations are represented pictorially below with their source code. It Includes removing missing values in the dataset, dropping those missing values.

```
import pandas as pd
df = pd.read_csv('country_vaccinations.csv')
missing_values = df.isnull().sum()
print("Missing values in the dataset:")
print(missing_values)
df_cleaned = df.dropna()
# df_cleaned = df.fillna(0)
df_cleaned = df_cleaned.drop_duplicates()
df_cleaned.to_csv('cleaned_dataset.csv', index=False)
print("Cleaned dataset:")
print(df_cleaned.head())
```

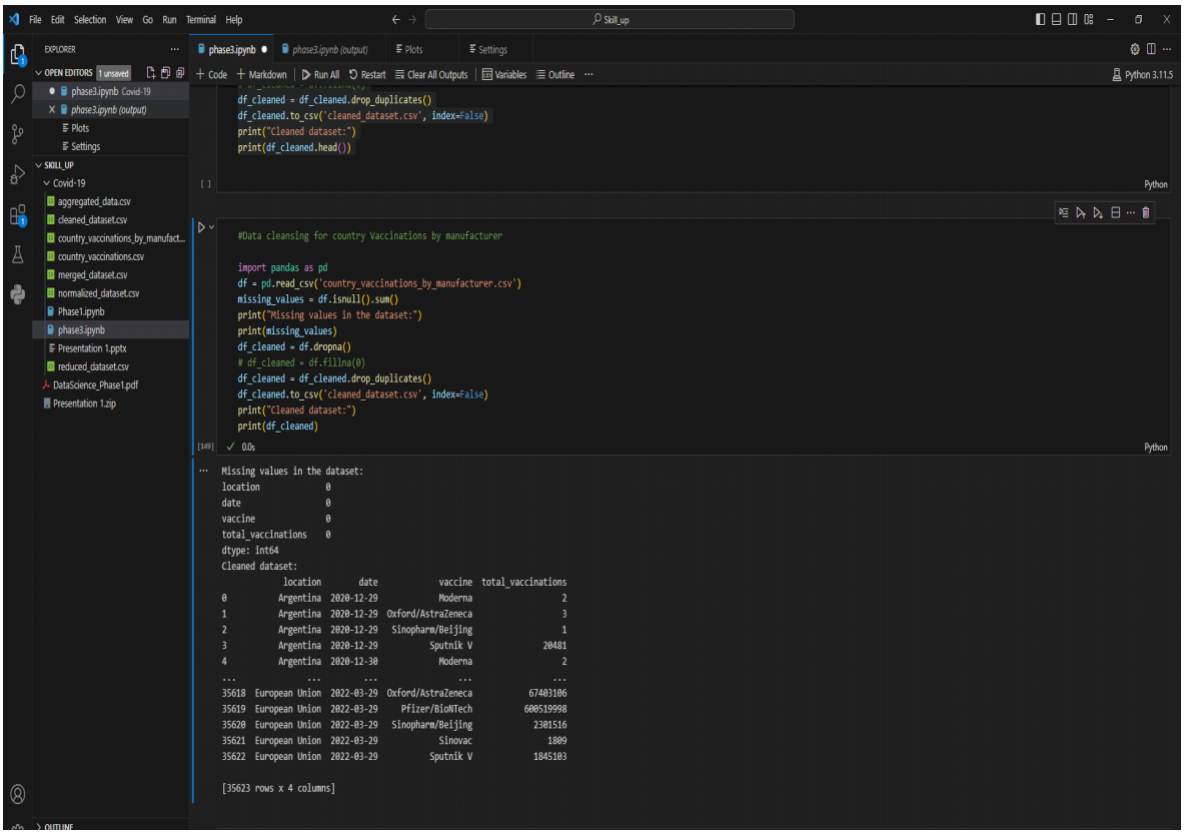
Output:



2)Data cleansing for the dataset country_vaccinations_by_manufacture is performed using the following code and represented pictorially below with their output:

```
import pandas as pd
df = pd.read_csv('country_vaccinations_by_manufacturer.csv')
missing_values = df.isnull().sum()
print("Missing values in the dataset:")
print(missing_values)
df_cleaned = df.dropna()
# df_cleaned = df.fillna(0)
df_cleaned = df_cleaned.drop_duplicates()
df_cleaned.to_csv('cleaned_dataset.csv', index=False)
print("Cleaned dataset:")
print(df_cleaned)
```

OUTPUT:



2.2Data Integration:

Data integration, as a vital component of data preprocessing, involves merging and harmonizing data from diverse sources into a unified data set. Imagine a sample dataset related to COVID-19 vaccinations, where information comes from multiple channels like healthcare providers, government agencies, and research institutions. Each source may have its own data format, terminology, and structure. Data integration in this context involves bringing together these heterogeneous datasets, aligning data fields, and ensuring consistency. It helps in harmonizing the data to form a single, coherent dataset. This integrated dataset can then be used to analyze vaccination trends, vaccine effectiveness, and public health outcomes.

