Worldwide Vaccination Report for COVID-19 Analysis and Visualization Using Deep Learning

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Abstract. Covid-19 is an ongoing pandemic, caused by the Acute Respiratory Disease Coronavirus 2 (SARS-CoV-2). The virus first appeared in Wuhan, China in December 2019. The World Health Organization announced the Public Health Emergency of International Concern on COVID-19 on January 30, 2020, and announced the epidemic on March 11, 2020. Due to high number of death cases the COVID-19 becames a deadliest pandemics in the history. The main aim of this work is to convey the analysis of various current vaccination programs around the globe by performing Exploratory Data Analysis on the scraped data present on the web. In the result analysis, the model visualizes and showcases the caused by Covid in different countries through the last one year and the progress of the vaccination program in various countries around the world. The result analysis shows that United States, United Kingdom, England, India and China are the top five country that are vaccinating maximum people in a day and Gabraltar have the most people vaccinated as compared to others.

Keywords: Covid-19 · Pandemic · Vaccination report · Visualization · Deep learning · Public health emergency of ınternational · Exploratory data analysis

1 Introduction

The Covid-19 pandemic is the one of the most vital health disaster humans have encountered with [1] Covid-19 is spreading rapidly among humans as well as animals. Corona viruses are a large family of viruses that causes illness. The illness may range from common cold to severe respiratory diseases to even death. Corona viruses are classified as zoonotic, which means they can transfer between humans and animals too. There are several known corona viruses that are circulating in animals but not yet infected humans [2]. In 2019, a new coronavirus was identified as the cause of the disease outbreak among humans. The virus is known as SARS-CoV-2. The virus is thus known as corona virus disease 2019 (COVID-19). The outbreak spread at an alarming rate as a result of which the WHO (World Health Organization) declared COVID-19 to be a pandemic [3]. The corona virus infects your body's healthy cells. There, the virus makes copies of itself throughout the body. The virus moves down the human respiratory tract and latches its spiky surface proteins to receptors on healthy cells, especially lungs. This makes the hosts lungs to become inflamed which makes it tough for them to breathe. This may lead

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to severe respiratory diseases to even deaths [4]. There are various methods introduced by scientists and people to know whether the patient is infected with Covid-19 virus or not. One of the methods include the study of the patient's Chest x-ray and chest CT scan, in which the doctors look out for shadows or patchy areas called "ground-glass opacity" [5]. Many health professionals, statisticians, researchers, data scientists and programmers have been tracking the corona virus outspread in different regions of the world using various different approaches. Data scientists have developed various algorithms which can identify whether the person is infected with corona virus or not, using the images of chest x-rays of that person [6]. The development of an efficacious COVID-19 vaccine has helped various countries all around the world to stand a chance against this pandemic. The rise in various vaccines developed by scientists have helped the countries to develop an immunization among their people against the Covid-19 virus. The vaccination programs are now ongoing in every major and minor city all around the world with aim to immunize the whole population against this virus [7, 8]. After the release of the first vaccine in January 2021, countries all around the world were trying to vaccinate and immune as many people as possible. But since March 2021, a second wave of Covid-19 struck various countries around the world. The Table 1 compares the new confirmed covid cases and deaths in various countries for 1st January 2021 and 5th March 2021, after they got struck with the second wave on Covid-19 [9].

Table 1. Covid-19 Data for new cases and deaths in various countries

Country Name	New Confirmed Covid-19 cases (1^{st} Jan 2021)	New confirmed Covid-19 cases (5^{th} May 2021)	New confirmed Covid-19 Deaths (1^{st} Jan 2021)	New confirmed Covid-19 Deaths (5^{th} May 2021)
India	20035	412431	256	3980
European Union	112548	106256	2296	2141
South America	47568	125704	912	4136
Brazil	24605	73295	462	2811
France	19348	260004	133	244
Japan	3257	4068	248	60
Nepal	426	8605	8	58
Thailand	216	2112	1	15

