Documentary Film Review Project on "America's Medical Supply Crisis"

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Introduction:

Long before the coronavirus outbreak, officials had been warning about shortages in medical supplies and issues about importing supplies from foreign countries. The US, after the coronavirus outbreak, was left unprepared in terms of manufacturing and distributing medical equipment towards the frontline healthcare workers. The 54-minute PBS *Frontline* documentary released on October 6, 2020, "America's Medical Supply Crisis", covers the medical supply crisis inside the United States regarding the novel coronavirus outbreak. This documentary reviews this multifaceted issue and takes into account numerous points of views from various professions about this crisis. It covers the US's reliance on China for masks and medical equipment, the failure of the government to purchase mask grants from companies (after the H1N1 pandemic), the disorganized "free for all" that ensued in every state across the nation to get medical supplies, and the importance of sustaining medical supply lines so that healthcare workers continue to get protected. The purpose of this documentary was to inform people about the complications in the medical supply line that lead to the failure of the US to support demands for protective equipment and other supporting supplies during the coronavirus outbreak.

Summary:

The documentary begins with the untimely death of a nurse named Sandy Oldfield, caused by exposure to the virus and a lack of personal protective equipment (PPE). This led to protests with nurses demanding sufficient PPE so that they would be protected from the outbreak while dealing with patients. Healthcare workers can be set into a *clearly defined population***,** as they are being affected by the pandemic due to having a lack of efficient medical equipment and

working in high risk jobs, where patients can transmit the disease. Variables that could be measured from this population include the amount of medical supplies and, in certain cases, death rate. The levels of these variables can be compared to other populations. A factor contributing to this issue is the US's increased reliance on China for mask production. When the pandemic first struck the US, there was a critical mask shortage because China briefly stopped exports of N95 masks. Only when China started to have the pandemic under control did they start to export N95 masks to the US. However, as more masks started to come into the US, a worrying trend was being spotted. People began to sell counterfeit N95 masks which did not meet the necessary standards required for actual masks, putting healthcare workers at risk. This occurred because of the very high demand for the short supply of masks. This high demand started because mask companies started to move out of the United States into other places like China because the companies simply couldn't compete against the lower prices and powerful manufacturing power of foreign producers. In fact, most masks were manufactured outside of the US by the late 2000s. This can be related to *time plot statistics*, because the referenced variable of domestic mask production is changing over time. In the last 20 or so years, the US used to produce many masks domestically, but this changed when China started to export cheaper masks which couldn't be competed against by domestic producers. If the proportion of masks produced in the US was graphed on a time series plot, it would show a decrease in proportion produced domestically; 9 out of 10 masks were produced in the US 15 years ago, which became 1 out of 10 less than a decade later. Dan Reese, a domestic mask manufacturer, was forced to produce masks during the H1N1 pandemic. He made a facility called the "Global Pandemic Preparedness and Response Center". However, after the H1N1 pandemic, the funds for the response center dried up as attention was diverted to other matters. Reese's business nearly went bankrupt as a

result of hospitals buying masks from cheap, foreign exporters. Moreover, the H1N1 pandemic depleted the Strategic National Stockpile (SNS) of masks and medical equipment. The government failed to refill and update the stockpile and purchase more masks in the following years. In an attempt to replenish the stockpile, Nicole Lurie, responsible for disease preparedness and response for the Department of Health and Human Services, contracted Philips Respironics in order to purchase cheap, small, and effective ventilators. However, Philips Respironics was delayed in delivering the contract, partly because of a delay in FDA clearance and software issues. Therefore, there were only 18,000 ventilators in the stockpile, a very small fraction of what would be needed in a pandemic. With this in mind, health officials tried to persuade the incoming Trump administration to stock up on medical supplies, but it was never done.

As the pandemic rolled into the US, the country was taken off guard and many companies tried to optimize their resources to help. For instance, furniture manufacturers started producing masks and alcohol producers switched to making hand sanitizer. As a result of this short supply, Rear Adm. John Polowczyk was put in charge of Project Airbridge to obtain medical resources from foreign sources and distribute them to the US. This effort later devolved into a "free-for-all", as states rushed to quickly secure resources for themselves. However, Polowczyk asserts that there has been coordination and transparency in this process. Dan Reese, viewing this situation, offered to manufacture masks domestically, but wanted a deal that the government would continue to purchase masks even after the end of the pandemic. Many health officials went to the Trump administration and discussed with Trump about the medical supply issue. Trump insisted that all the supplies were there for the hospitals.

