Indian Institute of Technology Gandhinagar

INTRODUCTION TO DATA SCIENCE
CS 328

WRITING ASSIGNMENT

Yash Kokane 20110237
Tanvi Chaudhari 20110043
Divya Chinchole 20110060

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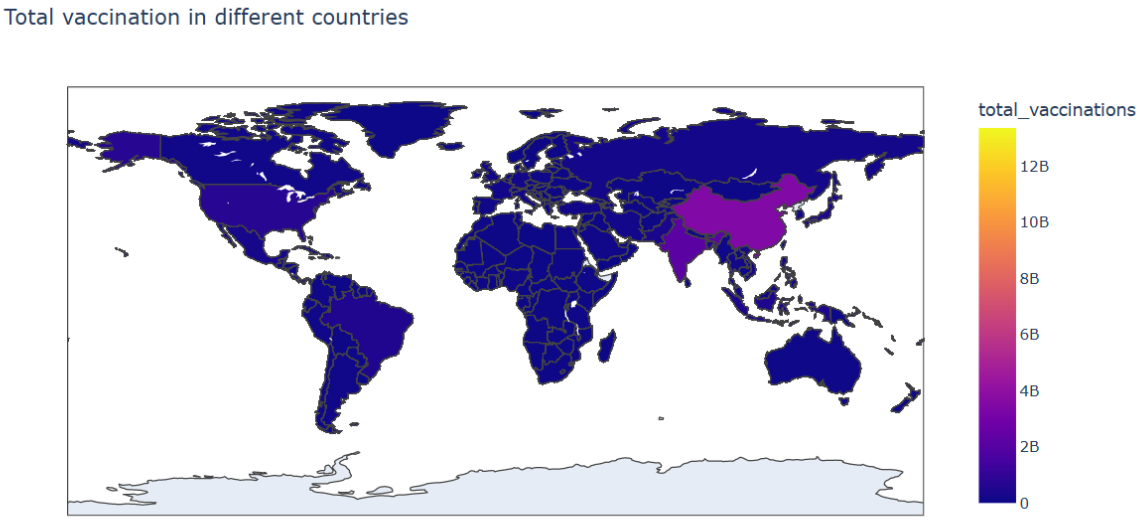
- **INTRODUCTION**

The COVID-19 pandemic led to widespread disruption and has significantly impacted our lives. With health emergencies and lockdowns happening all around the world, the pandemic has had a huge economic and social impact on each and every person. The pandemic has hit all countries equally; whether rich or poor, weak or powerful, it has affected all of us. This is true even for countries as countries which are rich or poor were all hit by the pandemic. The only solution to stopping the spread of the virus had been the vaccines. Thus the vaccines were developed and authorized for emergency use. However, when the vaccines were finally manufactured, we observed a huge inequality in vaccine distribution. Even though the pandemic had affected the entire world, only a part of the world had immediate access to vaccines. We would therefore be studying the underlying inequalities in the vaccination drives of different countries. In this project, we will be trying to understand the inequalities in vaccine distribution with time, the inequalities associated with which vaccines were used to vaccinate people, and the sources of vaccines by whom the vaccines were acquired.