2 Related Work

In [8], the author has performed a study where the author tried to predict the progression of disease caused by COVID- 19 Vaccine. The author performed machine-learning models on the data collected at two hospitals, The Huoshenshan and Taikang Tongji (Wuhan, China) hospitals. Some patients were characterized as severe COVID-19 cases with fever plus one of SpO2 $<93\%$ or rate of respiration >30 breaths/minute in room. Then, in the

dataset, the author selected the most representative features. using a feature selection. Factors which show differences between the two groups namely, critical and non-critical patients were selected by the author for the machine learning process. In the results, the author found that the patient's median age was 62.75 years, with more than 50% being male. The severe patients are much older than the non-severe patients. High blood pressure (>30%), heart disease(<10%) and diabetes (>12%) were the most common complications, and were frequently presented in severe patients. Increased levels of CRP, D-dimer and α-hydroxybutyrate dehydrogenase, lactate dehydrogenase (LDH), and a decreased levels of hemoglobin and albumin are found in severe patients.

In [9], the author has prepared a background paper on Covid-19 vaccines. The author has depicted how the various vaccines such as CoviShield and Covaxin works. SARS-CoV-2 infection induces both B-cell (antibody) and T-cell specific immune responses. T-cells are responsible for producing memory T-cells that remember the virus and B-cells are responsible for producing virus specific antibodies. Basically, both the cells combined prepare our body for future infection. The two most famous vaccines around the world that are being used by most of the countries are CoviShield and Covaxin. The CoviShield uses Chimpanzee adeno virus approach. When a person gets vaccinated with CoviShield, the vaccine doesn't inject the person with the actual SARS-CoV-2 virus, but instead the person gets injected with an adeno virus that infects animals, especially Chimpanzee. Adeno virus used in CoviShield is modified to carry a corona virus gene. When CoviShield is administered the adeno virus, enters the living cell and the modified gene instructs the cell to produce SARS-CoV-2 spike proteins and display it on the surface of the healthy cells. These spike proteins are then detected by the T-cells and B-cells and our body starts building immunity whereas, the Covaxin (BBV152) is an inactivated SARS-CoV-2 virus vaccine. An inactivated virus won't cause an infection in your body as it is basically powerless. It helps our body to make SARS-CoV-2 specific antibodies with the mechanism same as of CoviShield. In [10], the author conducted a study on the effects of the pandemic on the air quality of major Indian cities. The author reported that the COVID-19 has forced many countries around the world to declare a lockdown nationwide to further prevent the spread of coronavirus in the community. On March 24, 2020, India declared a lockdown nationwide. The author analysed the quality of air of three major cities in India, which are Delhi, Kolkata and Mumbai during the lockdown phase and compared it to before and after the lockdown conditions. The author looked at seven major air pollutants and analyzed data obtained from 56 stations under the Central Pollution Control Board present across the selected cities. The author has marked the air quality indicator and the local pattern for these pollutants. According to the author, atmospheric particulate matter 2.5, 10 and carbon monoxide are the main pollutants in India which have been reduced by a rate of 52%, 39%, and 13% in Delhi, 47%, 41%, and 27% in Mumbai and 49%, 37%, and 21% in Kolkata. This study shows that the temporary closure can result into a refreshing breeze in these big cities.

In [11], the author conducted an analysis of factors related to cardiovascular risks among patients infected with COVID-19. The author wants to analyse and evaluate the increase in factors related to CVD risks among COVID-19 patients based on the Framingham risk score, and to assess the correlation of CVD risk factors with clinical outcomes. In thae cross-sectional study, the author analysed 264 confirmed cases of COVID - 19

at King Saud University in Saudi Arabia. The electrical records of patients, including the ones in the age group 18–80 are recorded and updated. The patients are classified in three FRS categories mainly low, medium and high. In these results, more than half needed a treatment regarding the serious illness and 58 patients died, merely adding up to 27%. Pneumonia, shortness of breath and kidney damage was the most common complications that are found among the patients. In [12], an analysis is conducted by the author to gain information regarding the vaccination program among the population: a cross-sectional study is done by author from 1,449 people. The author wants to put across the point that the success of the vaccination program depends on the knowledge of people about the vaccines. By increasing the people's knowledge about the vaccine and strengthening the promoters, the acceptance of vaccine program can be increased among the population. The author performed the survey with the help of Google online survey platform. A total of 1249 responses are received, with majority from the age group >38. In the survey, the author found that most of the people have limited knowledge about the vaccines in groups already suffering from some conditions. Participants having age >45 years are more willing to take the Covid-19 vaccine as they believe that the vaccine is harmless. The younger generations maily from age group <30 are more concerned about the availability of the vaccines and their validity.

