

## Efficient and Short-Range Forecasting Model for COVID-19 Time Series Parameters - Daily Confirmed Cases, Deaths, Recoveries

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### Abstract

Coronavirus cases maintain to sore up to 16.2 Million worldwide. Human beings globally had been pronounced to be intensified by the virus as almost 6.5 Lakh human beings have misplaced their lives. Researchers throughout the arena are making attempts to forecast the movement of this pandemic, using Artificial Intelligence (AI). In this paper, we are using Prophet Model to forecast the daily number of new cases, new deaths, and new recoveries that would be brought about by COVID-19 in India. A dataset of 179 (30 January 2020 to 24 July 2020) days is used for training the proposed model, and we forecasted values for the next 15 days, i.e. till 08 August 2020. The forecasted data obtained by the proposed method is accurate within a certain range and will be very beneficial in promoting the understanding of the spreading pattern of COVID-19 across the nation.

### Keywords

COVID-19, India, Prophet, Machine Learning, Forecasting

### I. Introduction

COVID-19 is highly infectious and it shows the impact on the respiratory system of the body, and it is caused due to a virus named coronavirus-2. The primary medium is droplets from our mouths, which use air to travel. Fever, tiredness, and dry cough are the most common symptoms identified in a COVID-19 infected person. Alongside these side effects, a patient additionally encounters breathing issues, general aches, and sore throat. Not many individuals have encountered diarrhea, queasiness, or a runny nose. People having high fever, consistent cough, or inconvenience in breathing should search for clinical help immediately. Human to human transmission is exponentially expanding the tallies of the contaminated individuals. The incubation period of COVID-19 is 1-14 days or considerably more [1]. At the point when the COVID-19 began to spread at a remarkable rate; preventive measures were worked out. These measures incorporated a total lockdown of the vigorously contaminated zones, prohibition on global travels, suspending schools, and other unimportant everyday exercises. The primary points of these measures were to confine relational contact, thinking about the infectious idea of the disease. As the incubation time of the infection is longer than different infections it is hard to break down the ideal time required watching a time limit. On the off chance that the time limit is lifted too early, the circumstance can get more dangerous. The individuals who get attacked by COVID-19 fall under three classifications. First in the class are the older, who are exceptionally susceptible to the infection. Measurements show that due to the feeble insusceptible framework the older surrender to the infection without any problem. The subsequent class is that of the youngsters. As the invulnerable frameworks of little youngsters are as yet being worked on, the kids are at higher hazard. The third order is that of the people who already have

medical conditions like diabetes, high BP, asthma, dangerous development, cardiovascular affliction, etc. As their safe frameworks have been undermined effectively because of a common ailment, these individuals become obvious objectives. Contaminations experienced by the third classification of individuals can be lethal [2]. Public health authorities express the most ideal approach to prevent this sickness is to abstain from being exposed to this infection. Following practices are suggested by CDC (Centers for Disease Control and Prevention) to help shield yourself and others from the spread of COVID-19; Wash your hands multiple times, avoid close contact, Cover your mouth and nose, Cover your coughs and sneezes, Clean and purify now and again contacted surfaces day by day [1,2]. The half-year anniversary of the episode corresponds with arriving at 10 million cases and 500,000 deaths, WHO's Director-General's introductory statement while addressing the media about COVID-19 on 29 June 2020. WHO released a readable timeline of WHO's reaction to the pandemic on its site [3].