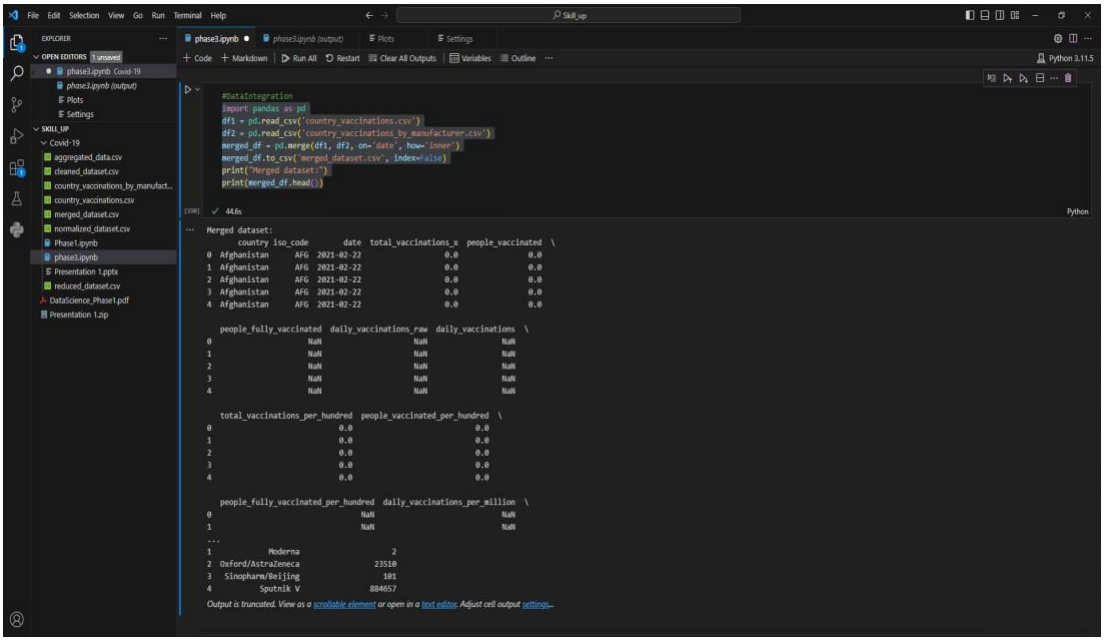
So, we have created an integrated dataset by making use of the two different datasets that we are given. The integrated data sets are created

separately and stored as csv files.
The pictorial representation of integrated dataset's output is given below along with the source code:

Program:

```
import pandas as pd
df1 = pd.read_csv('country_vaccinations.csv')
df2 = pd.read_csv('country_vaccinations_by_manufacturer.csv')
merged_df = pd.merge(df1, df2, on='date', how='inner')
merged_df.to_csv('merged_dataset.csv', index=False)
print("Merged dataset:")
print(merged_df.head())
```

Output:



2.3 Data Transformation:

Data transformation, a key step in data preprocessing, involves converting and reshaping data to make it suitable for analysis or modeling. This process may include changing data types, scaling, encoding categorical variables, and aggregating data. In a given dataset, data transformation helps ensure data consistency and prepares it for advanced analytics. For example, you can transform textual descriptions into numerical features, normalize numerical values, and aggregate data for summary statistics. Data transformation is essential for extracting meaningful insights and patterns from the data, making it a fundamental aspect of data preprocessing.

Data Transformation includes various subprocess which are listed as below:

- Changing Data Types
- Encoding Categorical Variables
- Normalizing data in dataset
- Aggregating data

2.3.1Changing Data Types:

Changing data types, as part of data transformation, involves converting the type of data in a dataset from one format to another. This process is essential when dealing with a dataset that contains data in formats that are not suitable for the analysis or tasks you want to perform. Changing data types ensures that the dataset's content is in the right format for analysis and modeling, preventing issues like data type incompatibility and enabling more effective data processing.

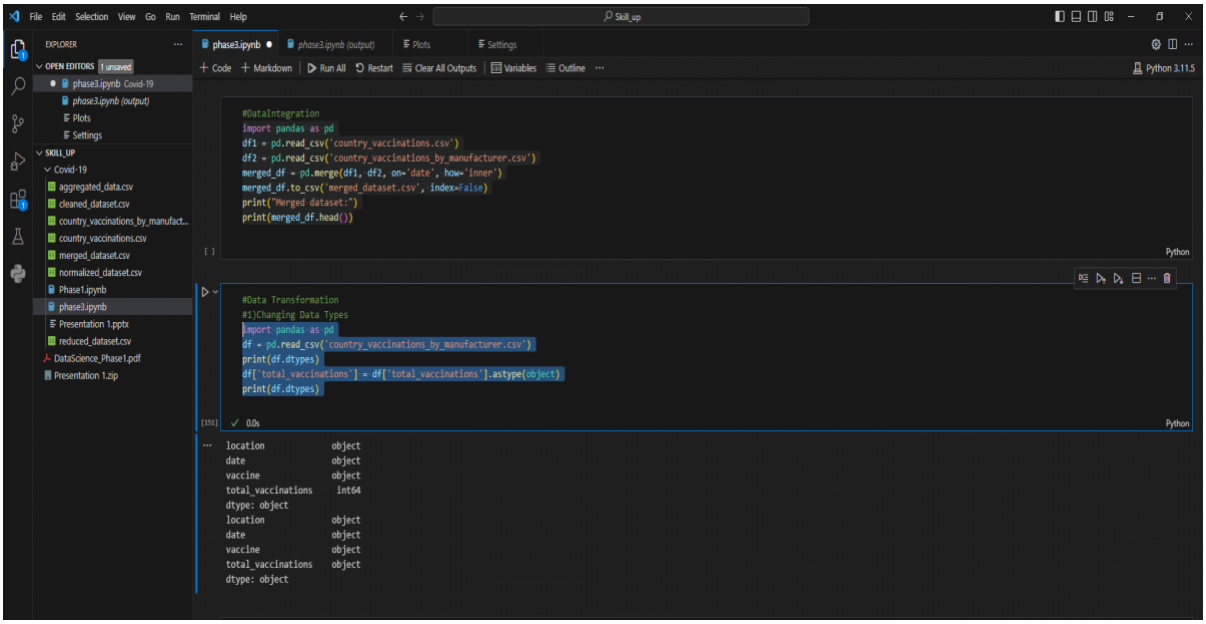
Here in the data set country_vaccinations_by_manufacturer we have changed the data type of the column total vaccination into ‘object’ from 'int64’ by making use of the method astype() suffixing the column name

before it.