In an attempt to satisfy the high demand of medical supplies in the light of the pandemic, many called for the use of the Defense Production Act (DPA) to accelerate manufacturing inside

the United States. However, private companies like General Motors were already producing essential supplies even before the implementation of the DPA. Peter Navarro, who oversees the DPA, underscored the effectiveness in the government's use of the DPA. He also echoes the concerns of many others about the dangers of moving manufacturing of medical supplies outside the US. The DPA was used to produce more ventilators, with controversy over making a contract with Phillips again after their failure to meet the original contract for ventilators. Many felt that the Trump administration could have done more to respond to the pandemic, and felt that his administration should have invoked the Defense Production Act (DPA) earlier.

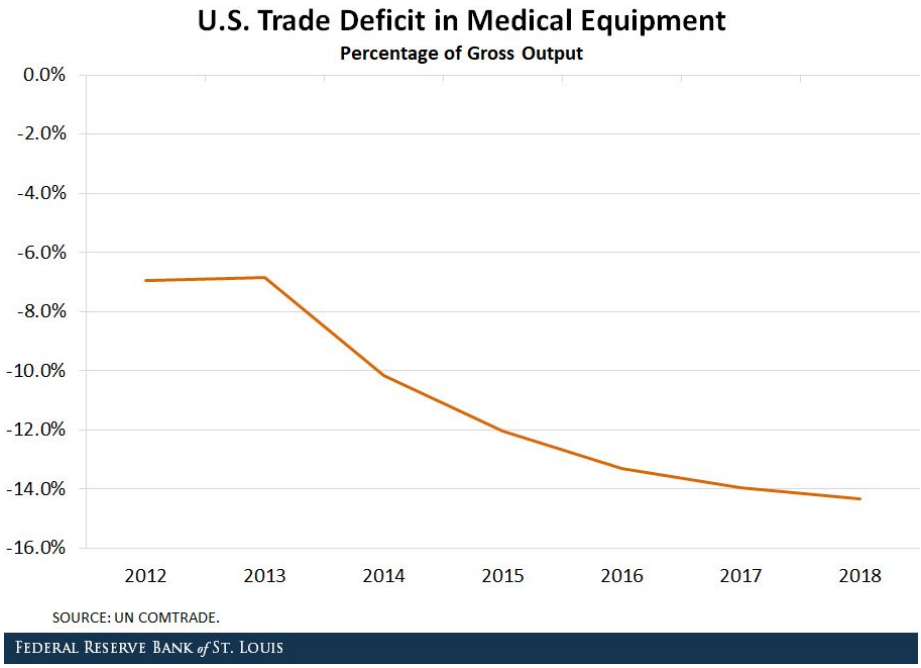
The supply lines connecting to hospitals are of importance too, alongside lines from other countries. Warehouses typically deliver supplies to hospitals on a "just in time" basis- in this way, the cost of storage and excess material is reduced. However, with a shortage in the supply lines to warehouses during the mandemic, many hospitals were left scrambling for materials. Group purchasing organizations (GPO) work with numerous hospitals in distributing supplies. Many argue that GPO keeps costs down, while others posit that they disrupt the supply chain and stifle competition. Despite this, GPOs failed to keep up with the increased demand during the pandemic. Michael Alkire, the president of Premiere (a GPO) said that some supply lines overseas were cut, making it difficult to get needed supplies during the pandemic. Thus, Premiere turned to Dan Reece's company to start a reliable domestic chain of N95 masks. However, masks manufactured in the US were still much more expensive than masks made in China, underlining the difficulty of moving supply lines to the US. The differences in price can be seen by using a *comparative bar chart* with two clearly defined populations- masks made in the US and masks made in China. This chart would allow the differences in mask prices to be easily seen. In order to support that masks made in the US are more expensive, mask prices

should have measures of central tendency (mean and median) consistently above the prices in China.

Politicians from various backgrounds recognize the importance of having medical supply lines inside the US, with Trump and Biden both making it a campaign goal. Looking into the near future, these supply lines being discussed need to sustain a continual demand for more equipment and the administering of a vaccine to millions of Americans. Determining where medical supplies are allocated, produced, and transported amidst a global pandemic is a complex issue.