#### **i. The Shot of Hope - Vaccine**

We won't come back to anything moving toward ordinary - such is, reality without maintaining social distance, isolated quarantines, face covers, schools, and workplace terminations, and other control measures - until the vast majority of the world has been vaccinated against this infection. Another innovation being developed - RNA immunizations - holds the possibility to disturb the whole way to deal with antibody advancement. Before an immunization is prepared for open use, analysts must demonstrate to government controllers that it is both compelling and safe to utilize. That requires significant investment in time. There are more than 150 vaccine developers who are in work to battle the coronavirus in the various phases of trials over the world. Three COVID-19 vaccine developers reached the last phase of the trial, at present [4]. The vaccination prototype created by the University of Oxford alongside pharmaceutical organization AstraZeneca is the most encouraging among the three developers. Another immunization made by Chinese pharmaceutical firm Sinovac Biotech has entered the last period of testing. Moderna Inc's COVID-19 antibody has also likewise arrived at conclusive stages [4]. Particularly, the world cheered when information from Oxford University-British Swedish firm AstraZeneca's stage I/II investigation of their novel COVID-19 antibody was discharged. While the antibody is as yet experiencing stage III of its preliminaries, primer outcomes from the observatory information affirmed that the immunization evokes a solid safe reaction in the host bodies and gave empowering results. WHO, in its most recent preparation commended the move yet said that it despite everything is not looking realistic to have an antibody conveyed before early long periods of 2021 [5].

#### **ii. Timeline of COVID-19 in India**

On January 30<sup>th</sup>, 2020, the principal case was affirmed in Kerala's Thrissur region in an understudy who had to get back for a holiday from Wuhan University in China [6]. In under a half year, the COVID-19 flare-up in India has spread to all states and association domains, tainting more than 10 lakh individuals. By 24 July 2020 09:54 AM IST, refreshed information indicated that the full-scale number of COVID-19 cases in India is at 12,87,945 where, 4,40,135 are dynamic cases while 8,17,208 individuals have recovered from the infection [7, 17]. Figure 1 shows the timeline from 30 January 2020 to 24 July 2020, some of the crucial moments of this COVID-19 outbreak in India. Social distancing as a method of keeping the virus at bay was first officially flagged by the Prime Minister of India when he spoke to the nation on March 19 to call for a one-day 'Janata Curfew' for March 22. The Indian Government, submitting a general direction to other significant economies, had chosen to force an across the country lockdown to contain the profoundly infectious infection from March 25, considered as the principal national regulation measure. Prime Minister of India forced the nation over 21 days lockdown on 24 March 2020, to protect the huge population of the nation from COVID-19 [8,9]. This lockdown was put when there are 500 confirmed cases in the country [10]. Analysts communicated that the lockdown had moved back the improvement pace of the pandemic by 6 April to a pace of multiplying like clockwork and by 18 April, to a pace of multiplying at regular intervals [11]. The coronavirus-actuated lockdown prompted uprooting of a huge number of transients, work losses, and economy winding up in a sorry situation level [13].

On the positive front, the lockdown urged India to act naturally dependent were, different state governments, Center, NGOs, corporates, and people adapted to the situation to take care of the hungry and help the down and out [10,12,16].



Figure 1 - 2020 timeline of covid-19 in India (till 24 July 2020) [14,15]

## 2. Visualization and Forecasting using Facebook Prophet

There are many areas where AI is contributing by standing aside of the human race, to fight against the COVID-19 pandemic [18,19,20], few are; providing early warnings and alerts, enabling tracking and prediction, facilitating interactive data dashboards, etc. Our emphasis is on AI that can foresee the spread of COVID-19 illness over time and space [21,22]. It is critical to ensure that, there is appropriate accessibility of information in legitimate amounts, to make a decent model [25]. Because of an absence of information, AI estimates won't look precise or solid.

The proposed work is modeled with Facebook's 'Prophet' Platform. The prophet is an open-source library distributed by Facebook that depends on decomposable models. It gives us the capacity to make time arrangement expectations with great exactness utilizing basic instinctive boundaries and has support for including the effect of custom irregularity. At the point when an estimating model doesn't run as arranged, we need to have the option to tune the boundaries of the strategy concerning the particular issue close by [23,24]. Tuning these techniques requires an intensive comprehension of how the hidden time arrangement models work typically an examiner won't realize how to alter these requests to dodge the behavior and this is the kind of skill that is difficult to obtain and scale. The Prophet bundle gives natural boundaries that are anything but difficult to tune. Indeed, even somebody who has fewer skills in anticipating models can utilize this to make significant predictions for a variety of issues in a business situation.

The contribution to Prophet is consistently a data frame with two sections: ds and y. The ds (datestamp) segment ought to be of an organization expected by Pandas. The y section must be numeric and speaks to the estimation we wish to conjecture. Accordingly, our dataset contains the

DATE column and NEW\_CASES, NEW\_RECOVERIES, and NEW\_DEATHS columns. At a time we consider the DATE column as ds and anyone of the other three columns as y.

