COVID-19 Predictions in India

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Business Problem

COVID-19 outbreaks don’t only impact lives of people but disrupts economy and healthcare infrastructure of the county. So, it is important to study the pandemic and predict potential future infectious disease outbreaks. A comprehensive understanding of the spread and past count of cases will help in predicting recent future and enable administration by giving a heads-up to stay alert and can provide sufficient time to facilitate support interventions.

Keywords: Covid-19, Predictions

Background/History

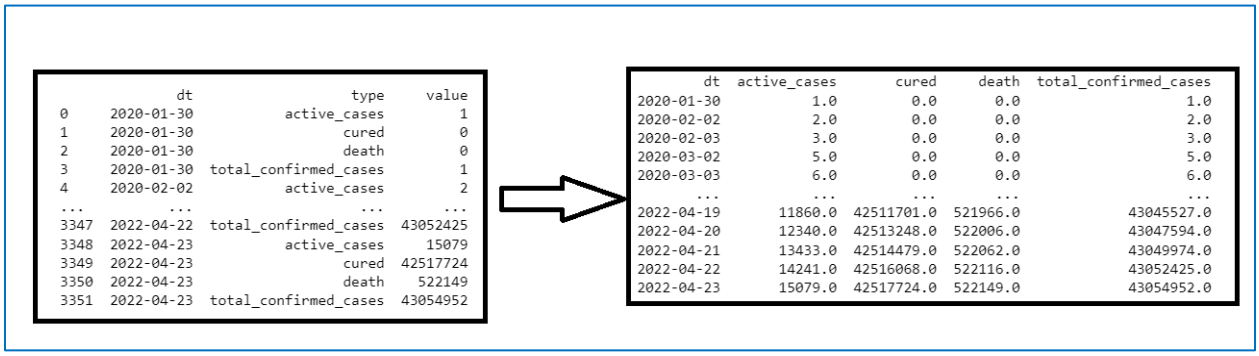
India has seen an increase in COVID-19 case again during the start of year 2022. A simple google search can tell us that on April 4th 2022, there were only 795 new cases, on Apr 14th 2022 there were 949 and in last week count of new cases have been on constant rise and going above 2000 per day now. This trend shows the cases have been rising. As per Ministry of Health and Family Welfare Government of India (https://www.mohfw.gov.in/) there had already been more than half a million documented deaths due to COVID and active cases are on rise. Government of India has also issued new guidelines and restrictions. Referring to the below google graph, we can see that COVID spread had increased in India during the summer months in last 2 years. So, the concerning questions that we have are, are we going to have another wave of COVID? If so, then how severe it can be? When will we see the peak? How long did the previous waves last? What was the trend in death toll every day? What was the cured trend?

Why it is important to solve this problem?

Here are some of the reasons why it is very important and useful to predict COVID-19 trends. It saves lives by keeping the numbers low. Reduces impact on country's economics. International Monetary Fund (IMF) estimated that median global GDP dropped by 3.9% from 2019 to 2020, making it the worst economic downturn since great depression. Advance predictions will allow healthcare sector to be prepared for drastic rise in cases. Predictions can help in determining type (partial or complete) and timeline of lockdowns, if required. Help supply chain in managing and distribution by providing estimates on demand of products such as PPE, ventilators, sanitizer, etc