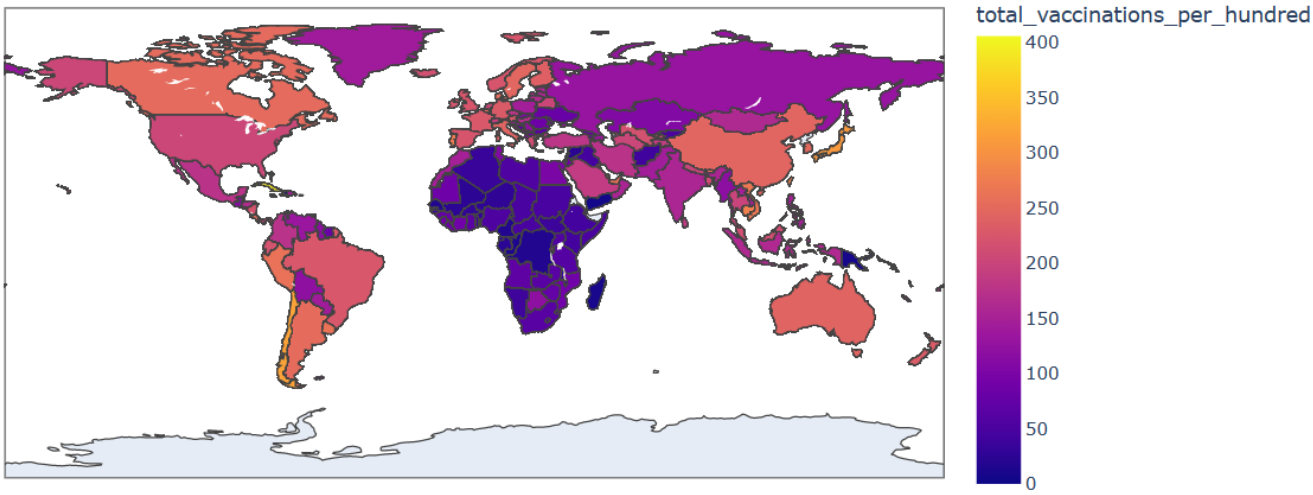
To complete this project, we have used two data sets from Kaggle. These datasets have information regarding the number of vaccinations carried out worldwide and the data regarding the vaccine manufacturers. Here's the necessary dataset https://github.com/owid/covid-19-data.

- **BEFORE AND AFTER TOTAL VACCINATIONS**

Let us first see the total number of vaccinations in the various countries in the map below. As evident from the map, we can see that China has the maximum number of total vaccinations, close to 3 billion doses, with no other country even close. This is expected due to the huge population of China. The second closest country, close to 2 billion people, is India which, like China has a high population, and thus the large numbers are not surprising. However, in the following graph, we can see most of the world in the blue zone, which is again expected as neither of the countries needs to vaccinate close to a billion people due to the huge population difference between India, China, and the rest of the world. Therefore total number of vaccinations is not a good measure of the country's vaccination drive, though vaccinating such a large population is noteworthy. Thus, the total number of vaccinations, in a way, shows us the inequality in the populations of countries as the more the population more the number of people that need to be vaccinated.



As the total number of vaccinations is not a good measure of the effectiveness of the vaccination drives, total vaccinations per hundred people can be a good measure of the effectiveness, as it discounts the population factor of the countries. From the plot of the countries with their total vaccinations per hundred people, we can see a huge inequality. In rich countries like those in Europe, Canada, China, the USA, and Australia, we can see that the total number of vaccinations per hundred people is about 200. Therefore most of the population must have gotten at least two doses of the vaccines, and their people are more or less fully protected from the virus, at least from the data. This is because these countries had the manufacturing ability and/or the funds to pre-book the vaccines from the manufacturers and thereby hoard them for their people. On the other hand, we can see the African countries that did not have access to the vaccines due to their lack of manufacturing ability and the lack of funds and power to purchase them. These countries have total vaccinations per hundred of less than 50. This shows that for some of these countries, not even half the population has had at least one dose of the vaccine.