Program:

```
import pandas as pd
df = pd.read_csv('country_vaccinations_by_manufacturer.csv')
print(df.dtypes)
df['total_vaccinations'] = df['total_vaccinations'].astype(object)
print(df.dtypes)
```

Output:



2.3.2 Encoding Categorical Variables:

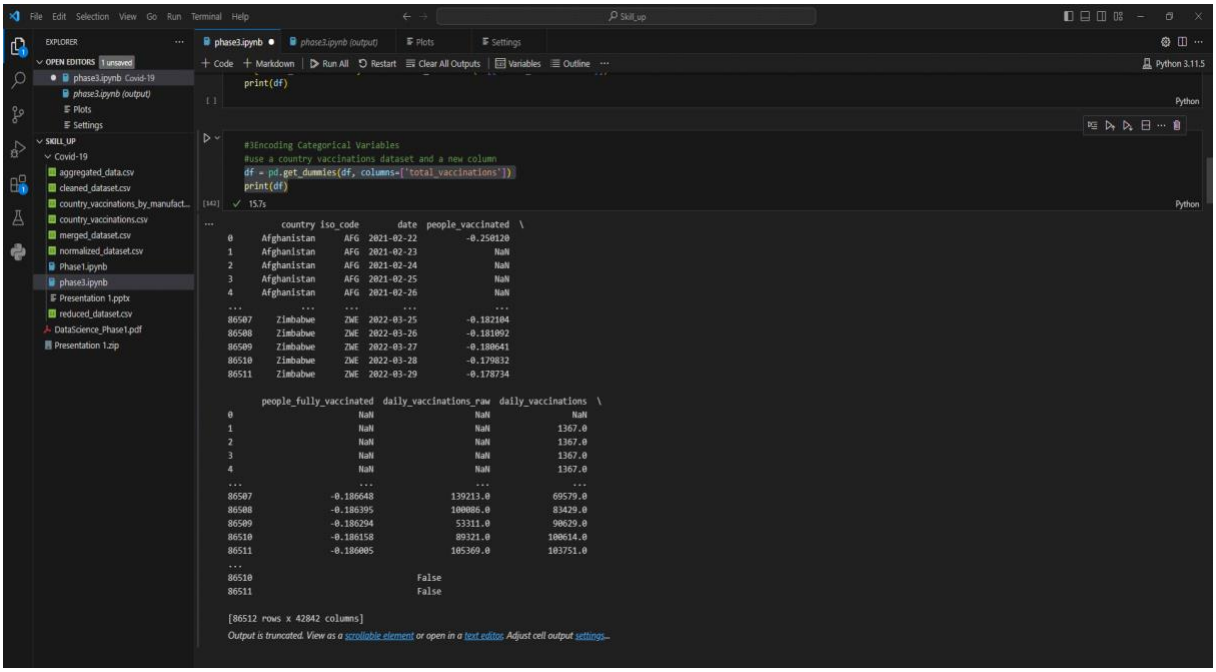
Encoding categorical variables is a crucial step in data transformation, particularly when working with machine learning models or data analysis. Categorical variables represent categories or labels rather than a numeric values. To make these variables compatible with most machine learning algorithms, you need to encode them into

numerical form.

Program:

```
df = pd.get_dummies(df, columns=['total_vaccinations'])
print(df)
```

Output:



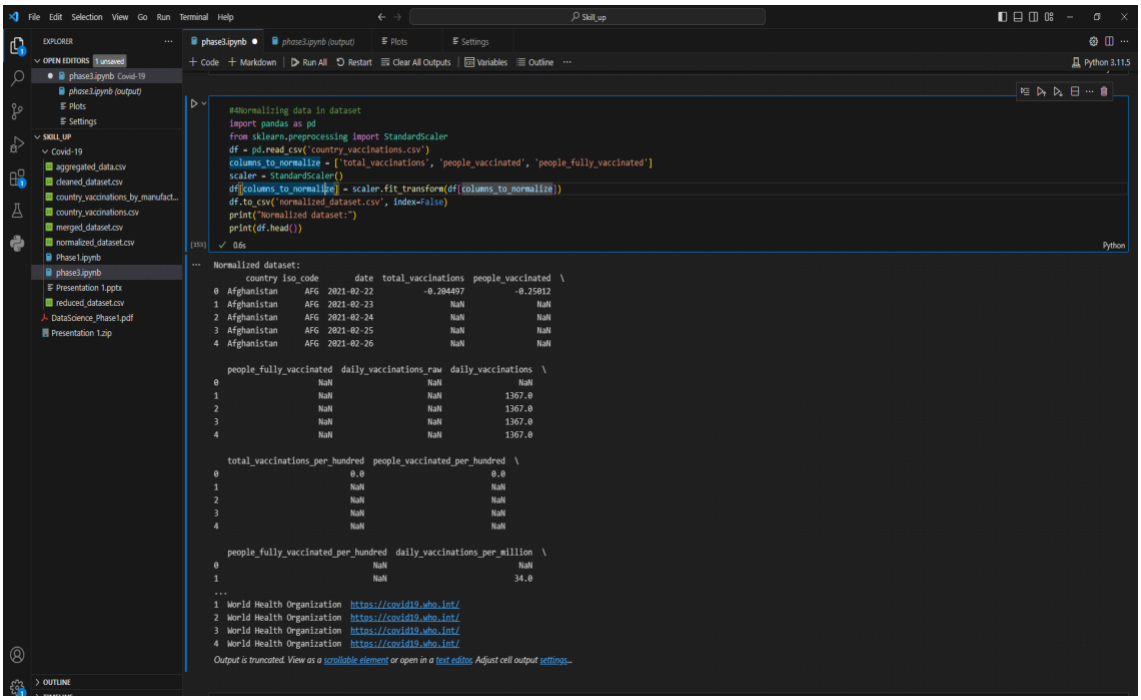
2.3.3 Normalizing data in dataset:

Normalizing data is an essential data transformation technique used to scale numerical features within a dataset to a common range. The goal is to make different features or variables comparable, eliminate the influence of differing units or scales, and ensure that no single feature dominates the analysis. Normalization typically scales the data to a range between 0 and 1, but it can also involve other scales depending on the specific needs of the analysis.
We have normalized the dataset country and vaccinations, and its source code and output are given as follows:

Program:

```
import pandas as pd
from sklearn.preprocessing import StandardScaler
df = pd.read_csv('country_vaccinations.csv')
columns_to_normalize=['total_vaccinations','people_vaccinated','peopl
e_fully_vaccinated']
scaler = StandardScaler()
df[columns_to_normalize]                                                =
scaler.fit_transform(df[columns_to_normalize])
df.to_csv('normalized_dataset.csv', index=False)
print("Normalized dataset:")
print(df.head())
```

Output:



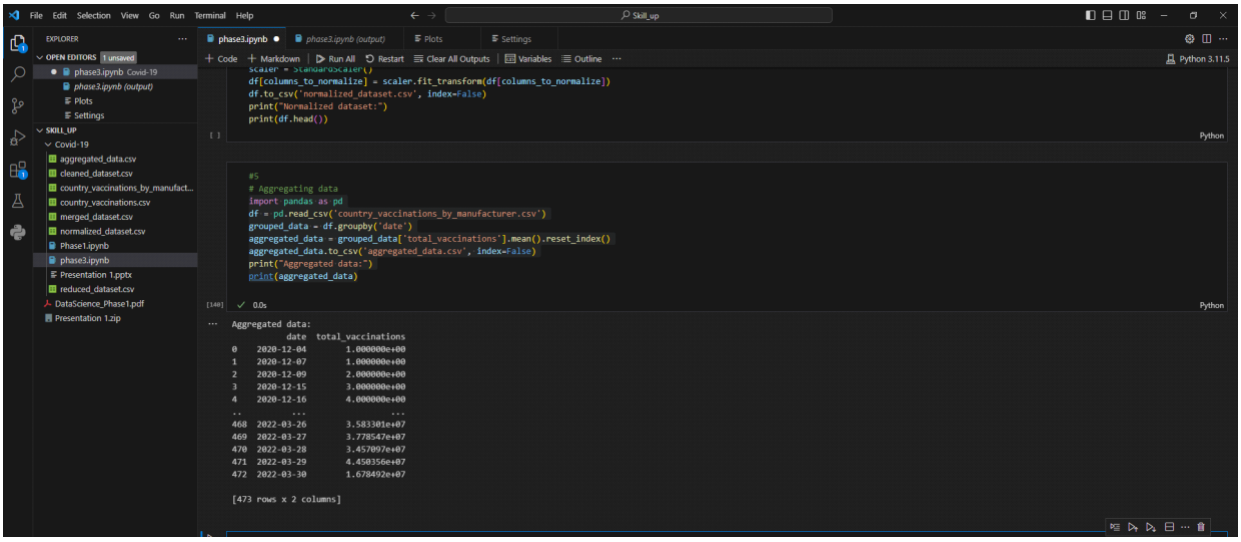
2.3.4 Aggregating data:

Aggregating data in a dataset, as part of data transformation, involves the process of summarizing, grouping, or reducing data to obtain a more concise and understandable representation of the information. It is especially useful when dealing with large datasets or when you want to analyze data at a higher level of granularity. Aggregation often involves applying functions like sum, count, mean, median, or other statistical functions to groups of data points based on one or more grouping criteria.