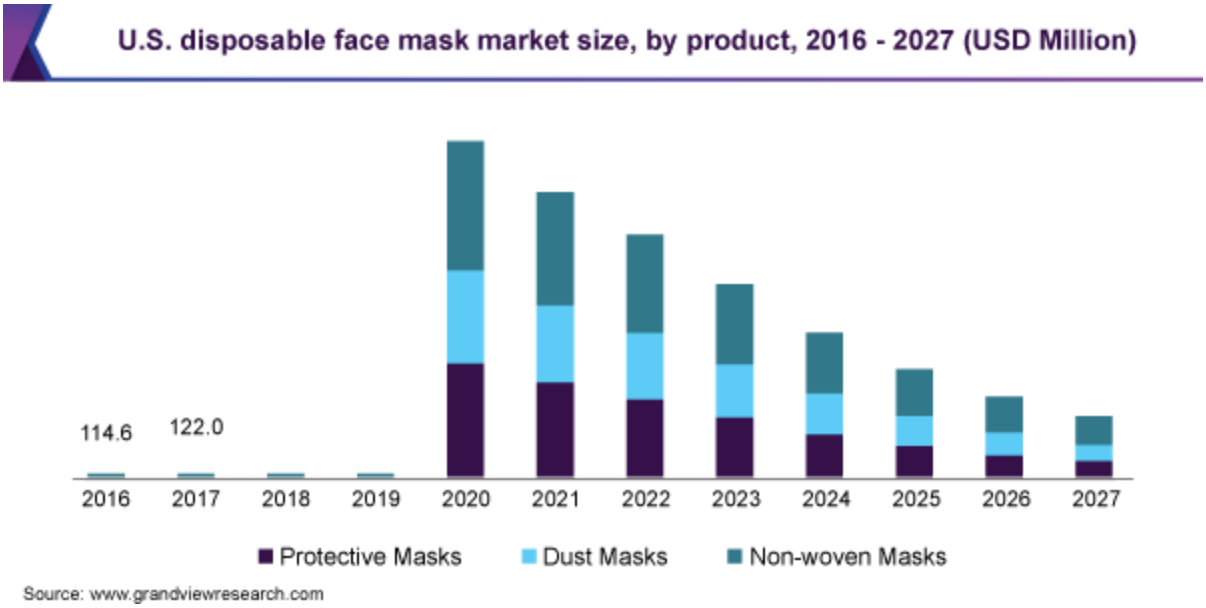
Additional Sources:

Additional sources that add to the discussion of the supply chain crisis include an article by the Federal Reserve Bank of St. Louis. This article highlights the increased reliance of the US on foreign countries for medical equipment exports. In their study, the cumulative levels for the import and export of 16 different essential medical supplies from the US were analyzed. Trade deficit was measured as the difference between exports and imports. The *time series plot* shown below displays the increasing trade deficit of the United States. Drawing appropriate context from this graph, it can be seen that in the years 2013-2018, the magnitude of the US trade deficit started to sharply increase. This means that the United States started importing increasing levels of goods from foreign countries, which displays its over-reliance on medical equipment exports. This fact can be disastrous during a pandemic, as many countries would want to prioritize giving medical equipment to their own population rather than exporting it to other countries. In fact, this is what happened when China stopped mask exports to the US for a brief period of time until they got their pandemic under more control as seen in the documentary.



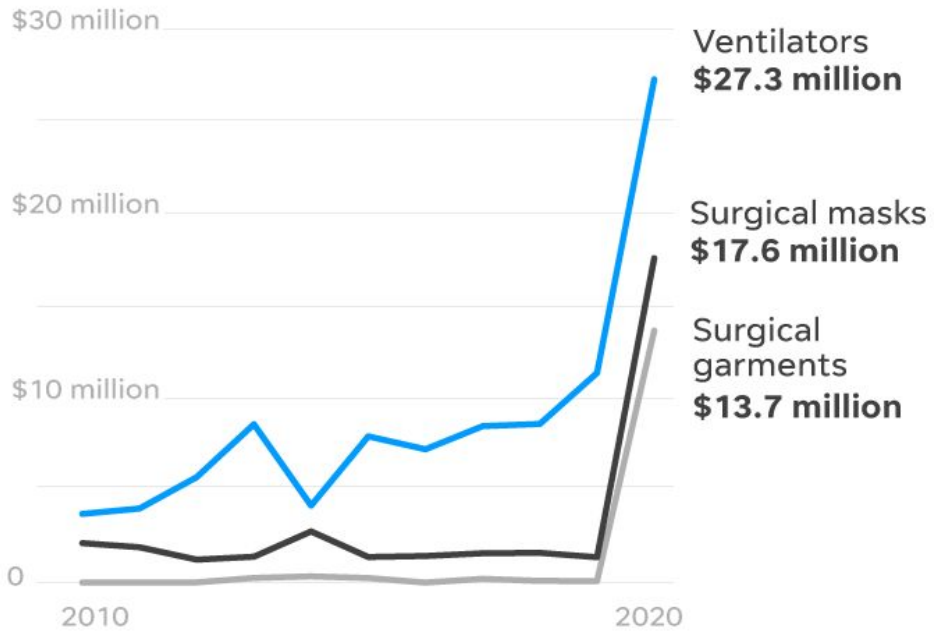
Even though this data was from 2012-2018, similar trends should be expected leading into 2020. The study rises to the conclusion that the US should bolster domestic production of medical supplies to ensure the stability of supply lines. This supports the argument of Peter Navarro and Rep. Michael Burgess in the documentary.