Our investigation depended on the freely accessible information of the day-wise positive cases, recoveries, and deaths in India from January 30 to July 24, 2020, available from <https://covid.ourworldindata.org/data/owid-covid-data.xlsx>, <https://data.humdata.org/dataset/novel-coronavirus-2019-ncov-cases>. Our dataset contains 4 columns and 179 rows, where we take two columns at a time, with the DATE column as mandatory. Figure 2 shows the plot drawn from our dataset, using Matplotlib plotting library, which is showing the daily number of new cases, new recoveries & new deaths.

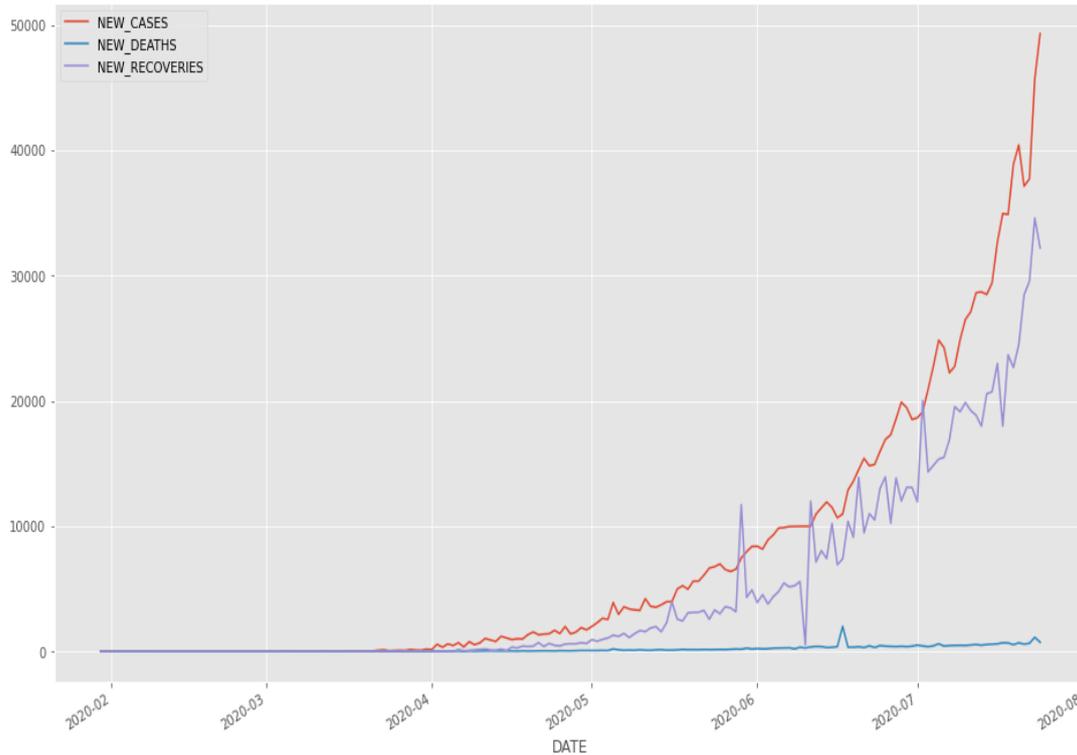


Figure 2 - Day-wise confirmed cases, recoveries & deaths in India from January 30 to July 24 2020

**i. Forecasting daily recorded new cases, new recoveries, and new deaths**

**a. Forecasting daily new cases**

Figure 3 visualizes the NEW\_CASES column from the dataset on the x-axis and the DATE column on the y axis. The data represented here is from 30 January to 24 July 2020. And the forecasted results are represented in Figure 4, where the black dots are the actual data from the dataset and the blue color line is the predicted data, through which we can also verify the model validation. The blue shade which is on both sides of the forecast line is the upper and lower forecast threshold. Exclusively in Table 1 the forecasted values are mentioned with both  $\hat{y}_{upper}$  (upper forecast threshold) and  $\hat{y}_{lower}$  (lower forecast threshold). Finally Figure 5 shows the increasing and weekday related trends observed in overall data, i.e. from 30 January 2020 to 08 August 2020.