The researches spurred curiosity in me to work on the Covid-19 World Vaccination Analysis with the objective of understanding and predicting how the vaccination program is being conducted all around the world.

3 Material and Method

In this section the dataset used for analysis is discussed with proposed methodology.

3.1 Dataset

The dataset used in this paper is taken from Kaggle [11], which is been updated daily regarding the vaccinations done worldwide. The data used in the proposed work is being updated till 26th April 2021. This data set is further divided into 16 columns serving different purposes which will discuss later in this section. The vaccination data is collected for 195 different countries. The length of the dataset used is 13600 on the date it was taken from the Kaggle repository. A brief description of the dataset labels is discussed further in this section to understand the dataset and make prediction. This makes easy for us to understand the dataset and make prediction. The Country and Country ISO Code helps to identify the details of vaccination used for a country. The people are differentiated for covid-19 dose by anlayzing their vaccination report like, taken 1st dose or fully vaccined (i.e., both of the doses). Daily vaccination column describes the number of vaccinations for that particular date/country.

3.2 Proposed Work

Data obtained from the Kaggle repository contains some missing values as it is data from the real-world. The reason could be many such as data entry errors or problems

related to data collection. The dataset is first cleaned and the missing values are replaced with 0.0 in order to make the results more accurate. To implement the deep learning algorithm EDA, this work follows the following approach depicted in the Fig. 1

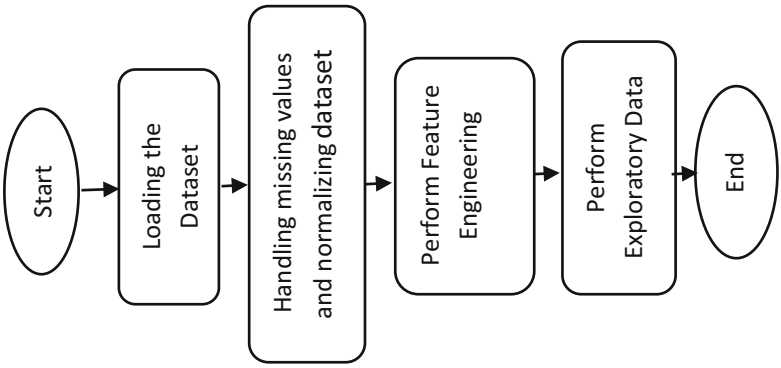

Fig. 1. Proposed model for analysis and prediction of Covid -19 on the basis of worldwide vaccination report

4 Experimental Results and Discussions

4.1 Analysis of COVID-19 Around the World

A brief overview of the Covid-19 situation, the daily confirmed cases and the deaths all around the world are depicted further in Sect. 4.1. In Fig. 2, the daily Covid-19 cases confirmed all around the world are shown. The figure shows data from 22nd January 2020 to 25th August 2021 about the new cases from Covid-19.