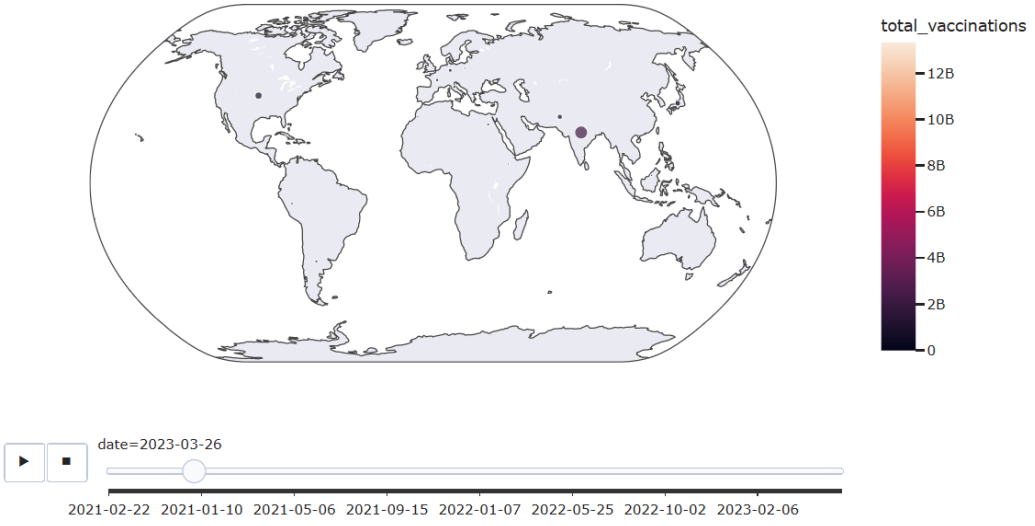


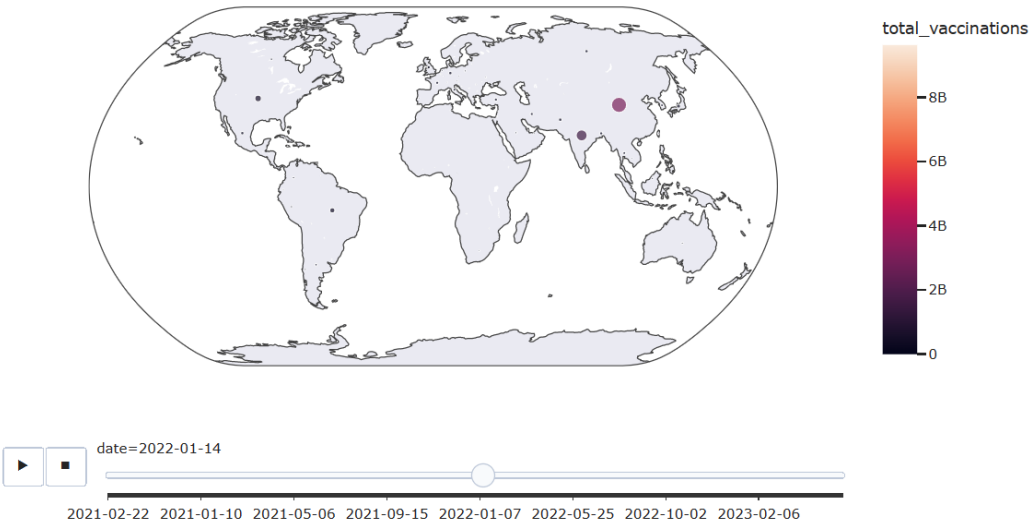
The first vaccination drive started in China, wherein they started vaccinating their people with the locally made vaccines in June 2020 for military use. However, the mistrust of other countries in China after they had allowed the pandemic to spread led to less popularity of the Chinese vaccines. The next breakthrough came when the Russians approved the Sputnik V vaccine in their country, however, their speed to distribution was very slow. In November 2020, the US based Pfizer–the USA's FDA approved BioNTech vaccine. In December, the Pfizer– BioNTech vaccine was approved by the UK, and its use was authorized. Thus the UK became the first country to launch a vaccination drive for the public. The Oxford-Astrzeneca and Moderna vaccines were also approved in December 2020. However, the initial rollout was slow, and since all of these vaccines were made by companies in the US and Europe, thus only these countries had initial access to them through the respective governments.