Another statistical source is a study by Grand View Research. The study investigates and extrapolates possible future trends in mask market size. It can be seen that due to the COVID-19 pandemic, the market size for disposable masks quickly skyrocketed. The display shown is a *segmented bar chart* containing information about protective, dust, and non-woven masks. From the graph, it can be seen that the relative market size of non woven masks is expected to increase. The segmented bar charts are situated on a time series plot, which makes it possible to view differences in market size across various years. Face mask market size has been projected to decrease overall in the years following 2020. This may be due to companies moving manufacturing to foreign countries because of cheaper prices.



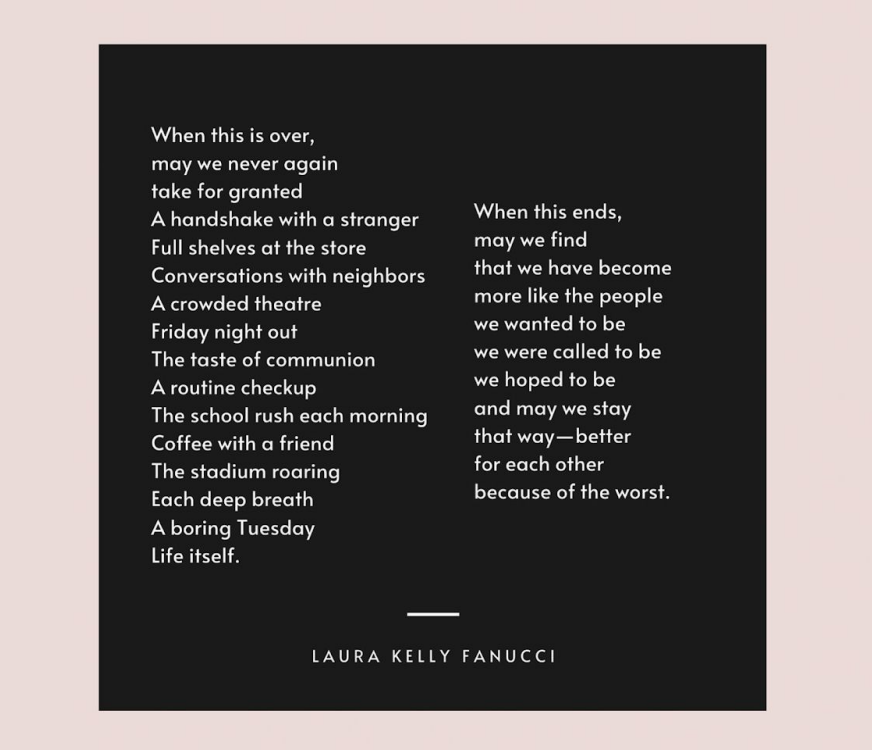
The study also includes a discussion about counterfeit masks, claiming that counterfeit masks decrease market growth for masks. This adds to the negative consequences of the counterfeit N95 mask issue presented in the documentary.

Third additional source was a USA Today article that investigated the amount of export of medical supplies to China at the beginning of the pandemic. Using data from the US Census Bureau, the time series plot below was produced, showing the exports (in millions of dollars) of 3 essential medical supplies to China in January and February from 2010-2020. From this plot, it can be seen that the US exported supplies far above previous years to China in the beginning of 2020. This could explain the shortage of PPE that was faced by healthcare workers as described in the *Frontline* documentary when the US was experiencing rapid growth of coronavirus cases.