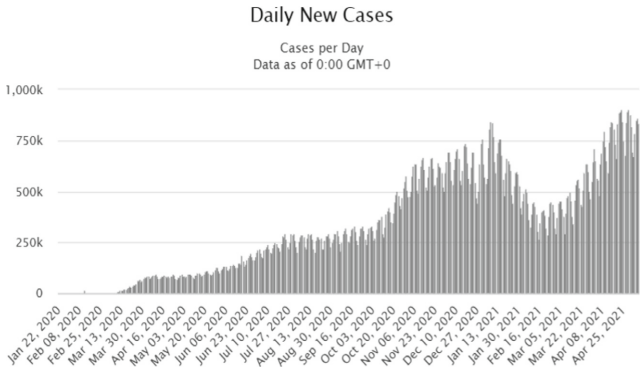

Fig. 2. Covid-19 new cases analysis through last one year

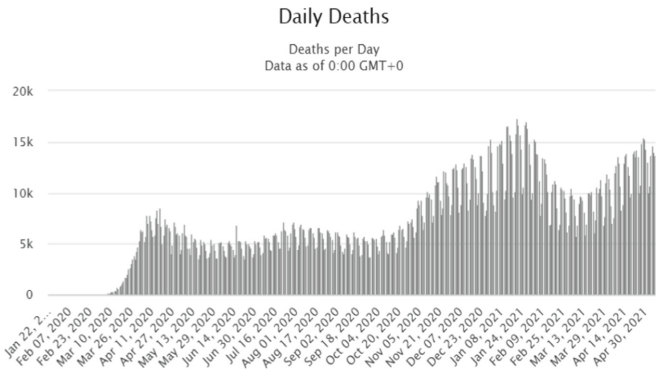

Fig. 3. Covid-19 death analysis through last one year

In Fig. 3, the death analysis through the last one year all around the world is been depicted in a graphical manner. After performing Exploratory Data Analysis on the collected dataset the results are shown with the help of graphs. For that, different libraries like matplotlib and seaborn are used. Given below are the results after implementing the algorithm:

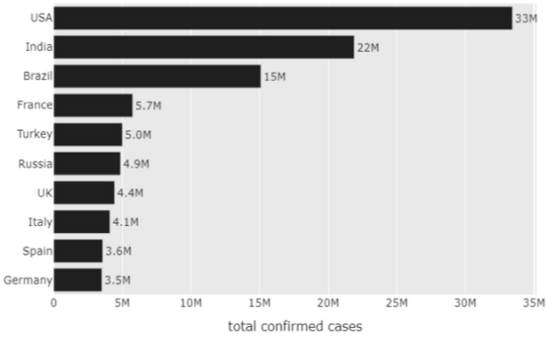

Fig. 4. Top 10 countries by total confirmed cases

In Fig. 4, the top 10 countries that are worst hit by Covid-19 pandemic are shown. The graph shows that USA leads by cases over 30 million. India and Brazil follow with 15 million cases reported.

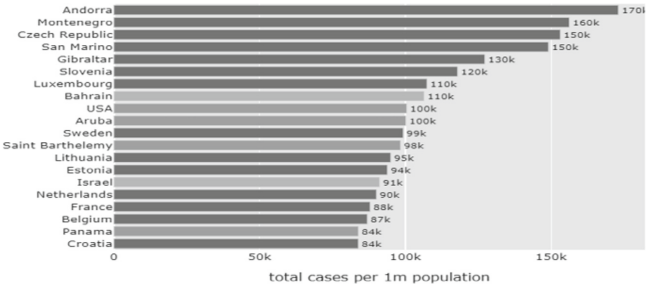

Fig. 5. Top 20 countries by total cases per 1 million population

In Fig. 5, the top countries with the greatest number of Covid-19 cases per 1 million of the population is shown. The graph shows that 14 out of top 20 are European countries, 4 are North American and remaining from Asia. Andorra is the country with most people tested positive for Covid-19. Also, 1 out of every 10 person in America has been tested positive for Covid-19.

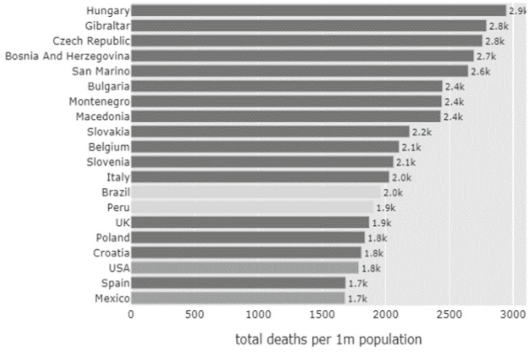

Fig. 6. Top 20 countries by total deaths per 1 million population

Figure 6 shows the top 20 countries having most deaths per 1 million of the population. Factors like age-group, chronic illness, healthcare measures and public awareness plays a crucial role in this. The graph has more European countries, 16 out of 20. Gibraltar has the greatest number of deaths as depicted in the figure followed by countries like Spain, UK and Brazil.

4.2 Analysis of Vaccination Program

After analysing the Covid-19 situation, this section discusses the analyse of the vaccination program is advancing in various countries around the world.