Program:

```
import pandas as pd
df = pd.read_csv('country_vaccinations_by_manufacturer.csv')
grouped_data = df.groupby('date')
aggregated_data =
grouped_data['total_vaccinations'].mean().reset_index()
aggregated_data.to_csv('aggregated_data.csv', index=False)
print("Aggregated data:")
print(aggregated_data)
```

Output:



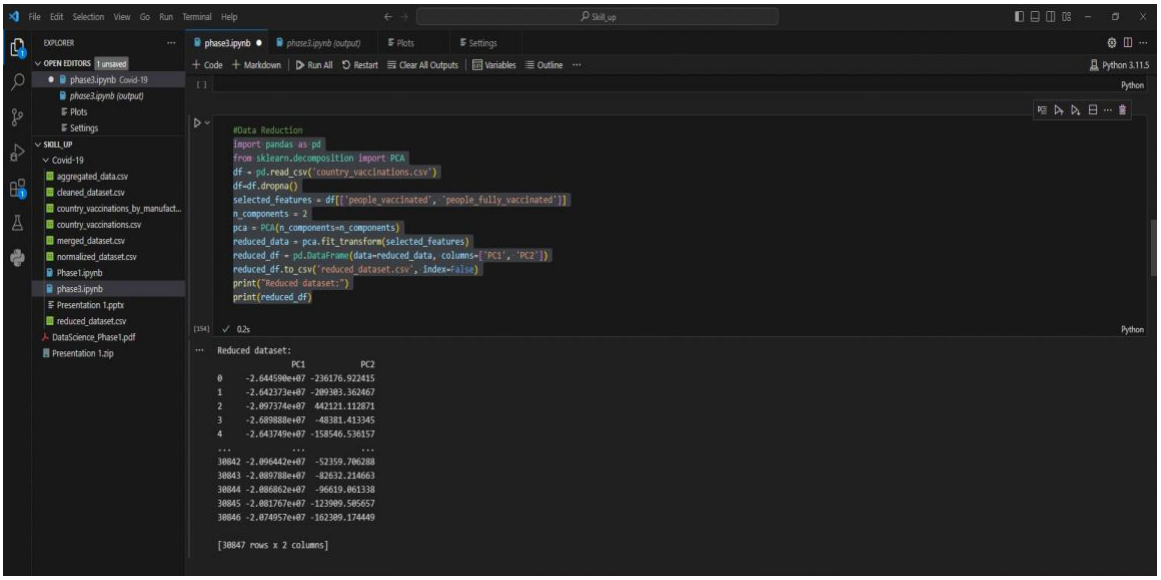
2.4 Data Reduction:

Data reduction, in the context of data preprocessing, refers to the process of reducing the volume but producing the same or similar analytical results. It involves techniques and methods to simplify and condense a dataset while retaining the essential information. Data reduction is often necessary for various reasons, including improving the efficiency of data processing, reducing storage requirements, and mitigating the curse of dimensionality in machine learning. Data Reduction simply reduces the data by reducing their size.

Program:

```
import pandas as pd
from sklearn.decomposition import PCA
df = pd.read_csv('country_vaccinations.csv')
df=df.dropna()
selected_features = df[['people_vaccinated', 'people_fully_vaccinated']]
n_components = 2
pca = PCA(n_components=n_components)
reduced_data = pca.fit_transform(selected_features)
reduced_df = pd.DataFrame(data=reduced_data, columns=['PC1',
'PC2'])
reduced_df.to_csv('reduced_dataset.csv', index=False)
print("Reduced dataset:")
print(reduced_df)
```

Output:



Visualizing The preprocessed datasets:

Visualizing preprocessed datasets is an essential step in exploratory data analysis (EDA) and data-driven decision-making. Once you've cleaned and transformed your data, creating visualizations can help you understand the data, identify patterns, and communicate insights effectively.

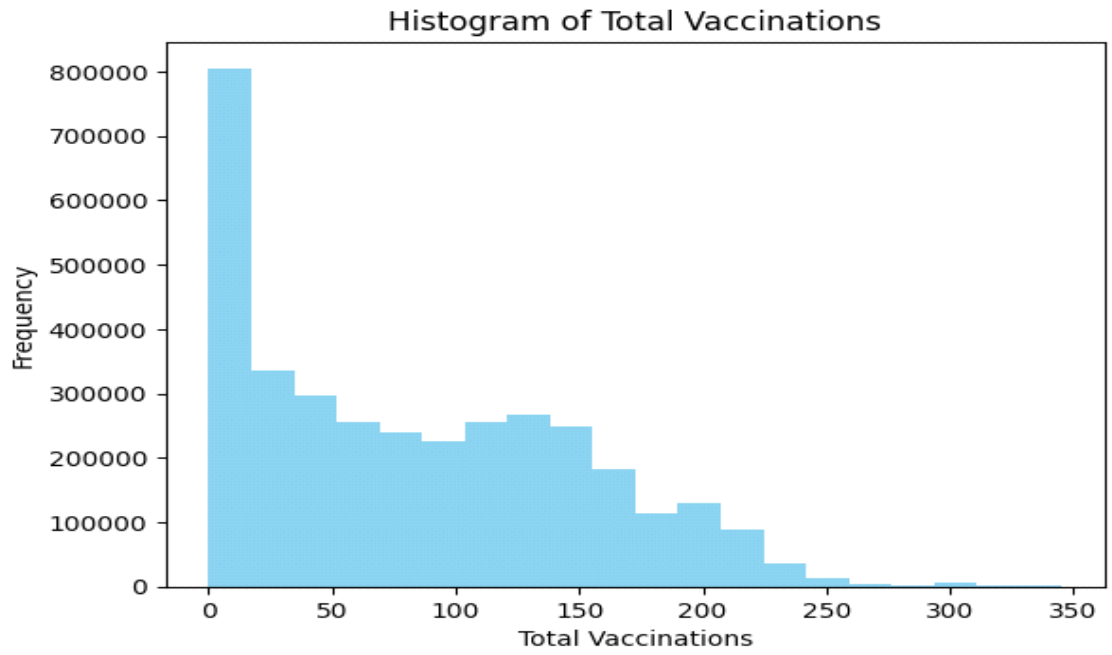
- So as a very first part of visualization we have visualized the merged dataset of both country_vaccinations and country_vaccinations_by_manufacturer by means of histogram.