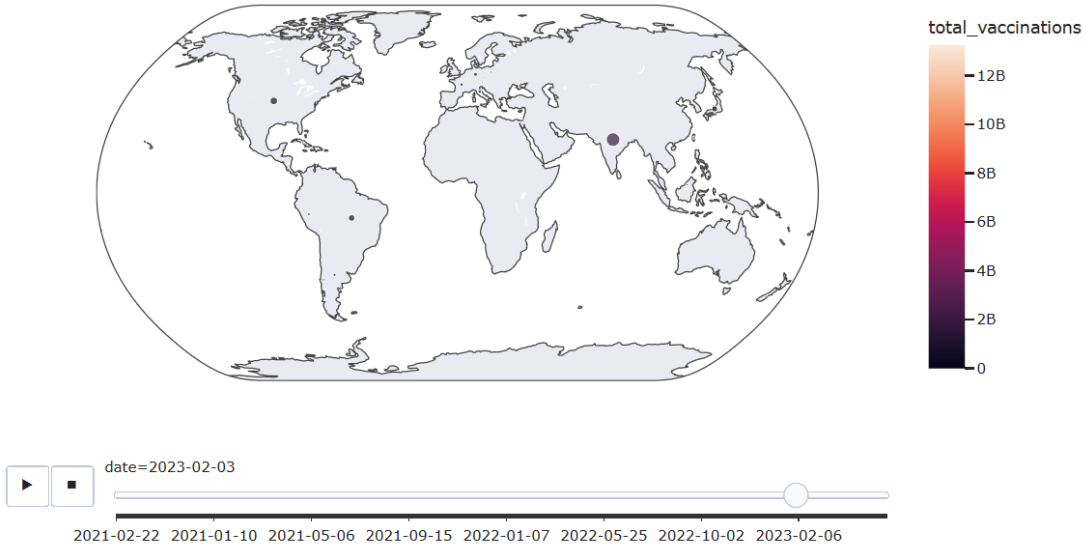
The vaccine orders from rich countries started coming into the vaccine manufacturers through the rich countries that could afford to pay for the vaccines for their people. The rich countries thus had access to the most vaccines, whereas the poor countries, which could not afford to place orders for heavy prices, had no access to the vaccines. From the animation below, we can see the initial vaccinations in the UK starting from December 2020.

This was followed by the US, which started its vaccination drive in the same month. India, too started its vaccination drive with the locally manufactured Oxford-Astrzeneca vaccine and the locally developed and manufactured Covaxin in January 2021 for the elderly. The vaccination drives were slowly and steadily progressing in most of the developed and rich countries, whereas we can see parts of the world where there have been no vaccinations, whereas, in other parts of the world, millions of people were being vaccinated. This clearly shows the vaccine inequality in the distribution of vaccines worldwide. With the distribution being sharply tilted towards the rich and powerful. We can also see the vaccination drives increasing as the new Omnicron varient of Covid strikes in early February-March 2021. The countries also slowly start to open vaccination drives for common people. As the year progresses, vaccinations begin in the poorer countries as the World Health Organization manages to get vaccines through the CoVax program and starts to distribute vaccines to the countries that could not afford them or did not have access.