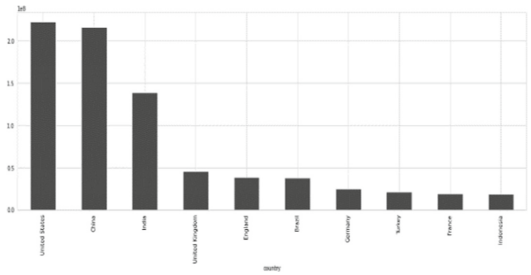

Fig. 7. Top countries in vaccination program

In Fig. 7, the graph shows that United States, United Kingdom, England, India and China are the top five country that are vaccinating maximum people in a day.

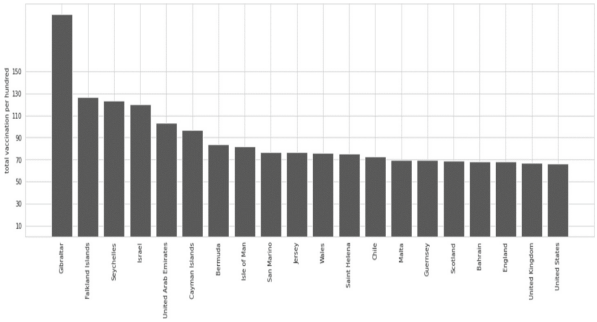

Fig. 8. Country wise total vaccinations done per hundred

Figure 8 shows the country wise total vaccinations done per hundred of population. Due to less population i.e., 33701 in 2019, Gibraltar is the most vaccinated.

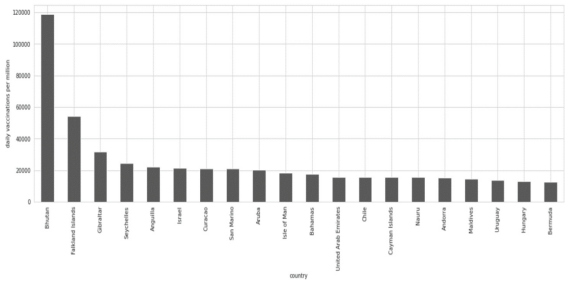

Fig. 9. Daily vaccinations in different countries in ppm

In Fig. 9, the graph shows the country in which country maximum people are being vaccinated in people per million (ppm). It has been noticed that Falkland Islands is the

leading country having most people being vaccinated daily. Maybe, it's because of the low population of the islands, they cover most of the people to get vaccinated daily.

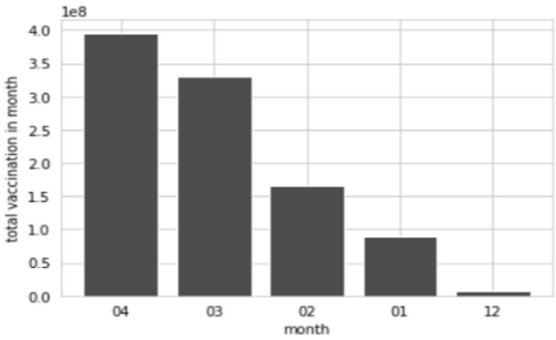

Fig. 10. Total vaccinations in a Month

In the above Fig. 10, it shows that maximum number of people got vaccinated in March all around the world. As most of the countries have the vaccinations in March, they tried to vaccinated as much as people as possible.

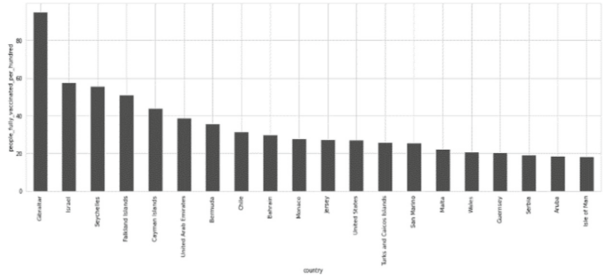

Fig. 11. People fully vaccinated in different countries

As a final result, Fig. 11 shows the countries in ascending order in which people are vaccinated the most. It is shown that because of the low population, Gabraltar have the most people vaccinated as compared to others.