Similarly, Figure 6, Figure 7, Table 2 & Figure 8, represents the Visualizations, Forecasts & Trends regarding the NEW\_RECOVERIES column of the dataset, and Figure 9, Figure 10, Table 3 & Figure 11 is all about the NEW\_DEATHS column of the dataset.

DAYWISE NEW CASES IN INDIA (Jan 30 to July 24, 2020)

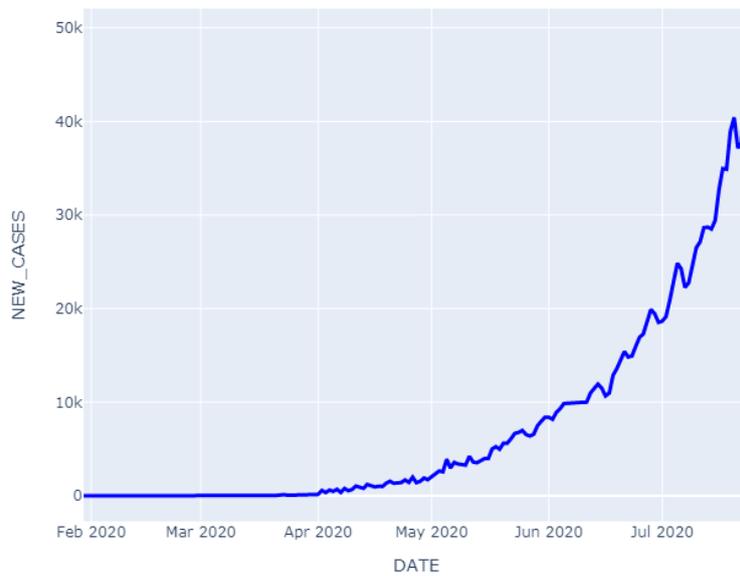


Figure 3 - Day-wise confirmed cases from 30 January to 24 July 2020

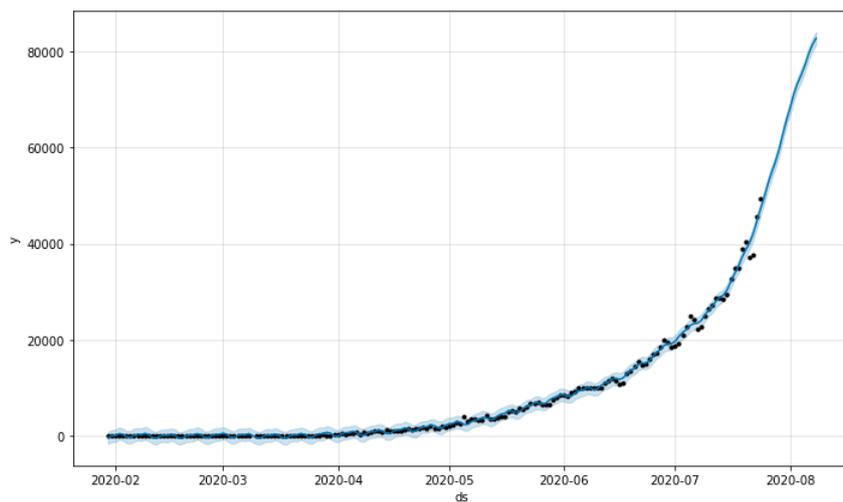


Figure 4 - Day-wise confirmed cases from 30 January to 08 August 2020 | forecasted from 25 July to 08 August 2020

In the below-mentioned table, column one represents the future dates for which the cases are forecasted and yhat is the predicted value and yhat\_lower is the lower threshold forecast value and yhat\_upper is the upper threshold forecast value.