In addition to the graph above, the article discusses the effects of trade restrictions and tariffs with foeirgn countries. Chad Brown of the Peterson Institute for International Economics claimed that tariffs had a negative impact on medical supply chains, saying “nearly $5 billion of U.S. imports of medical goods from China, about 26% of all medical goods imported from all countries.”. This adds to the issue of moving manufacturing abroad from the US and provides insight into the cost of trading internationally for medical supplies.

Creative media:



This poem provides a nostalgic and yearnful look at life before the pandemic, where we took much of what we had for granted: going to school, talking with friends, sports, etc. However, in this pandemic, we have to be more careful and cognizant over the things that did not seem like a big deal in the past. By properly socially distancing, wearing masks, and avoiding large gatherings, we not only protect ourselves from the virus, but we also mitigate the enormous stress that is placed on the US supply line. Because of these dire circumstances and being more conscious about the impact that we can have on the larger community, we can push ourselves to be better people for the sake of other people. When this pandemic is over, therefore, we would come out of it with an altered perspective on the world and ourselves, and aim to be better humans and be kinder towards each other.

Documentary Analysis and Evaluation:

This documentary informed the viewer about the topic of the supply chain crisis by having commentary and multiple interviews, giving the viewer many perspectives. Moreover, although the documentary proceeded at a somewhat fast pace, it made sure to give concise explanations over the multifaceted causes of the supply line crisis. The documentary had a variety of visuals, capturing relevant video shots of different settings. These visuals provided substance other than the interviews, in many times giving extra context to what was being described. For instance, when the nurse Sandy was being described, footage of a hospital flag at half mast and pictures of her memorial were shown, adding to the weight of the description. The sound and music throughout the documentary gave off an unsettling effect, which may have been intentional given the darkness of the situation.

Some strengths of the movie include sharp and concise explanations about the issue of the medical supply crisis. The interviews with many experts helped to deliver that point across with many voices on the topic. However, some weaknesses were that the documentary got too melancholy at times, with very little optimism over the whole situation. Moreover, at times, the documentary went a little too fast and it was slightly hard to follow some transitions.

Conclusion:

Overall, this Frontline documentary was well made and very informational. Multiple perspectives of issues pertaining to the supply line crisis in the United States were examined, with expert interviews throughout. Visuals and sound added to the perspectives, adding more substance and context to the information. Despite the quick pace and melancholic theme, this documentary still provided viewers with concise explanations over the topic and left us with a

heightened understanding over the multifactorial causes and varying effects of the medical supply line crisis during the coronavirus pandemic.

We give this documentary **4.5 stat stars out of 5** for delivering mostly succinct explanations and informing the audience well, but losing a few points for being too melancholy and feeling rushed at times.

Bonus- Multivariate Regression Analysis on Coronavirus Cases using Machine Learning:

Multivariate linear regression is a very powerful tool used in data science and in statistics for its predictive power. It involves predicting dependent variables by factoring numerous independent variables and optimizing a least-squares regression line (LSRL) to the data. As a quick bonus, Python will be used to train and optimize a least squares regression line to data involving confirmed cases of each country and several other independent variables, including world region, new cases, new deaths, etc. The dependent variable in this investigation is the confirmed number of cases in the country. The goal of this analysis is to optimize a least squares prediction line to predict coronavirus cases, given the various independent variables. Note that the dataset is around 5 months old, meaning that the values used in the dataset are outdated.

The dataset was loaded in by importing **pandas,** a machine learning library ideal for loading in datasets, or dataframes (which can be abbreviated as df). The dataset contained unnecessary data about Country and WHO Region (e.g Africa, Europe, etc). This data was taken out using the command **df.drop**. The dependent variable "Confirmed", representing confirmed coronavirus cases, was defined as "target" and dropped from the original dataframe. The column containing the independent variable "Deaths / 100 Recovered" had inf values, which was converted to NaN (not available) values using the command **df.replace**. These NaN values can be dealt in many ways; they can be taken out entirely, or they can be replaced with measures of