Data Explanation

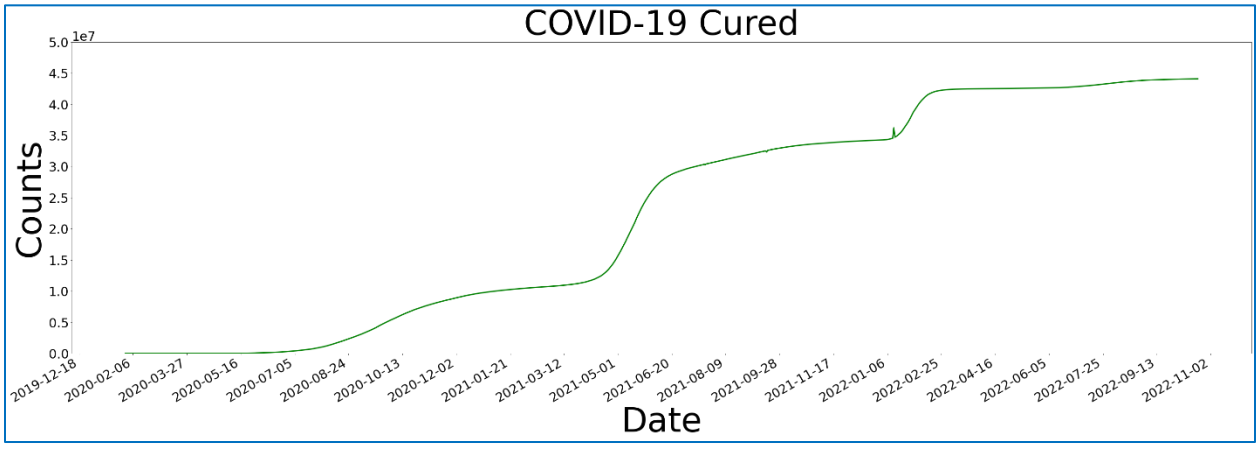
COVID-19 Data is collected mainly from **Datameet** website and Ministry of Health and Family Welfare Government of India website. For data cleaning, Keys and values were read separately from JSON dataset and then combined into a dataframe. At this point, dataframe has multiple lines for each date, one row for each type(active cases, deaths, cured, total confirmed cases). This need dataframe to be pivoted on date field to convert types to individual columns as shown below.