Program:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
df=pd.read_csv('merged_dataset.csv')
plt.hist(df['total_vaccinations_per_hundred'], bins=20, color='skyblue')
plt.title('Histogram of Total Vaccinations')
plt.xlabel('Total Vaccinations')
```

```
plt.ylabel('Frequency')
plt.show()
```

Output:

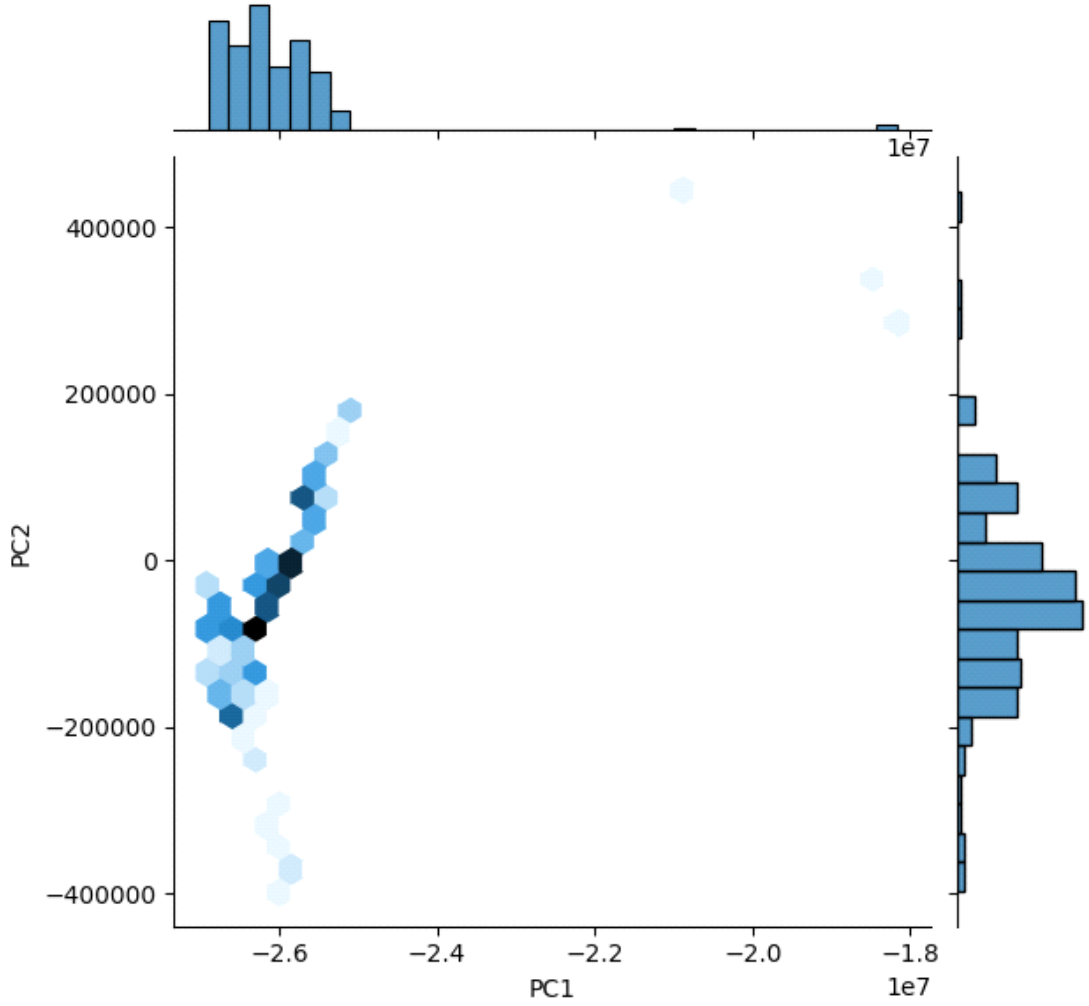


- Following this is the Joint plot representation of the reduced dataset that we have created during data reduction.

Program:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
df=pd.read_csv('reduced_dataset.csv')
df=df.head(200)
print(sns.jointplot(df,x='PC1',y='PC2',kind='hex'))
```

Output:



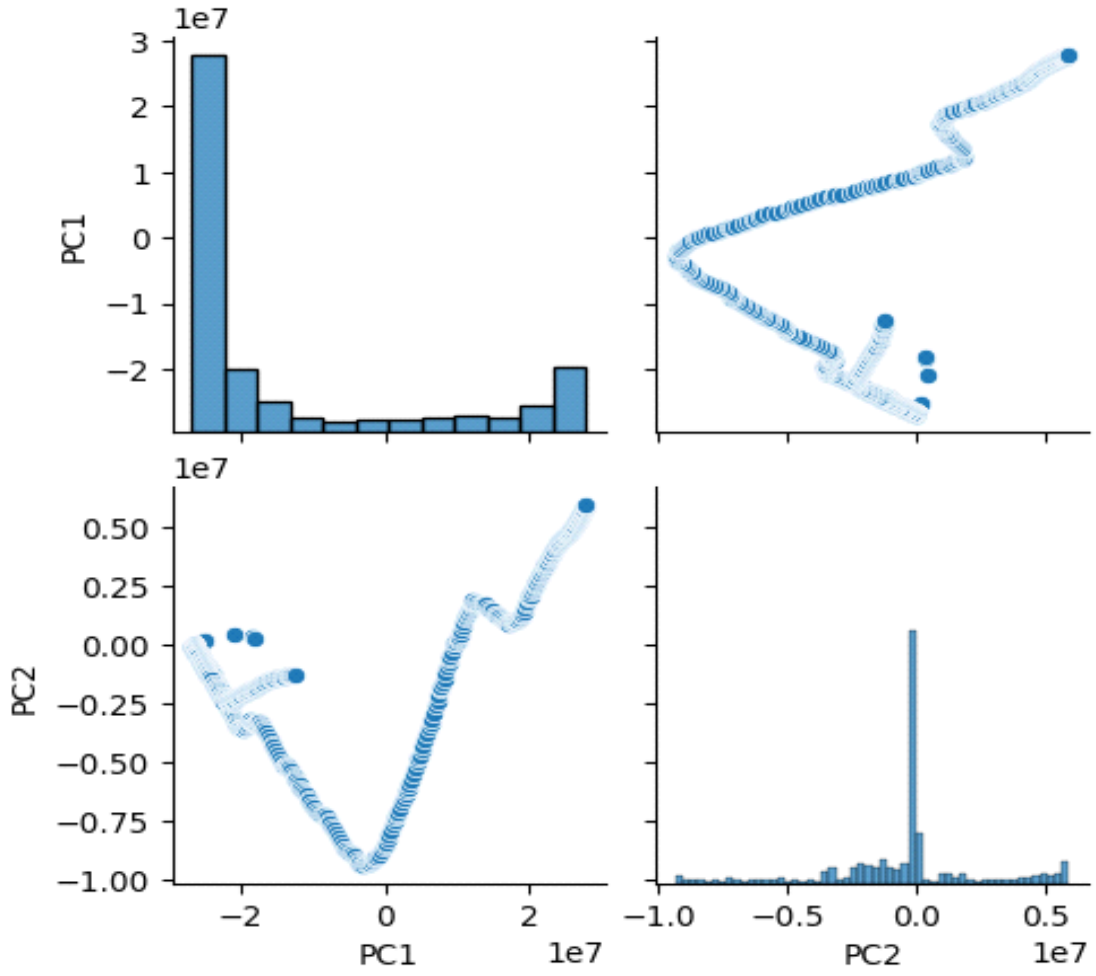
- Thirdly we have made use of the pair plot visualizing technique to visualize the reduced data sets.

Program:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
df=pd.read_csv('reduced_dataset.csv')
df=df.head(1000)
```

```
plt.figure(figsize=(12,8))
sns.pairplot(df)
```

Output:

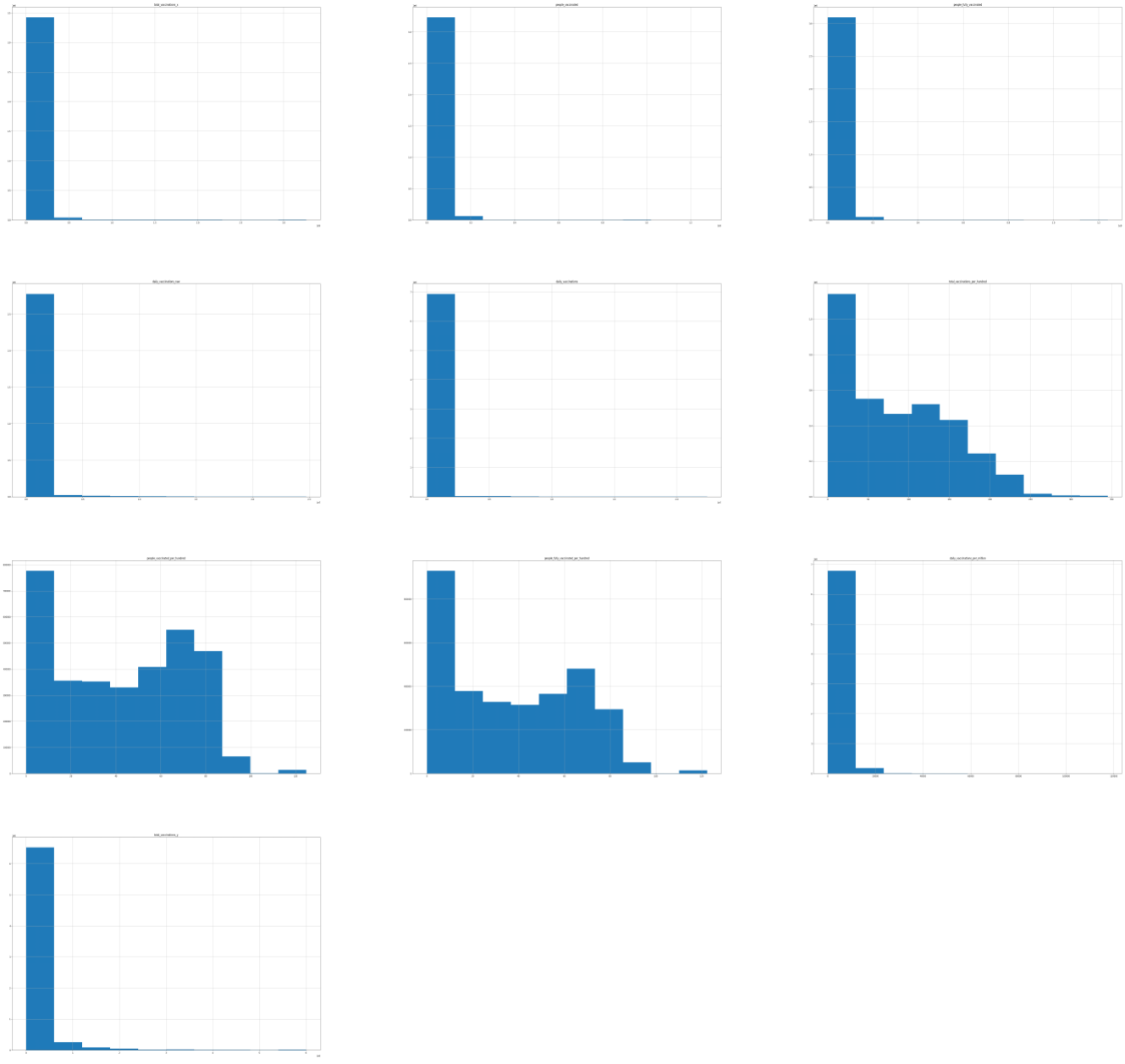


- Following these pair plots we have made use of the merged dataset to visualize it in histogram as it contains a combination of different columns and rows.

Program:

```
import numpy as np
import pandas as pd
df=pd.read_csv('merged_dataset.csv')
print(df.hist(figsize=(100,80)))
```

Output:

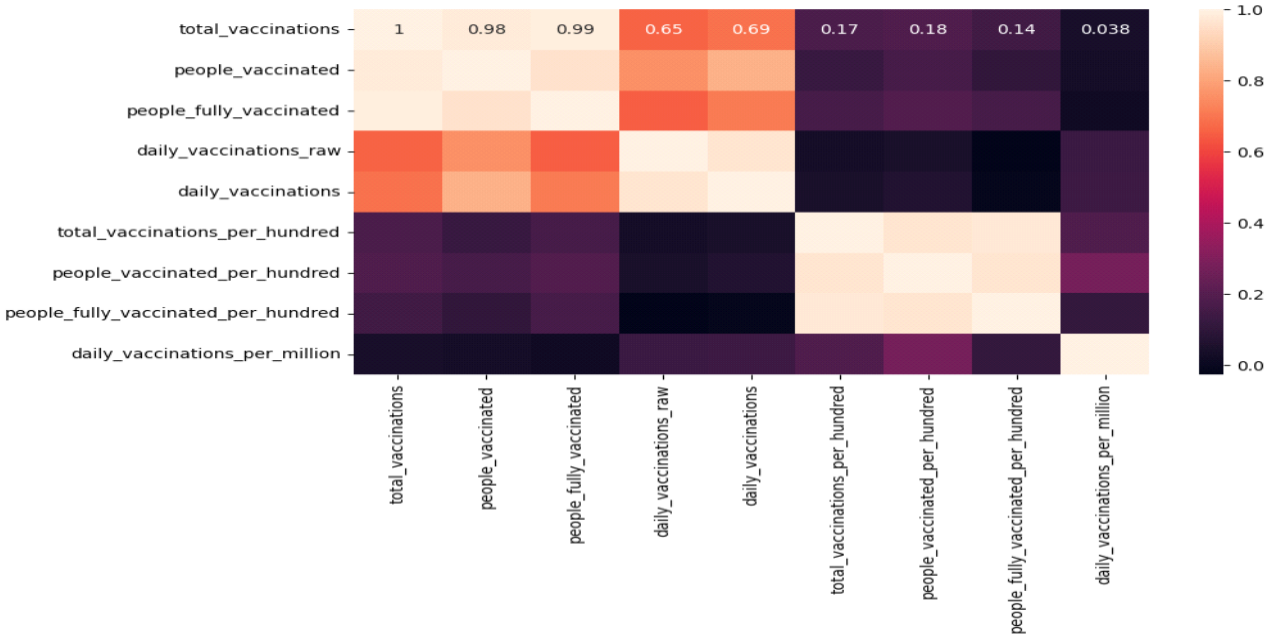


- Being last we have calculated the correlations for the country_vaccinations dataset and by making use of it we even have plotted a heatmap for it which is visualized below.

Program:

```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
df=pd.read_csv('country_vaccinations.csv')
df.corr(numeric_only=True)
print(df)
plt.figure(figsize=(10,5))
print(sns.heatmap(df.corr(numeric_only=True),annot=True))
```

Output:



Conclusion:

- In the quest of Covid-19 vaccine Analysis, we have embarked on a crucial journey that begins with loading and preprocessing the dataset. We have traversed through essential steps, starting with importing the necessary libraries to facilitate data manipulation and analysis.

- Understanding the data's structure, characteristics, and any potential issues exploratory data analysis (EDA)is essential for Informed decision-making.

- Data Preprocessing emerged as a pivotal aspect of this process.it involves cleaning, transforming, and refining the dataset to ensure that it aligns with the requirement of machine learning algorithms.

- With these foundational steps, completed, our dataset is now primed for the subsequent stages of building and training a Covid-19 vaccine analysis model.