COVID-19 VACCINES ANALYSIS

Phase 5: Project Documentation & Submission

In this part you will document your project and prepare it for submission.

Problem Definition:

The problem is to conduct an in-depth analysis of Covid-19 vaccine data, focusing on vaccine efficacy, distribution, and adverse effects. The goal is to provide insights that aid policymakers and health organizations in optimizing vaccine deployment strategies. This project involves data collection, data preprocessing, exploratory data analysis, statistical analysis, and visualization.

Design Thinking:

Data Collection: Collect Covid-19 vaccine data from reputable sources like health organizations, government databases, and research publications.

Data Preprocessing: Clean and preprocess the data, handle missing values, and convert categorical features into numerical representations.

Exploratory Data Analysis: Explore the data to understand its characteristics, identify trends, and outliers.

Statistical Analysis: Perform statistical tests to analyze vaccine efficacy, adverse effects, and distribution across different populations.

Visualization: Create visualizations (e.g., bar plots, line charts, heatmaps) to present key findings and insights**.**

Data collection

The first step is to collect data that is relevant to the product demand prediction task. Once the data is collected, it needs to be cleaned and prepared for modeling.

The given dataset:

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

Data Preprocessing

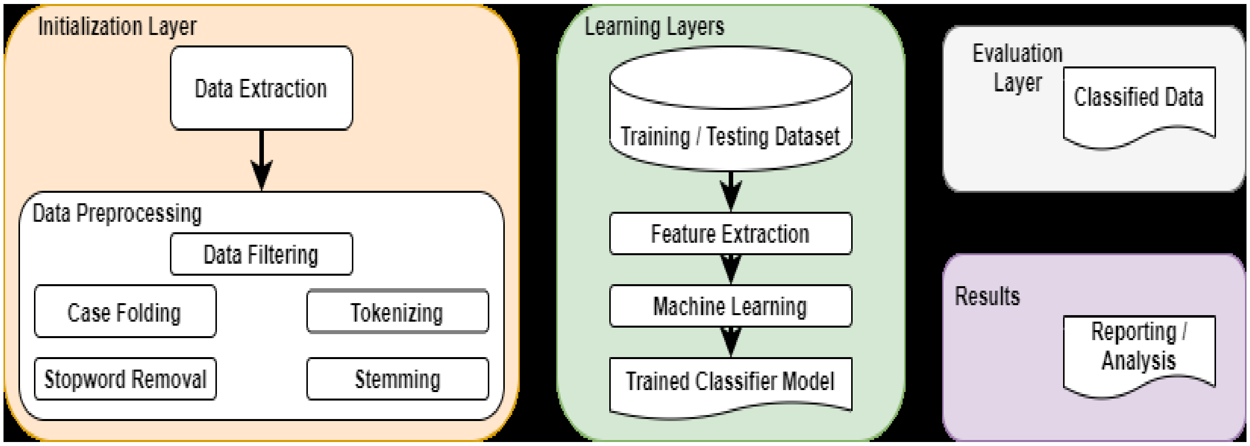
Monitoring the health situation, trends, progress and performance of health systems requires data from multiple sources on a wide variety of health topics. A core component of WHO's support to Member States is to strengthen their capacity to collect, compile, manage, analyze and use health data mainly derived from population-based sources (household surveys, civil registration systems of vital events) and institution-based sources (administrative and operational activities of institutions, such as health facilities).

Exploratory Data Analysis

Covid Explorer model's aim is to provide information on Covid 19 like- how you can prevent the Corona Virus, symptoms of Corona Virus or how to book slots for the Corona Virus. You can add the current data related to Covid 19 like a graph indicated the increase or decrease of death rate from this virus, a report is given to show the death rate, the number of vaccines doses given on a particular day, state wise cases are also shown through Application Programming Interface (API) in Covid Explorer model. The model is analyzing and tracking Corona Virus. As per the data analysis this pandemic creates mental health issues but if a model gave up-to date data of the current scenario then stress can be overcome and society can fight against this pandemic. https://covid19.who.int/ for Data analysis.

Framework

This research presents a framework for sentiment analysis of COVID-19 vaccines. We have used python as a programming language and several libraries for text mining that will be explained.



Statistical Analysis

The available data is limited and is affected by fluctuations i.e. highly variable cases were reported day by day. As a result, Cumulative data is used to predict the number of cases in Pakistan. The cumulative number of COVID-19 confirmed cases, deaths and recoveries are expected to show exponential growth over time. Therefore, we used the simple time series methods of Auto-Regressive Integrated Moving Average (ARIMA) Model to forecast the number of cases, deaths and recoveries for upcoming month. The ARIMA model has higher fitting and forecasting accuracy than exponential smoothing. It captures both the seasonal and non-seasonal forecasting trends. Due to the limited available data, we simply focus on non-seasonal models to describes the pattern (growth) over time. Hence, we assumed that the pattern of current cases will continue in the near future (at least a month). We believe that the ARIMA model, which is the combination of Autoregressive (AR) and Moving Average (MA) fits well to the nature of the available data and provide good forecasting for the short time series data.

Machine learning

Machine learning (ML) is a popular use of artificial intelligence since it automates the system and allows it to learn and improve from diverse experiences without being programmed. Computer programs can teach how to learn by giving them access to data and allowing them to utilize it for learning in ML. The learning process in ML begins with seeing the data through examples or instructions that humans offer; these observations enable ML to look for patterns in order to make the best predictions. Five different ML models were used to train the classifier and evaluate classification performance using the test dataset. These are discussed below.

Machine learning Techniques

- Random Forest
- Naive Bayes
- Decision Tree
- Logistic Regressions
- Support Vector Machine

Random Forest

The RF model is an ensemble model that generates high-precision predictions by combining the results obtained from several sub-trees. The supervised ML method known as RF may be used for both classification and regression analysis.

An RF can be represented as:

$$RF = mode\{tR_1, tR_2, tR_3, \cdots, tR_n\}$$

$$RF = mode\{\sum_{i=1}^{n} tR_i\}$$

where tR1, tR2, tR3,... , tRn represent the Decision Trees in RF and n denotes the number of trees.

Naive Bayes

The Bayes Theorem's premise of class conditional independence is used in the NB classification technique. This indicates that the existence of one characteristic in the likelihood of a certain event has no bearing on the presence of another, and each predictor has an equal impact on the outcome. Multinomial NB, Bernoulli NB, and Gaussian NB are the three kinds of NB classifiers. Text categorization, spam detection, and recommendation systems are all applications of this technology.

An NB can be represented as:

$$P(A \backslash B) = \frac{P(B \backslash A)\ P(A)}{P(B)}$$

Decision Tree

DTs are a technique for non-parametric supervised learning that may be used for classification and regression. DT is a model for ML that may be used for the problem-solving process of regression as well as classification. The purpose of this project is to build a model that can accurately forecast the value of a target variable by gleaning fundamental decision rules from the features of the data. A DT with multiple branches of varying sizes is used in conjunction with partitioning the dataset into an incremental method of construction.