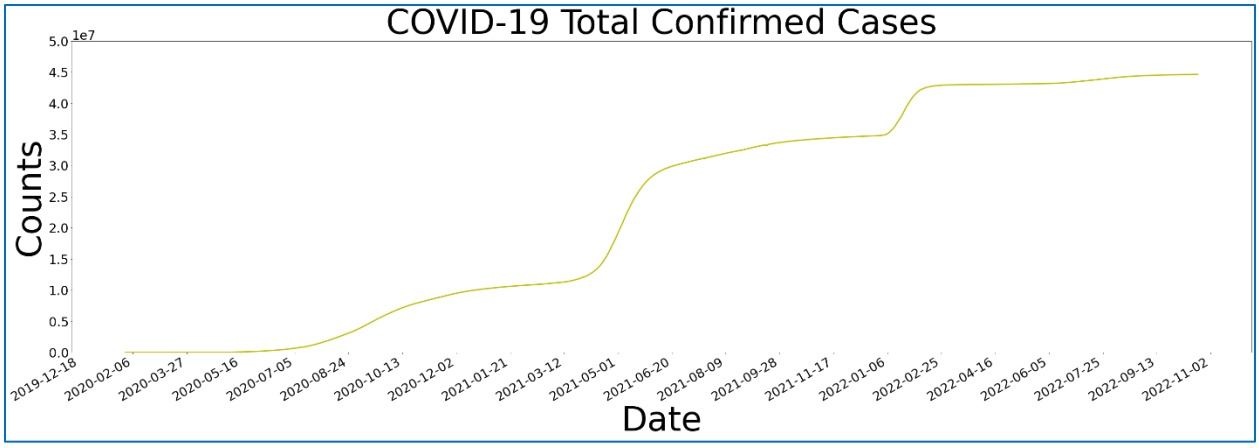


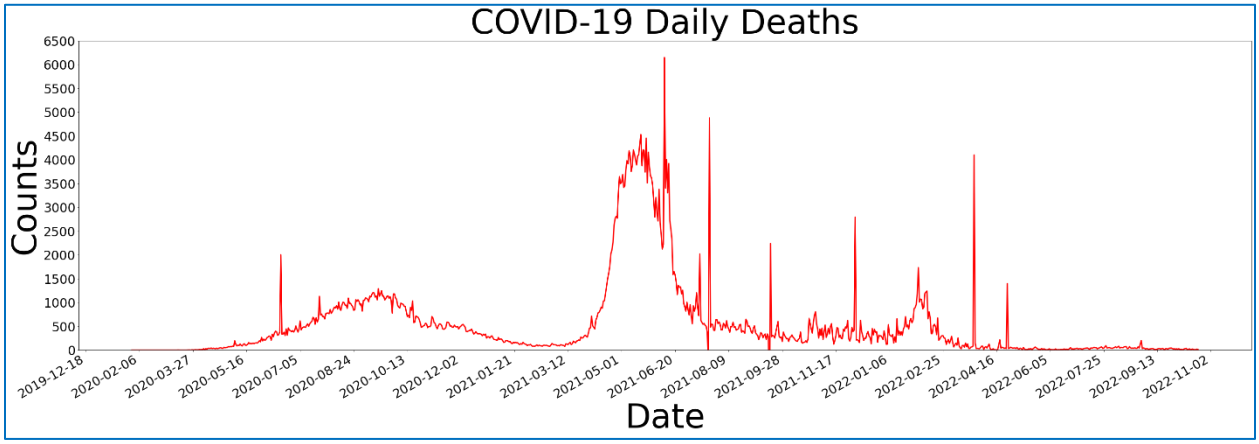
	dt	type	value
0	2020-01-30	active_cases	1
1	2020-01-30	cured	0
2	2020-01-30	death	0
3	2020-01-30	total_confirmed_cases	1
4	2020-02-02	active_cases	2
...	...	...	...
3347	2022-04-22	total_confirmed_cases	43052425
3348	2022-04-23	active_cases	15079
3349	2022-04-23	cured	42517724
3350	2022-04-23	death	522149
3351	2022-04-23	total_confirmed_cases	43054952

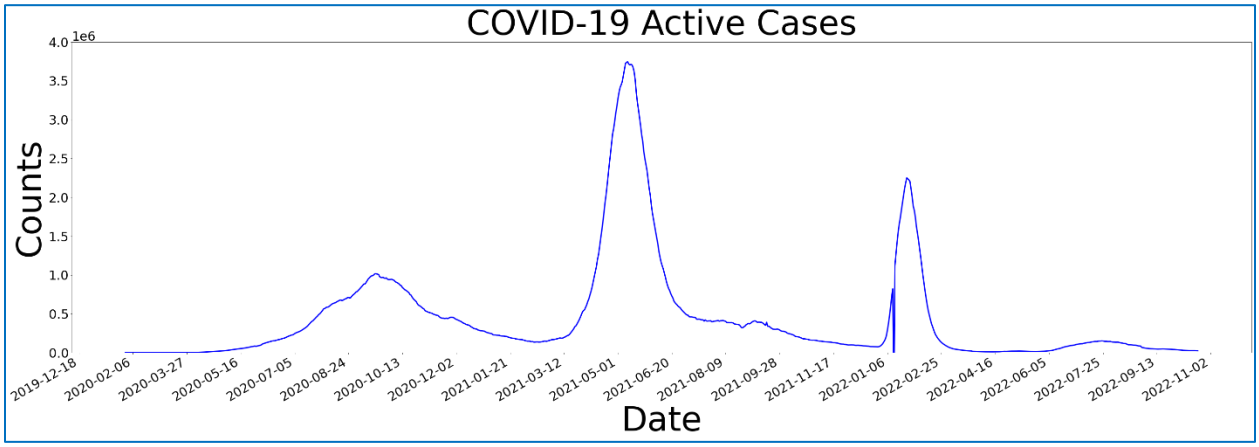
dt	active_cases	cured	death	total_confirmed_cases
2020-01-30	1.0	0.0	0.0	1.0
2020-02-02	2.0	0.0	0.0	2.0
2020-02-03	3.0	0.0	0.0	3.0
2020-03-02	5.0	0.0	0.0	5.0
2020-03-03	6.0	0.0	0.0	6.0
...	...	...	...	...
2022-04-19	11860.0	42511701.0	521966.0	43045527.0
2022-04-20	12340.0	42513248.0	522006.0	43047594.0
2022-04-21	13433.0	42514479.0	522062.0	43049974.0
2022-04-22	14241.0	42516068.0	522116.0	43052425.0
2022-04-23	15079.0	42517724.0	522149.0	43054952.0

Univariate Time Series: Each variable was plotted in time-series to study the trend.