Table 1 - Forecasted values in figure 4 with upper and lower threshold

DATE	yhat	yhat_lower	yhat_upper
25-07-2020	49571	48229	50918
26-07-2020	52387	51060	53657
27-07-2020	54788	53483	56121
28-07-2020	56906	55602	58248
29-07-2020	59519	58202	60695
30-07-2020	62695	61360	64065

31-07-2020	65630	64365	66981
01-08-2020	68249	67013	69505
02-08-2020	71102	69708	72369
03-08-2020	73344	72054	74580
04-08-2020	75093	73704	76448
05-08-2020	77118	75812	78346
06-08-2020	79482	78223	80712
07-08-2020	81379	80122	82715
08-08-2020	82738	81424	84111

As a matter of course Prophet will return vulnerability stretches (yhat\_lower, yhat\_upper) for the gauge yhat. There are a few significant suspicions behind these vulnerability stretches. There are three wellsprings of vulnerability in the gauge: vulnerability in the pattern, vulnerability in the irregularity gauges, and extra perception commotion.

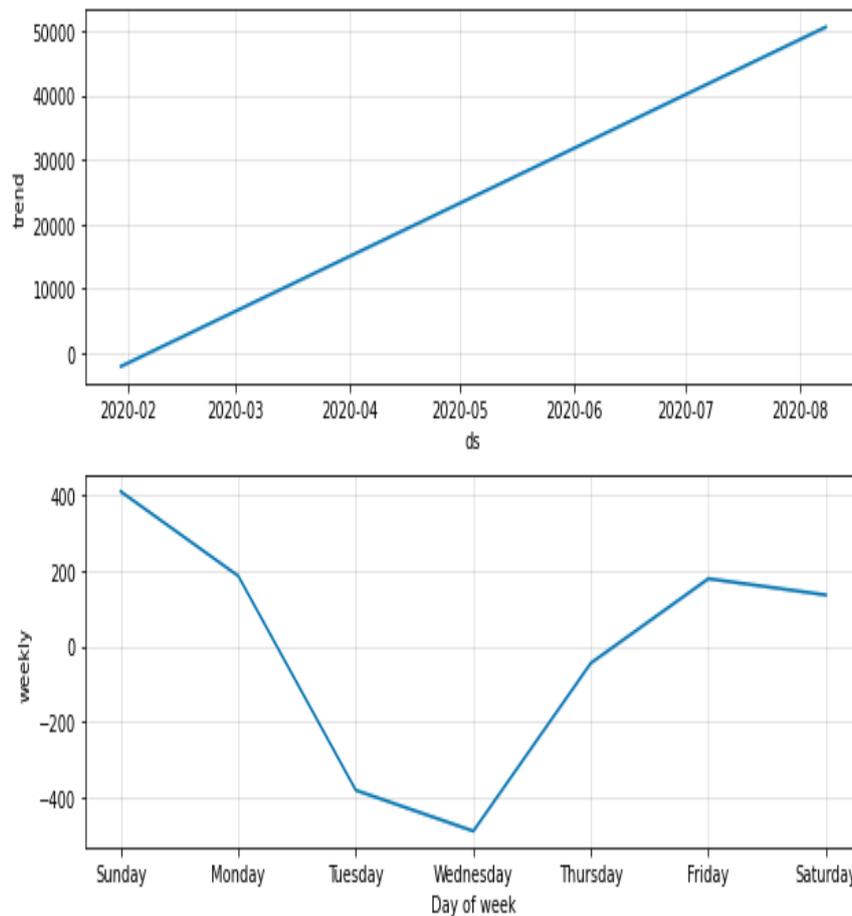


Figure 5 - Trends observed in day-wise confirmed cases from 30 January to 08 August 2020

The trend in Figure 5 clearly shows the increasing pattern of new cases, in the future and we can also understand that the cases rise is more likely to happen on Sunday, comparing to other weekdays.