Logistic Regression

Logistic Regression is a statistical approach to data analysis in which one or more variables are utilized to determine the outcome. When the target variable is categorical, the optimum learning model to utilize is LR, which is the regression model that was used to estimate the likelihood of class members. Linear Regression uses a logistic function to estimate probabilities for the association between the categorical dependent variable and one or more independent variables.

Support Vector Machine

A support vector machine (SVM), which was created by Vladimir Vapnik, is a supervised learning model that can be used to both classify and regress data . On the other hand, the most popular use for it is in the realm of classification problems; in this context, it is used to generate a hyperplane on which the distance between two classes of data points is maximized.

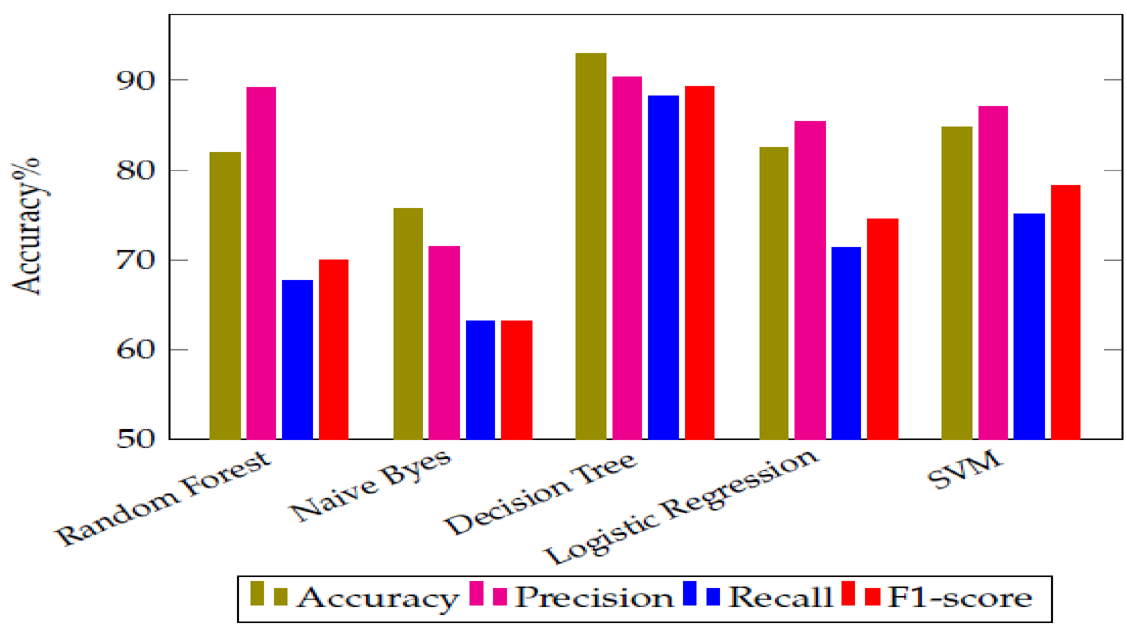
Types of SVM

-> Linear SVM

-> Nonlinear SVM

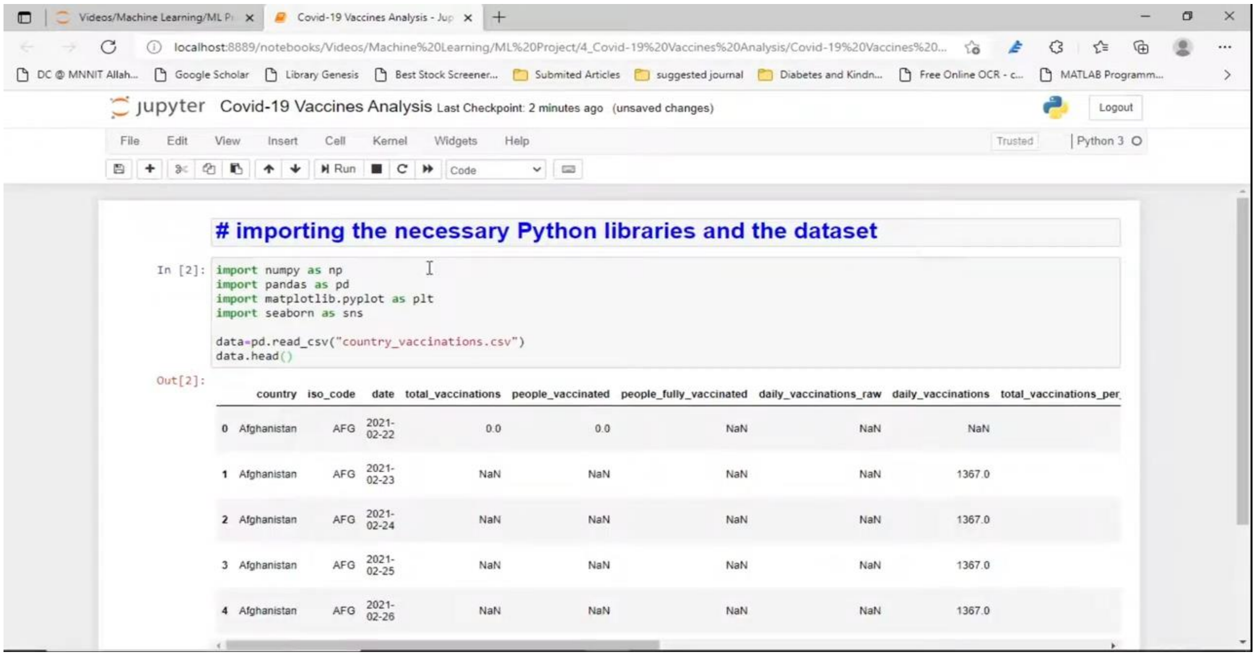
Machine learning Performance on COVID-19 vaccine analysis