Data Preparation

Joined case dataset with vaccine data(mohfw_vaccination_status.json) to get additional information. Dropped features not useful for analysis. Transformed features such as report_date

and used it as key to join case dataset with vaccine dataset. Dropped records with invalid values such as counts cannot be negative. Used imputer to fill in NANs with mean. Used MinMaxScaler() to rescale each column. Filled missing data with mode of respective column.

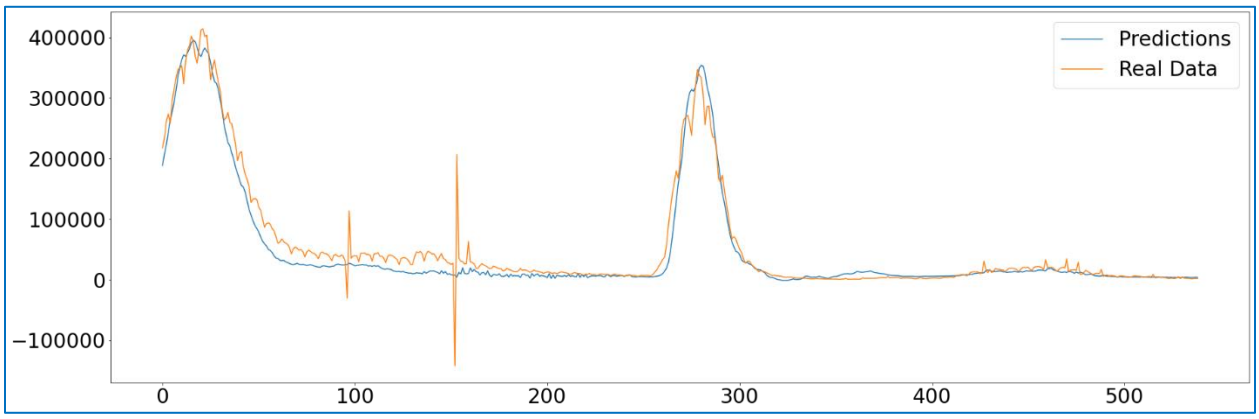
Method and Analysis: Model building and evaluation

Model Used: Long short-term memory (LSTM). It is an artificial neural network used in the fields of artificial intelligence and deep learning. I have used sequential model from tensorflow.keras package. Added a long short-term memory layer with 100 memory units. Used rectified linear activation function (RELU) which will output the input directly if it is positive, otherwise, it will output zero. Used 20% dropout. Compiled the model with adam optimizer. Data Fitting used EarlyStopping class from keras callbacks. This enables model to stop training when a metric has stopped improving.