4.3 Analysis and Comparison of First and Second Wave in India

India is country which is worse hit by the ongoing second wave of Covid-19. In this section, the deaths case of covid-19 in 2nd wave with the vaccination program in the country (i.e., India) is analyzed. From April – Sept, 2020, the ration of covid new cases came across the India was very high, its around thousand per day. After this tenure, the new case reported for this disease goes down. In mid of Feb 2021, the new covid cases encountered in India on daily basis and it reched to ~349k (April 24, 2021), which is

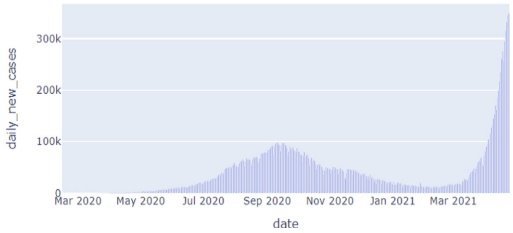

Fig. 12. Daily new cases from March 2020 to April 2021 in India

almost 3.5 times the case as compared to cases encountered in Mid-September 2020. After the first week of April, most states in India are under a complete lockdown.

Figure 12 shows the first as well as the ongoing second wave of Covid-19 in India. The graph analysis the daily new cases that are confirmed all around the country from March 2020 to March 2021. The graph depicts how the Covid-19 cases suddenly rose from under 100 k daily to more than 300 k between the spam of January 2020 to March 2021.

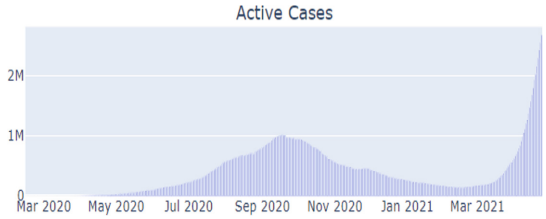

Fig. 13. Analysis of Covid active cases from March 2020 to April 2021 in India

Figure 13 shows how the count for active cases rise in the year 2021 in India. The count in April 2021 is 1.93 million, almost 2 times the active cases during the peak in September 2020.

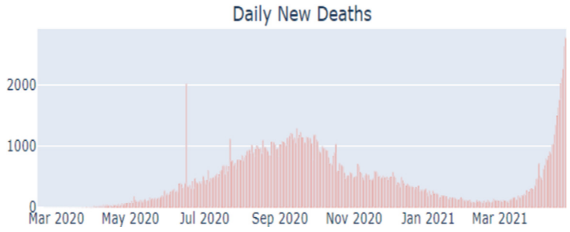

Fig. 14. Analysis of deaths by Covid-19 from March 2020 to April 2021 in India

In Fig. 14, the daily new deaths in India from March 2020 to April 2021 is shown. The graph depicts that the daily death toll is 1625 in April 2021, which is not more than 1.5 times the death toll during the peak of the first wave in India.

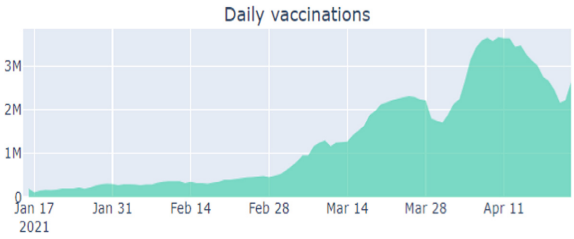

Fig. 15. Analysis of vaccination program India

In Fig. 15, an analysis of the advancement of vaccination program in India is shown. The number of vaccines being administered daily are increasing rapidly, with some periodic dips. Until now, 107 million people have received the first dose of vaccination and around 16 million people are fully vaccinated in India.

5 Conclusion and Future Scope

The Covid-19 pandemic is growing manifold daily. All around the world, the vaccination program is going at a high rate in order to vaccinate the people as soon as possible. In some parts of the world, the program is at a higher rate as compared to others. By using Exploratory Data Analysis, this paper has visualized and predicted the results and through graphs, United States, United Kingdom, England, India and China are the top five country that are vaccinating maximum people in a day. This work is not intend to develop a perfect predicting model but only analysis about the vaccination program in order to combat this disease. For future scope this research can be analyzed on the basis of dataset that is updated daily all around the world regarding the vaccinations done on daily purposes. Different Machine Learning Algorithms can be applied in order to improve the implementation phase.

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