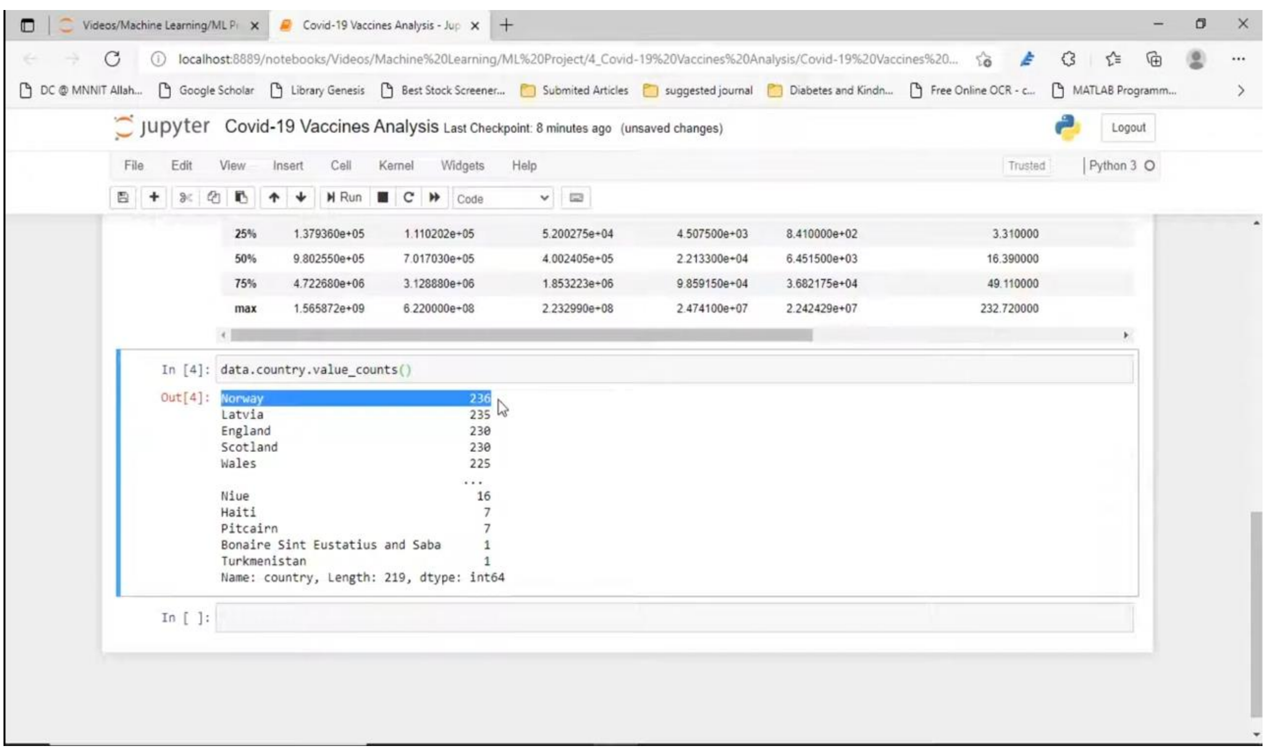
Classifier Name	Accuracy%	Precision%	Recall%	F1-Score%
Random Forest	81.94	89.18	67.76	69.9
Naive Bayes	75.67	71.55	63.19	63.2
Decision Tree	93.0	90.43	88.27	89.24
Logistic Regression	82.5	85.35	71.36	74.47
SVM	84.78	87.0	75.05	78.31



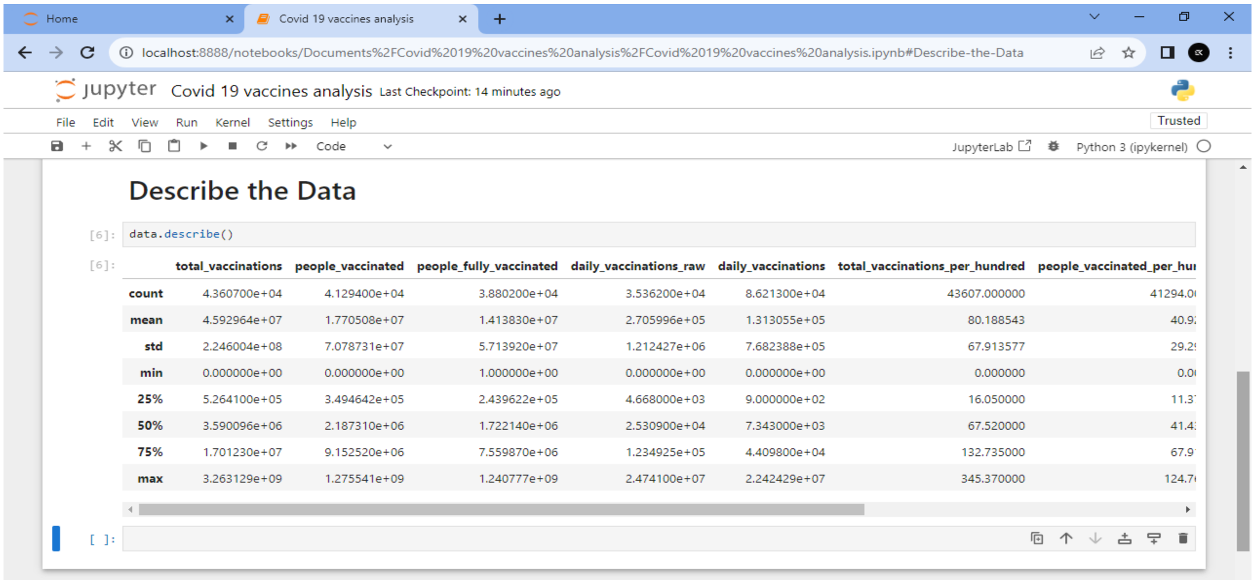
Visualization

Importing the necessary Python libraries and the dataset





Describe the Data



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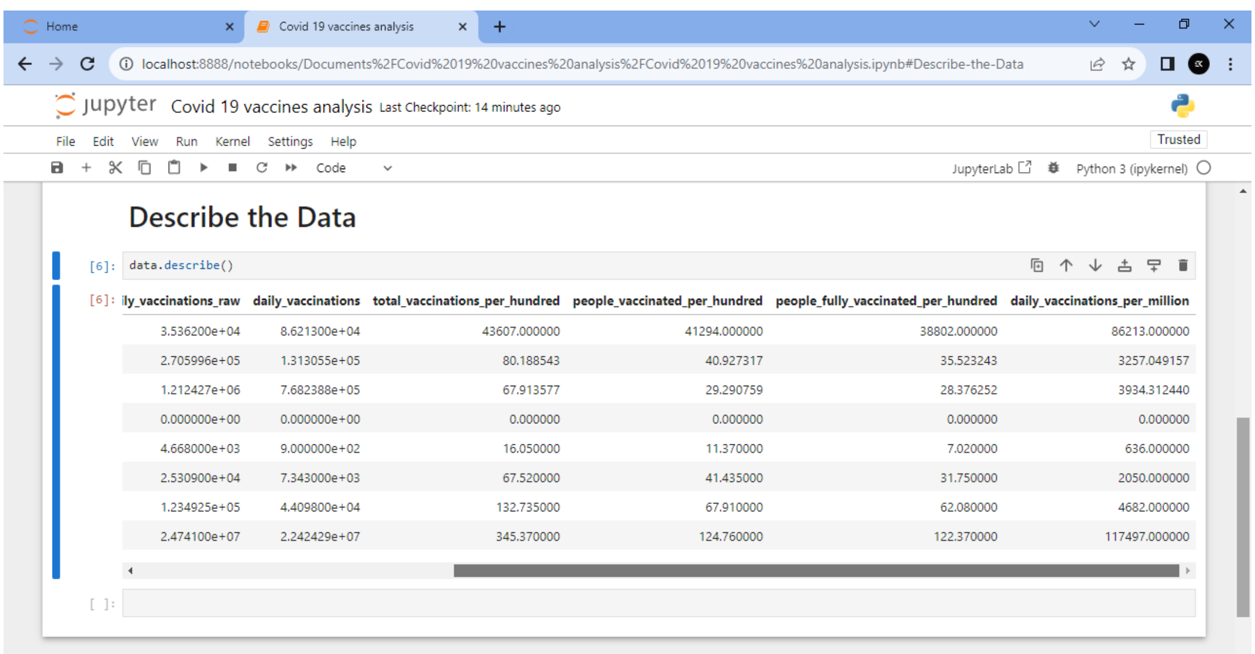
Jupyter Covid 19 vaccines analysis Last Checkpoint: 14 minutes ago