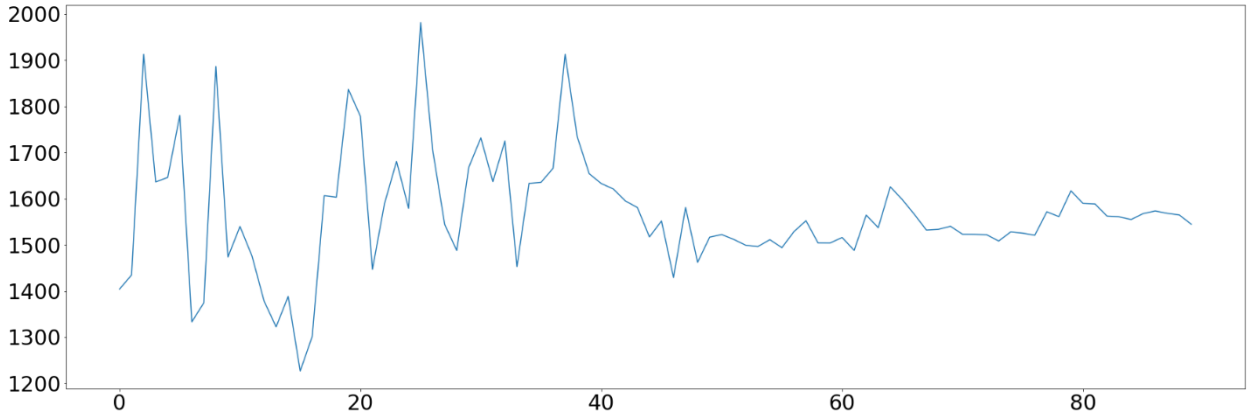
```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
lstm (LSTM)                  (None, 100)               76400
_________________________________________________________________
dropout (Dropout)            (None, 100)               0
_________________________________________________________________
dense (Dense)                (None, 100)               10100
_________________________________________________________________
dropout_1 (Dropout)          (None, 100)               0
_________________________________________________________________
dense_1 (Dense)              (None, 90)                9090
_________________________________________________________________
dropout_2 (Dropout)          (None, 90)                0
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 91
=================================================================
Total params: 95,681
Trainable params: 95,681
Non-trainable params: 0
_________________________________________________________________
```

Conclusion

Below plot clearly shows that our model is pretty accurate and predictions are mostly matching real values except at certain spikes in real data which I am going to ignore as outliers.



Below is the prediction of future 90 days as per our model.



As a conclusion, model answers all the questions and provided 90 days of predictions.

Question and Answers

1. Are we going to have a next wave of COVID?
   Yes, there could be mild wave as per our model.

2. If so, then how severe it can be?
   Although our model predicts the next wave in 90 days but it is not going to be as severe as previous waves. Maximum daily case counts are only going to be 2000 at peak.

3. When will we see the peak?
   As per our model, we can see the peak around 22nd days i.e. in the end of Feb 2023.

4. How long the wave will last?
   Wave is going to last around 30-40 days and starts flat lining after that.

Assumptions

One of the assumption is a uniform mixing of the infected and vulnerable populations along with the assumption that the total population is constant in time. Another assumption is that there was no biasing during data collection and mentioned website reflect actual data.

Recommendations

Case estimations are purely on past data, future numbers depend on lot of factors such as restrictions (mask mandate, social distancing, etc.) and vaccine dosage and boosters. Those factors can affect the numbers. Model considered only first vaccine dose and based on that we can recommend encouraging public to take vaccine and booster shots whichever is applicable.

Challenges/New Opportunities

Model can be enhanced in future predictions considering factors like subsequent vaccine dosage, Enforced Restrictions and guideline such as mask mandates, lock downs, number of people allows in public transportation such as buses and trains, weather conditions such as summer or winter counts.

Implementation Plan

Plan to start with data collection by reading data from both the websites. Followed by data cleaning step as explained in data explanation step above. Next step would be to prepare data by handing NaNs, dropping unnecessary features, transforming and joining wherever required. At this stage data would be ready to build and evaluate the model. Final stage would be conclude the findings.

Ethical Considerations

Uneasiness around the sudden loss of personal liberties that had been taken for granted by citizens in many countries. Regulation and protocols must be in place to avoid panic and frustration in public. Privacy is at risk with digital surveillance like tracing apps and enforcing people to report covid results. Personal biasing due to scare of COVID or otherwise. Personal biasing during the analysis can influence the result drawn from analysis.

References

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- Datameet Covid 19 (2022, Oct 21) Github. https://github.com/datameet/covid19/tree/master/data
- Covid 19 Positivity Rate (2023, Jan 27) MOHFW. https://www.mohfw.gov.in/