Plotting interactive graph for total vaccinations worldwide





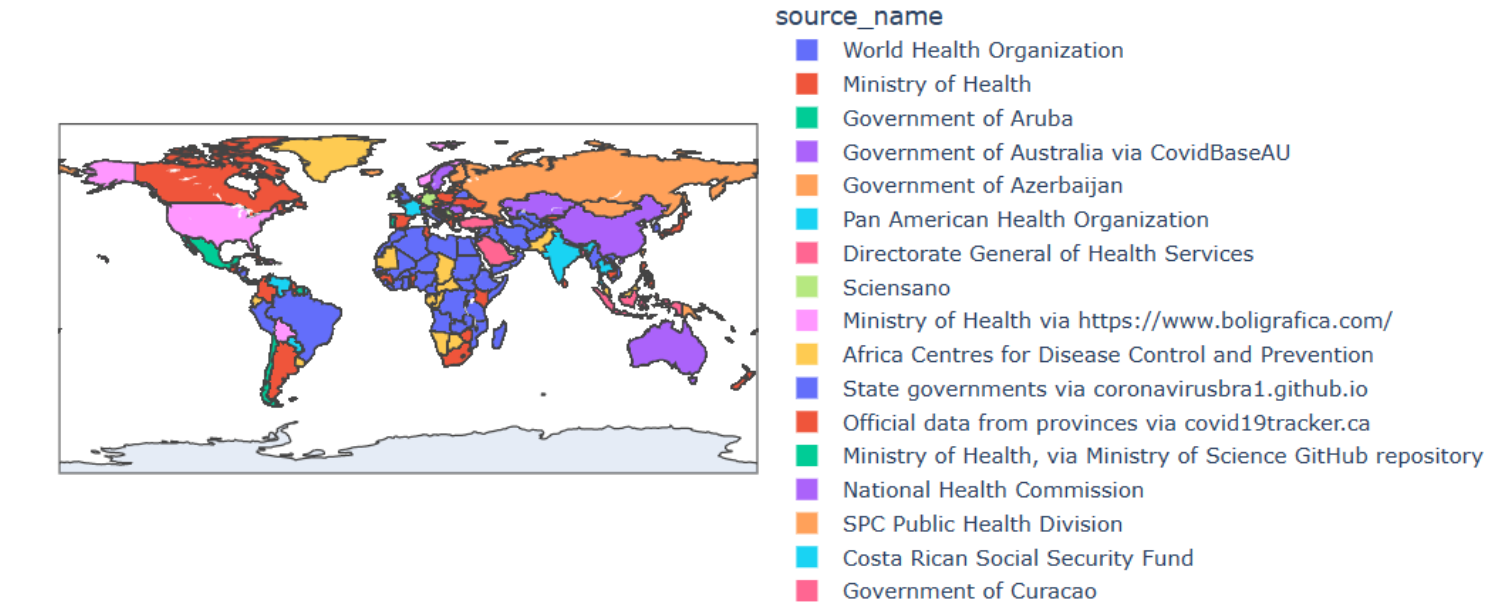


We have plotted the total vaccinations worldwide for the respective years: 2021, 2022, and 2023. We can see that well-developed countries have already started the vaccination drives, unlike under-developed countries like Africa.

- **SOURCES OF VACCINATIONS**

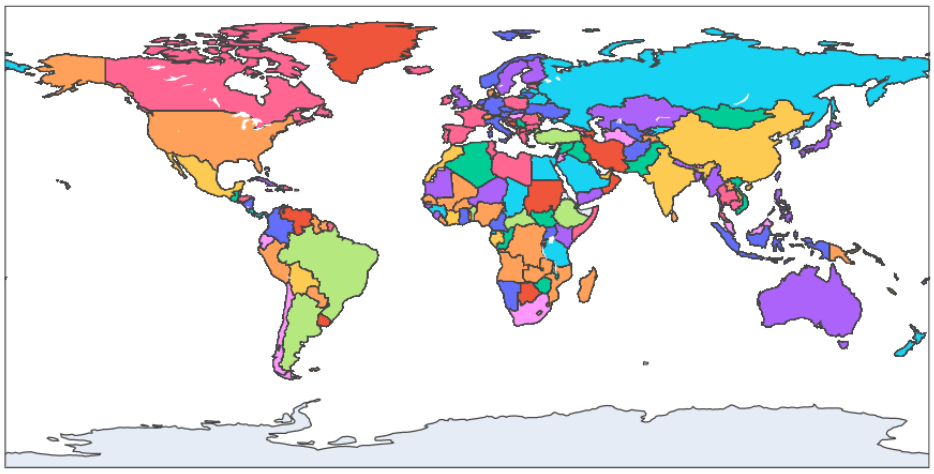
Here we try to analyze the source from which the vaccines that were being administered to the people of a country were acquired. They tell us about the source that purchased the vaccines being distributed in the country. As seen from the graph below, we can see that for most of the countries that have the means to buy the vaccines, the vaccines were purchased by the government of the country. However, there are many countries here that have the source as that of the World Health Organization.