Describe the Data

```
[6]: data.describe()
```

[6]:

	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hundred	people_vaccinated_per_hu
count	4.360700e+04	4.129400e+04	3.880200e+04	3.536200e+04	8.621300e+04	43607.000000	41294.0
mean	4.592964e+07	1.770508e+07	1.413830e+07	2.705996e+05	1.313055e+05	80.188543	40.9
std	2.246004e+08	7.078731e+07	5.713920e+07	1.212427e+06	7.682388e+05	67.913577	29.2
min	0.000000e+00	0.000000e+00	1.000000e+00	0.000000e+00	0.000000e+00	0.000000	0.0
25%	5.264100e+05	3.494642e+05	2.439622e+05	4.668000e+03	9.000000e+02	16.050000	11.3
50%	3.590096e+06	2.187310e+06	1.722140e+06	2.530900e+04	7.343000e+03	67.520000	41.4
75%	1.701230e+07	9.152520e+06	7.559870e+06	1.234925e+05	4.409800e+04	132.735000	67.9
max	3.263129e+09	1.275541e+09	1.240777e+09	2.474100e+07	2.242429e+07	345.370000	124.7



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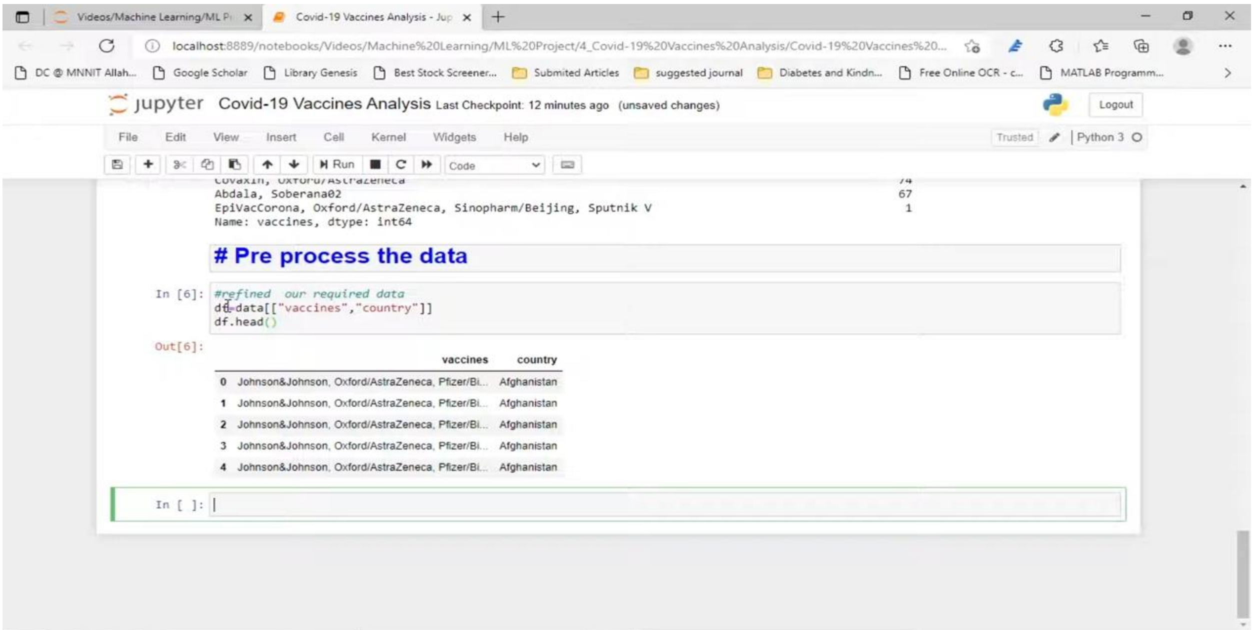
Describe the Data

```
[6]: data.describe()
```

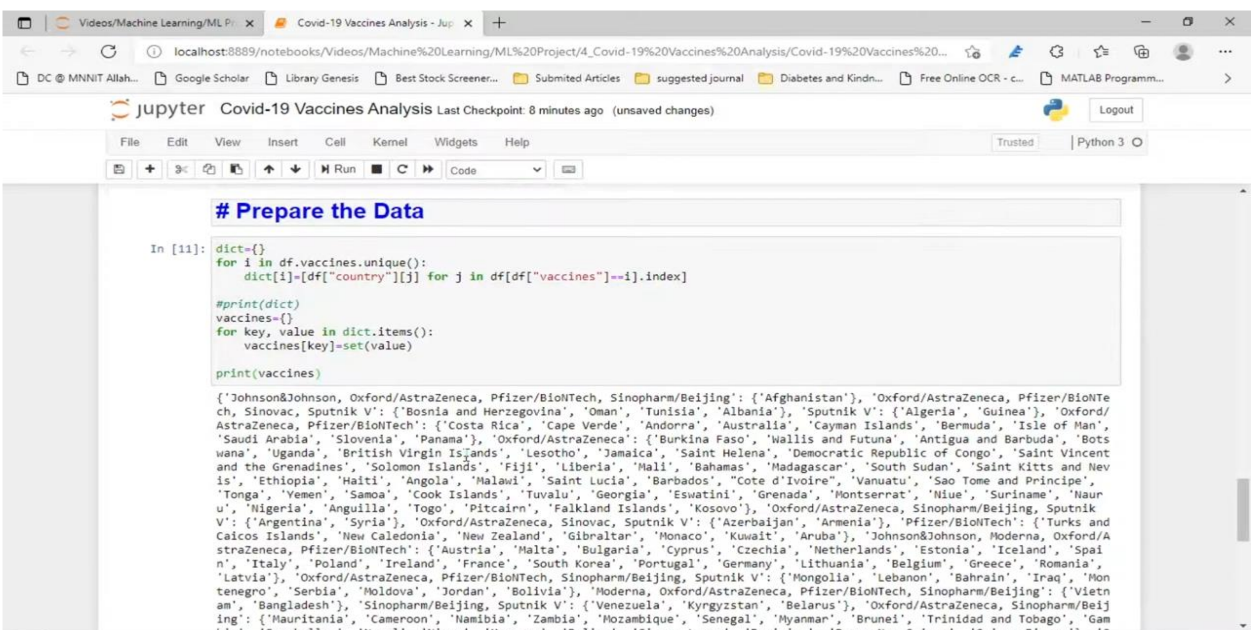
[6]:

ly_vaccinations_raw	daily_vaccinations	total_vaccinations_per_hundred	people_vaccinated_per_hundred	people_fully_vaccinated_per_hundred	daily_vaccinations_per_million
3.536200e+04	8.621300e+04	43607.000000	41294.000000	38802.000000	86213.000000
2.705996e+05	1.313055e+05	80.188543	40.927317	35.523243	3257.049157
1.212427e+06	7.682388e+05	67.913577	29.290759	28.376252	3934.312440
0.000000e+00	0.000000e+00	0.000000	0.000000	0.000000	0.000000
4.668000e+03	9.000000e+02	16.050000	11.370000	7.020000	636.000000
2.530900e+04	7.343000e+03	67.520000	41.435000	31.750000	2050.000000
1.234925e+05	4.409800e+04	132.735000	67.910000	62.080000	4682.000000
2.474100e+07	2.242429e+07	345.370000	124.760000	122.370000	117497.000000

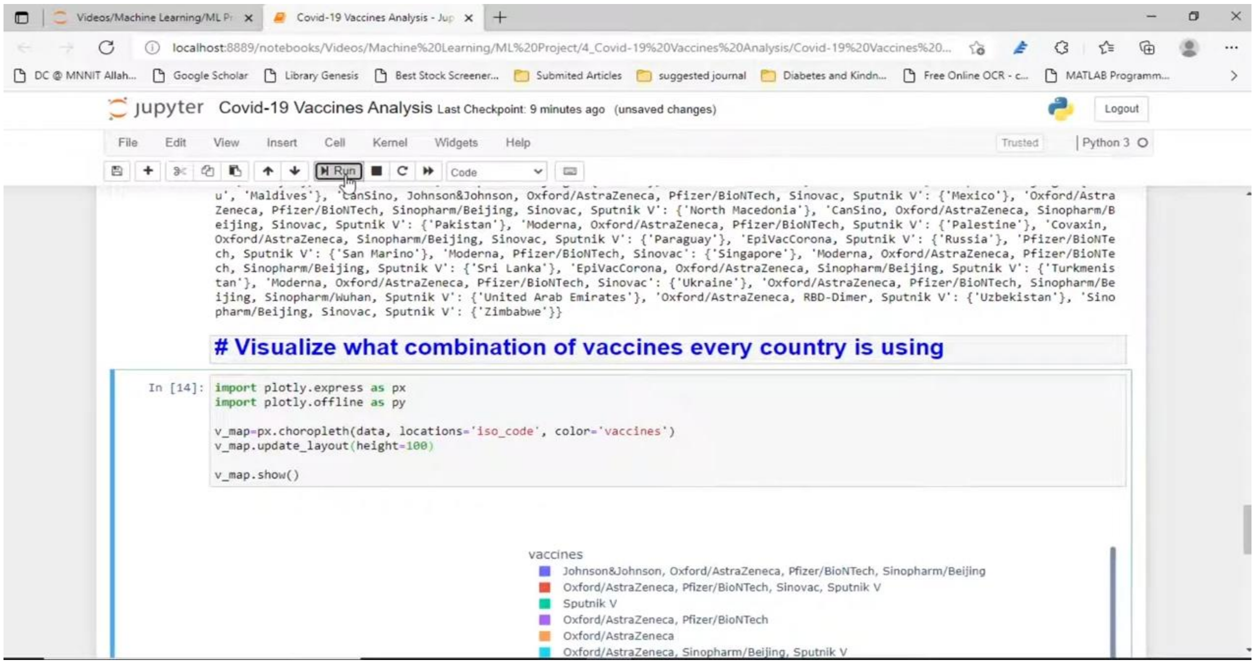
Pre-process the data

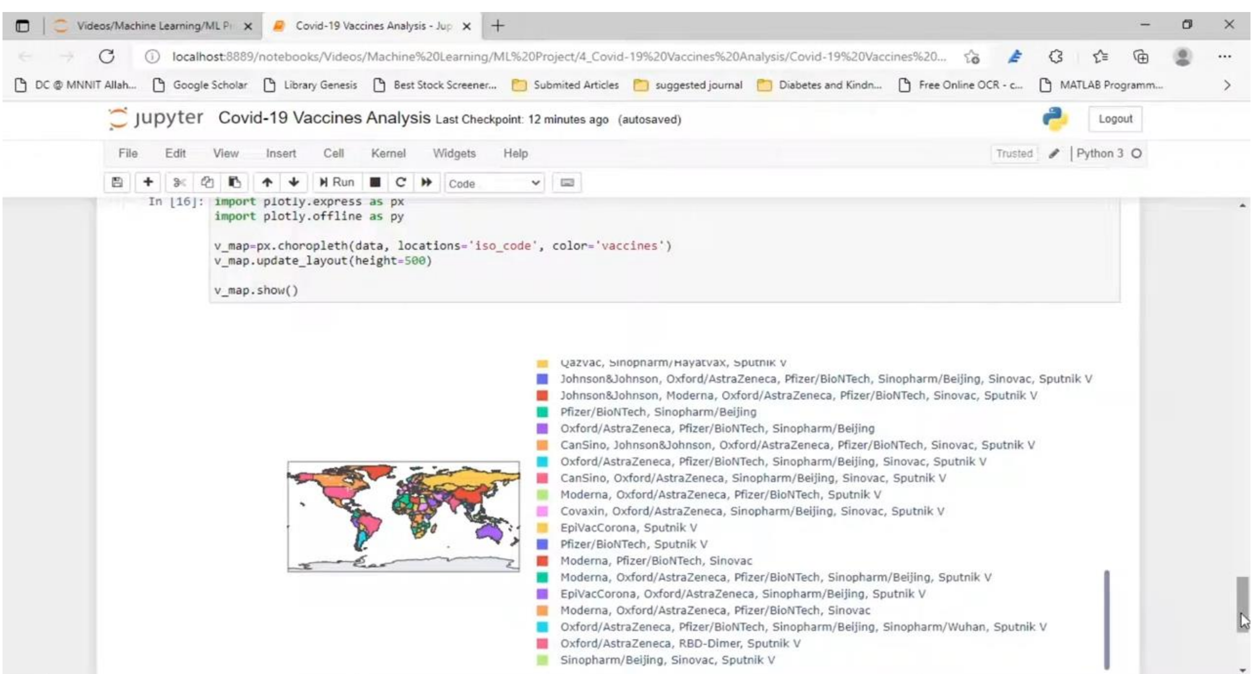


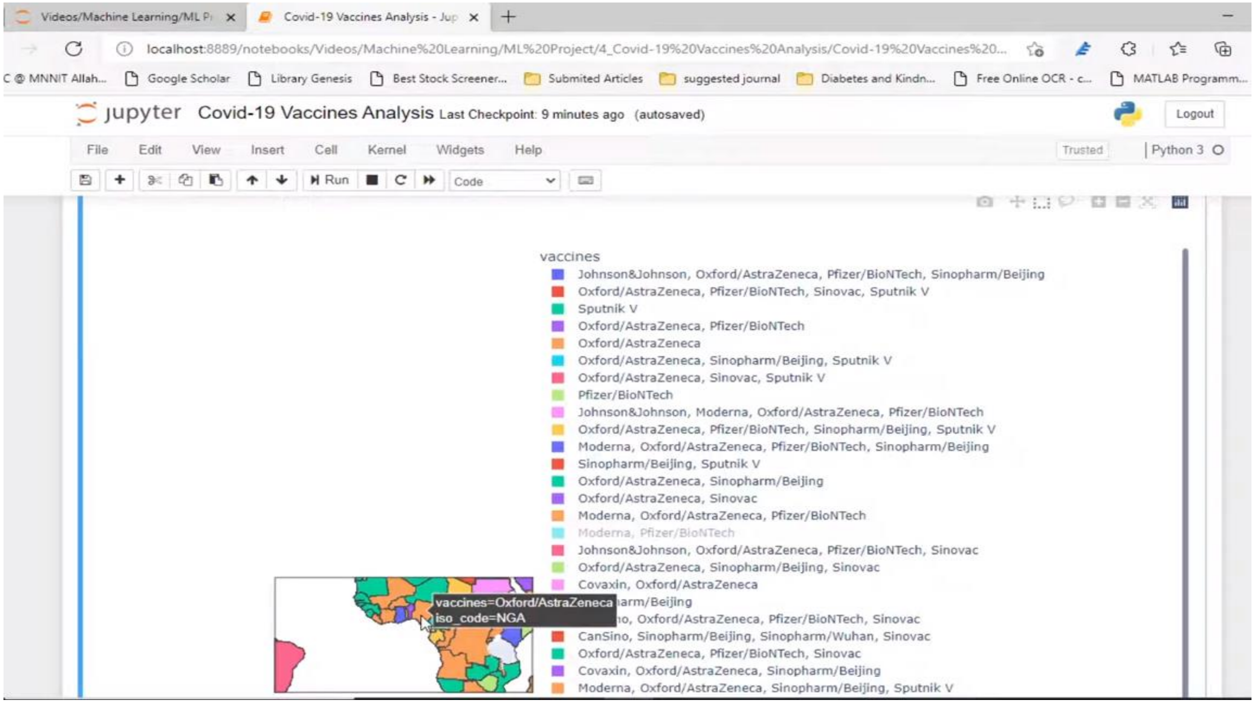
Prepare the Data



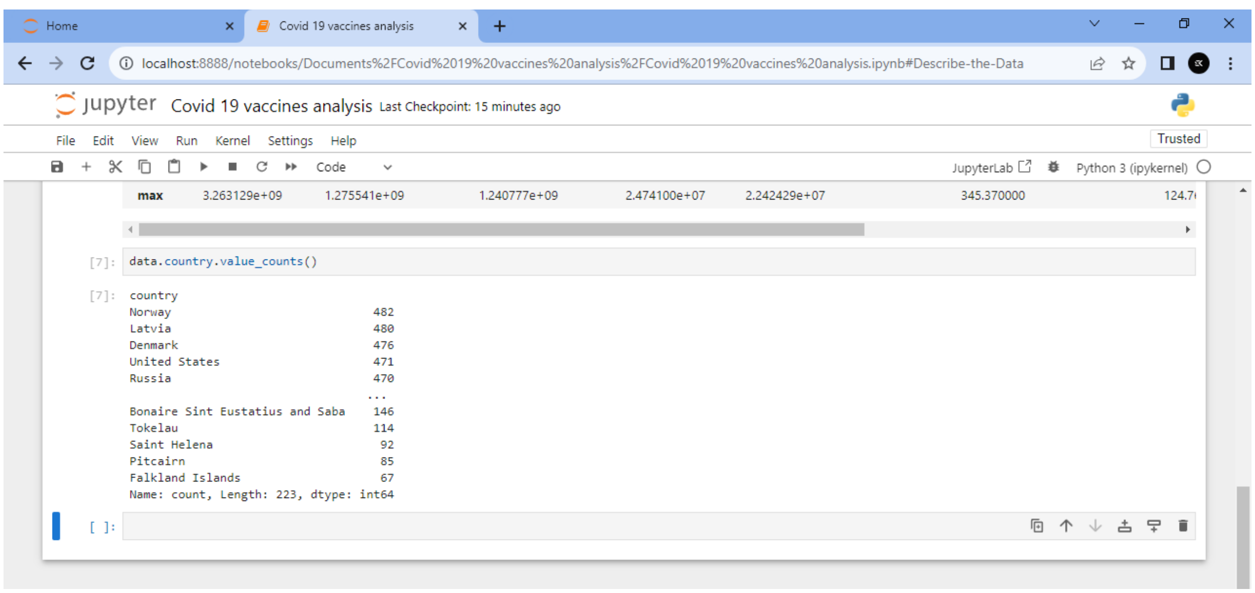
Visualize what combination of vaccines every country is using