center, such as the mean or median. For this project, the NaN values were replaced with the mean of the "Deaths / 100 Recovered" column using the **df.fillna** command. After the data was cleaned, it was ready to be inputted into a linear regression algorithm, imported from sklearn. After the algorithm was trained, it optimized the best parameters for multivariate linear regression following the equation $\hat{y} = B0 + B1(x1) + B2(x2)...$, where B0 represents the y-intercept, and B1 represents the coefficient of the independent variable x1, and so on. These are the independent variables for this project: Deaths, Recovered, Active, New cases, New Deaths, New Recovered, Deaths / 100 cases, Recovered / 100 cases, Deaths / 100 Recovered, Confirmed Last Week, 1 week change, and 1 week % increase. The picture below displays the calculated coefficients for the independent variables above, respectively.

```
In [145]: model.coef_
Out[145]: array([ 4.00000000e-01,  4.00000000e-01,  4.00000000e-01,  7.59461938e-15,
                 -4.93428459e-13,  4.20323498e-14,  1.64279875e-12,  9.45171652e-13,
                  1.13570720e-14,  6.00000000e-01,  6.00000000e-01,  1.24437377e-14])
```

The picture below displays the y-intercept of the least-squares regression line.

```
In [146]: model.intercept_
Out[146]: 4.3655745685100555e-11
```

Notice how some of the coefficients and the y-intercept are basically negligible and are close to 0 in the LSRL line (they have extremely low values, such as 4.365 x 10 ^-11 for the y-intercept). Thus, the overall equation for the least squares regression line can be written as:

$\hat{y}$ = 4.3656 x 10 ^-11 + 0.4 (Deaths) + 0.4(Recovered) + 0.4 (Active) + 7.5946x10^-15 (New Cases) -4.9343 x 10^-13 (New Deaths) + 4.2032 x 10^-14 (New Recovered) + 1.6428 x 10^-12 (Deaths / 100 cases) + 9.4517x10^-13 (Recovered / 100 cases) + 1.1357 x 10^-14 (Deaths / 100 Recovered) + 0.6 (Confirmed Last Week) + 0.6 (1 week change) + 1.2444 x 10^-14 (1 week %

increase). Since this data was taken from 5 months back, the regression line would change if today's data was fed.

Using this regression line, predictions can be made by inputting data for the independent variables. A sample prediction is shown below.

```
In [149]: model.predict([[1500, 30000, 10000, 120, 20, 30, 2.5, 70, 6, 40000, 600, 3]])
          #Predicted cases with 1500 deaths, 30000 recovered, 10000 active, 120 new cases, 20 new deaths, 30 new recovered,
          #2.5 deaths / 100 cases, 70 recovered / 100 cases, 6 deaths / 100 recovered, 40000 confirmed last week, 600 1-week change,
          #and 3 1-week percentage increase.

Out[149]: array([40960.])
```

The power of machine learning and regression analysis can be displayed here, as it becomes possible to form predictions taken from available data. Although the regression line is outdated, since the data was obtained from 5 months ago, a similar regression line could be constructed given today's available data. The possibilities are endless- for instance, data on cities or counties can be used to predict coronavirus cases, which can later be used to better allocate funds or resources to counties most in need. Better allocation of resources could help alleviate some stresses on the limited supply lines in the US. Coronavirus growth rates could possibly be extrapolated and be used to form forecasts of coronavirus deaths or cases in the future, given good data. As such, machine learning techniques such as regression can be used for the better and have the potential to save lives. For more information, the machine learning code has been posted below the bibliography section.

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Surgical Masks Market Size, Share & Trends Analysis Report By Product (Basic, Fluid/Splash Resistant), By Distribution Channel (Online, Offline), By Region, And Segment

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Machine Learning Code

```
import pandas as pd

df = pd.read_csv("covid")

list(df.columns)

target = df.Confirmed

df.drop(['Country/Region', 'Confirmed', 'WHO Region'], axis = 1, inplace = True)

df

target

pd.set_option('mode.use_inf_as_na', True)

pd.set_option("display.max_rows", None, "display.max_columns", None)

df['Deaths / 100 Recovered'].fillna(df['Deaths / 100 Recovered'].mean(), inplace = True)

df

from sklearn.linear_model import LinearRegression

model = LinearRegression()

model.fit(df, target)

model.coef_

model.intercept_

model.predict([[1500, 30000, 10000, 120, 20, 30, 2.5, 70, 6, 40000, 600, 3]])

#Predicted cases with 1500 deaths, 30000 recovered, 10000 active, 120 new cases, 20 new

deaths, 30 new recovered,

#2.5 deaths / 100 cases, 70 recovered / 100 cases, 6 deaths / 100 recovered, 40000 confirmed last

week, 600 1-week change,

#and 3 1-week percentage increase.
```