These are the countries that received the vaccines from the CoVax program of WHO. If we compare the previous maps with this, we can see that the countries that had the vaccines distributed from the WHO were the ones that received the vaccines late, and their total vaccinations per hundred are also low. This tells us that the WHO could not get the vaccines early, and the number of vaccines received was insufficient to vaccinate the population.

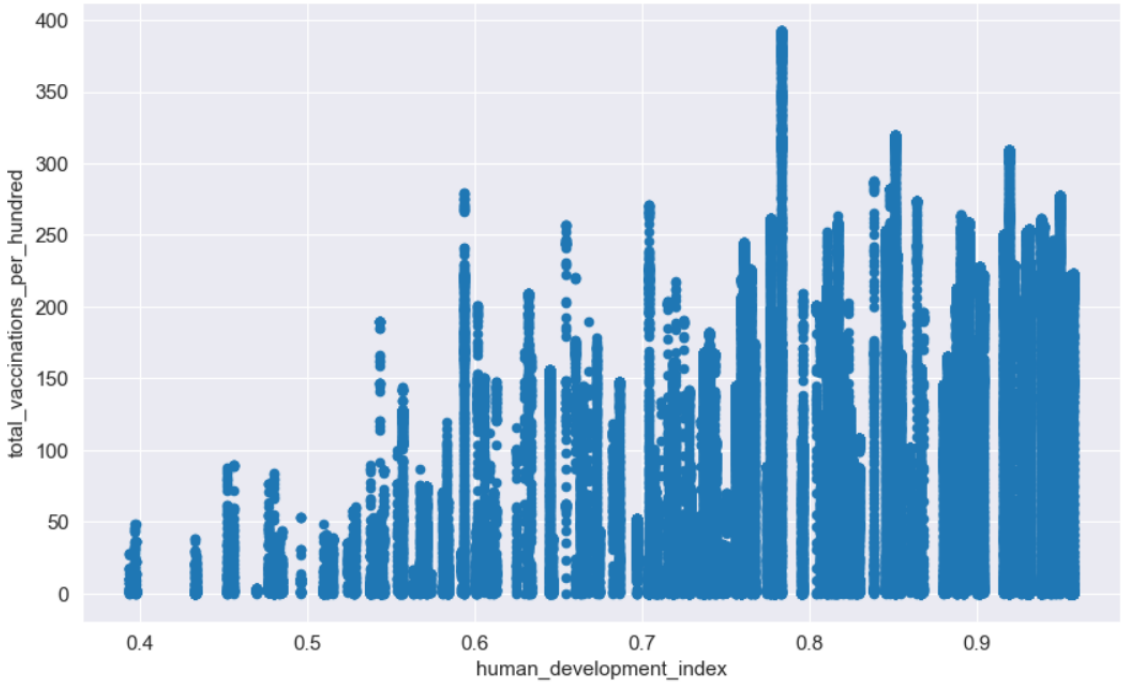


The following graph shows which vaccines were used by the respective countries. On closer observation of the data, one can see that the countries that have a local manufacturer mostly use the vaccines manufactured by them. The countries that do not have the manufacturing ability use vaccines acquired from multiple sources, be it donations by other countries, WHO distributions, etc. A huge inequality in the type of vaccines used by individual countries can be seen here.

Vaccines used by different countries



Next, we will observe how the total vaccinations per hundred are changing with the human development index. As can be seen from the graph, they have an almost linear relationship, i.e., the countries with high human development index, which are the developed countries, have more vaccinations per hundred.



- **CONCLUSION**

In conclusion, we can say that the vaccine distribution has been very inequal, with the the developed countries having an early and wide access to the vaccines with the poorer countries waiting a long time to access the vaccines. Thus we can say that even though the pandemic did hit all the countries equally, its cure for a long time was limited to the developed countries, which allowed them to fight back, and the underdeveloped countries suffered more out of it.