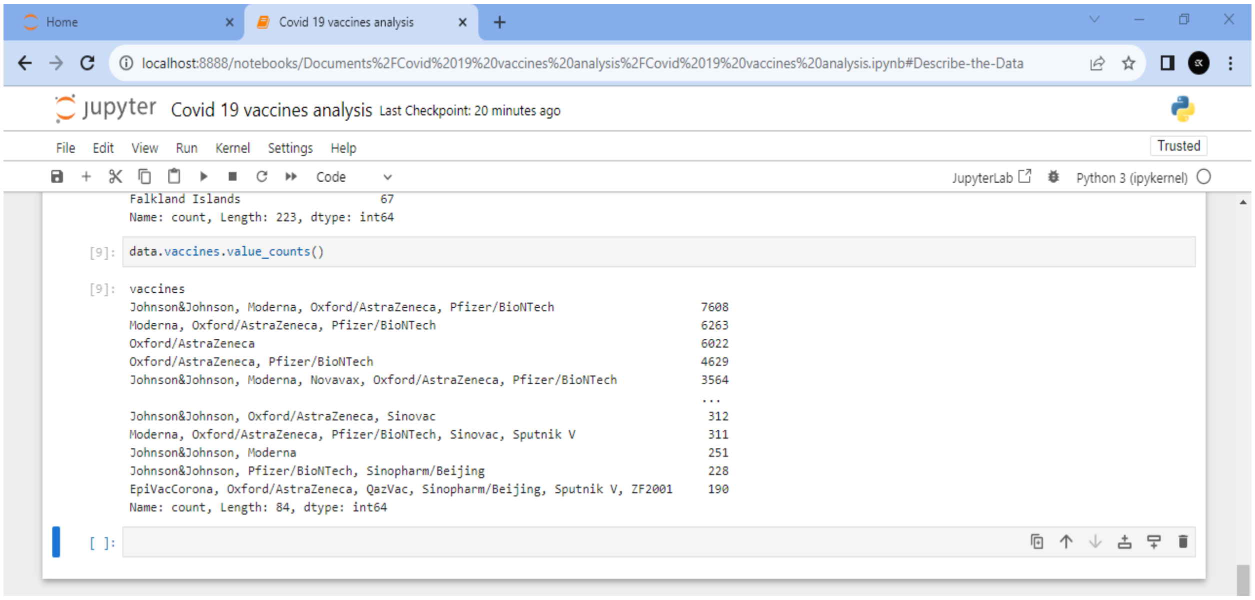




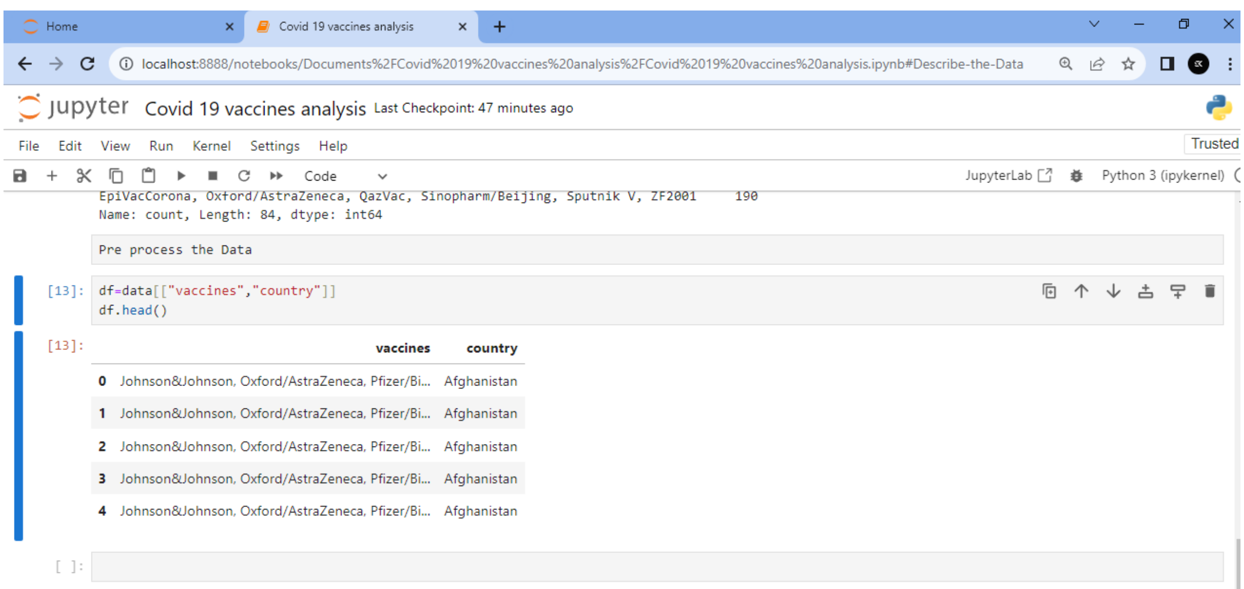
Data of country and value counts



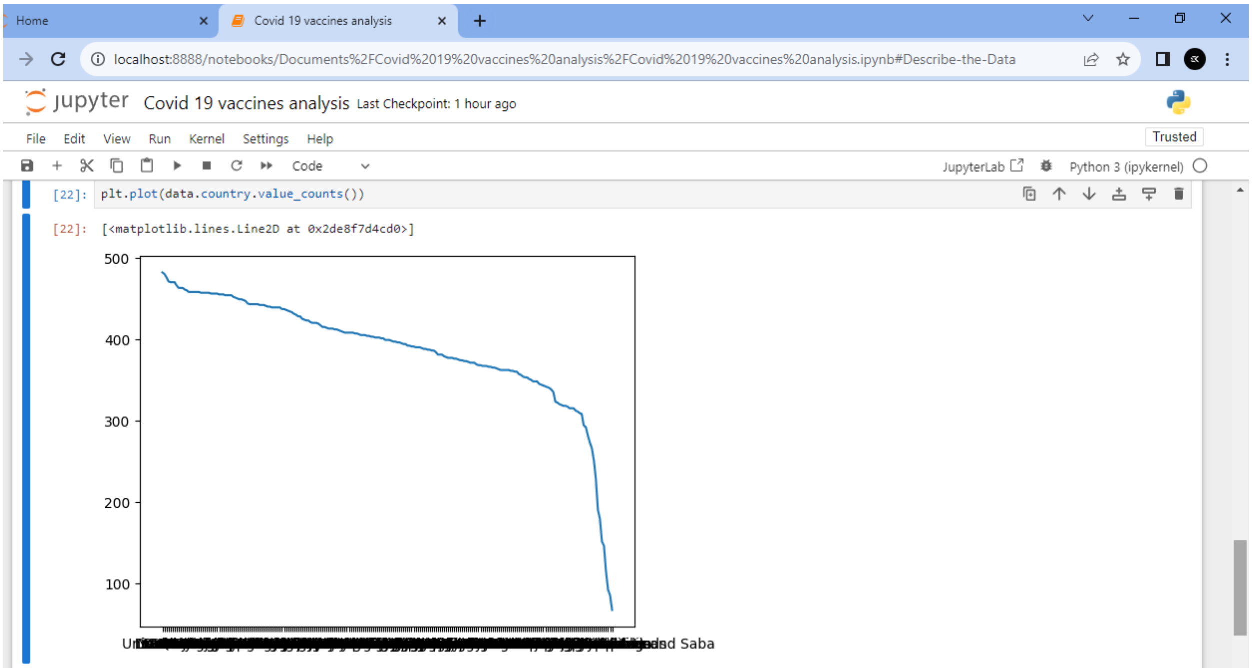
Data of vaccines and value counts



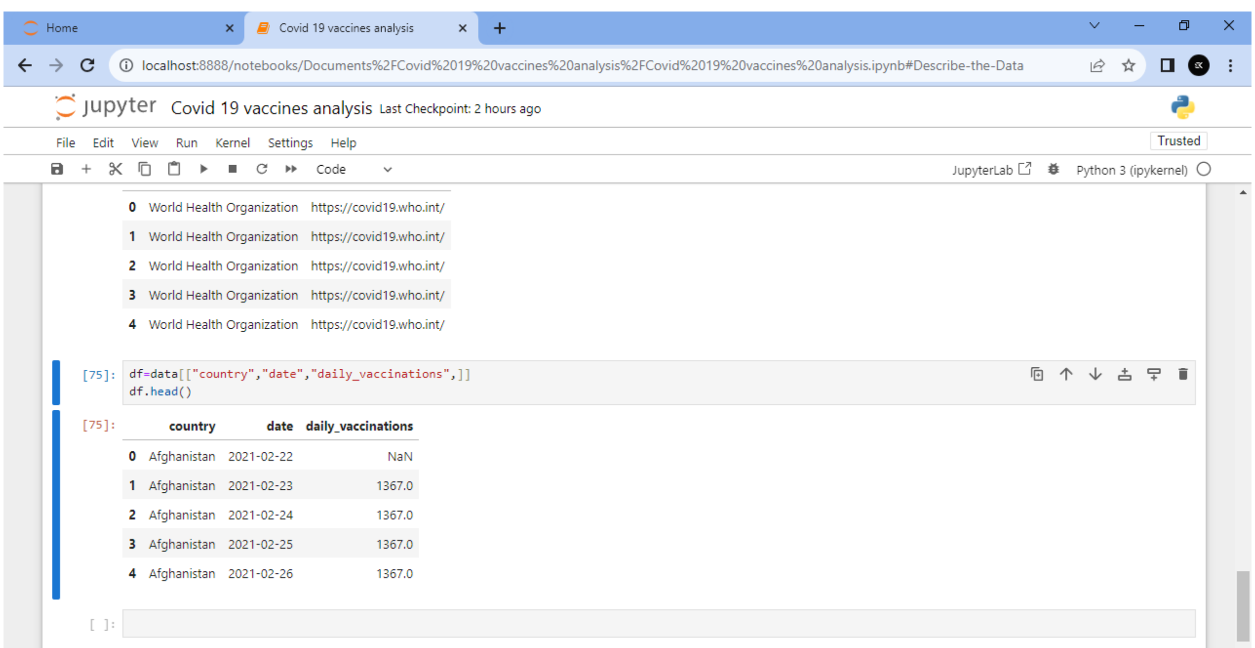
Data of vaccines used in country



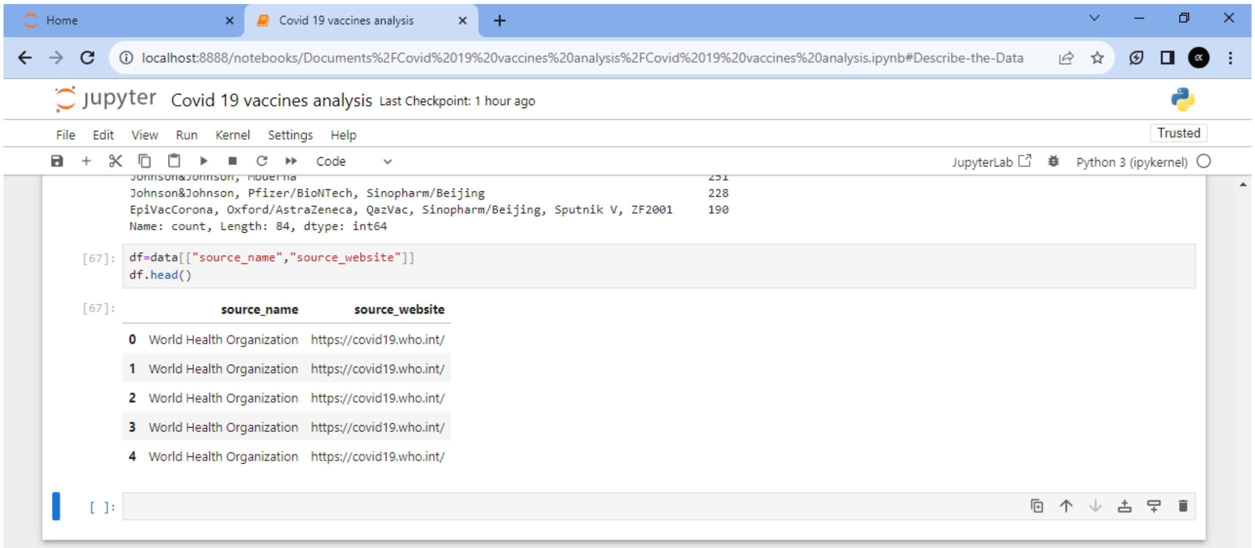
Line plot graph for Country and value counts



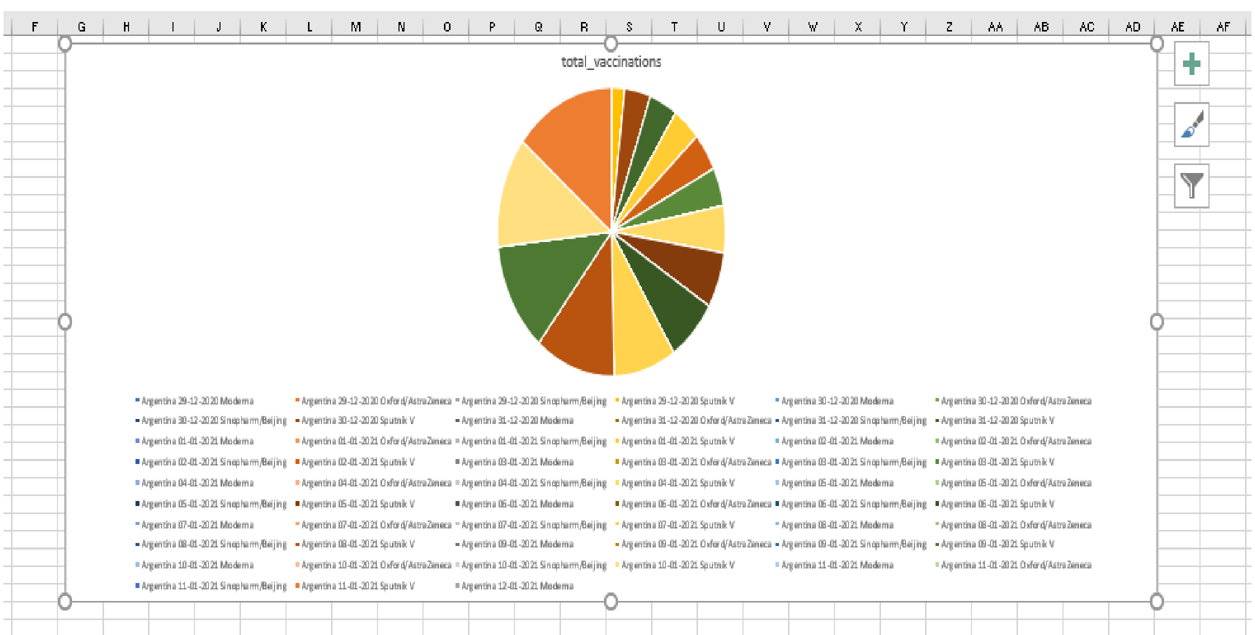
Data of country and date with daily vaccination



Data of Source name and source website



Pie chart for statistical analysis



Results and Discussion

This section presents the accuracy results of sentiment analysis carried out using five distinct methods applied to two distinct datasets, with the second dataset being further subdivided into five distinct vaccination datasets. The accuracy, precision, recall, F1 score, and support measurement are derived from the Random Forest, Naive Bayes, Decision Tree, Logistic Regression, and Support Vector Machine (SVM).