**b. Forecasting daily new recoveries**

DAYWISE NEW RECOVERIES IN INDIA



Figure 6 - Day-wise recovered cases from 30 January to 24 July 2020

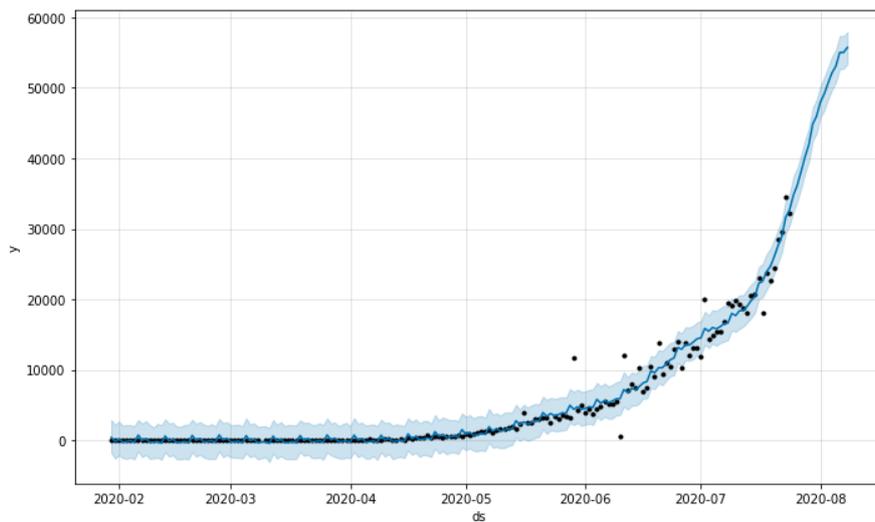


Figure 7 - Day-wise recovered cases from 30 January to 08 August 2020 | forecasted from 25 July to 08 August 2020

Table 2 - Forecasted values in figure 7 with an upper and lower threshold

DATE	yhat	yhat_lower	yhat_upper
25-07-2020	34789	32441	37483
26-07-2020	36205	33912	38632
27-07-2020	38162	35773	40555
28-07-2020	40218	37912	42575
29-07-2020	41943	39526	44297
30-07-2020	44863	42524	47202
31-07-2020	46008	43559	48350
01-08-2020	48001	45853	50319

02-08-2020	49166	46837	51523
03-08-2020	50694	48416	52974
04-08-2020	52139	49724	54441
05-08-2020	53073	50806	55408
06-08-2020	55024	52667	57389
07-08-2020	55032	52730	57374
08-08-2020	55730	53395	57932

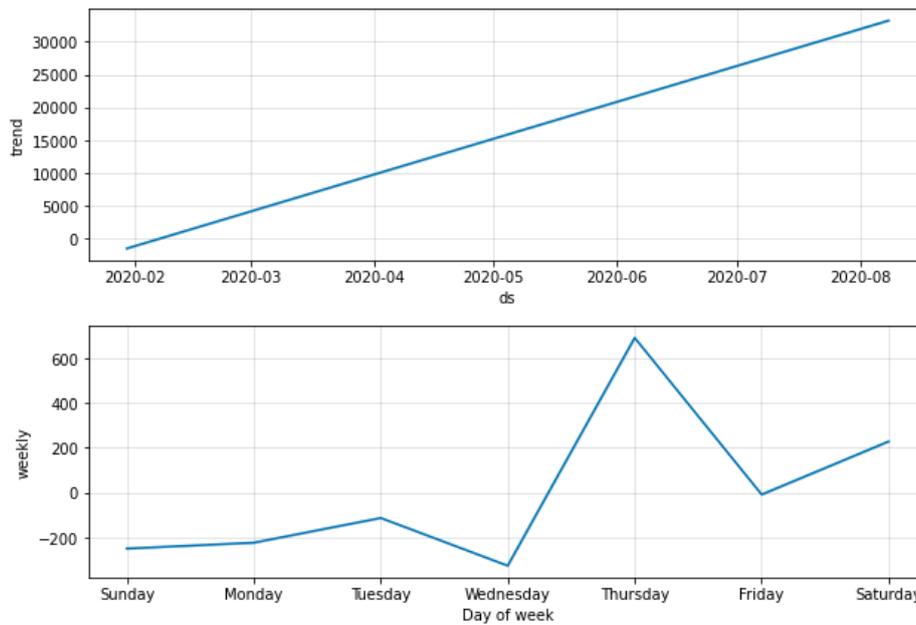


Figure 8 - Trends observed in day-wise recovered cases from 30 January to 08 August 2020

**c. Forecasting daily new deaths**

DAYWISE NEW DEATHS IN INDIA

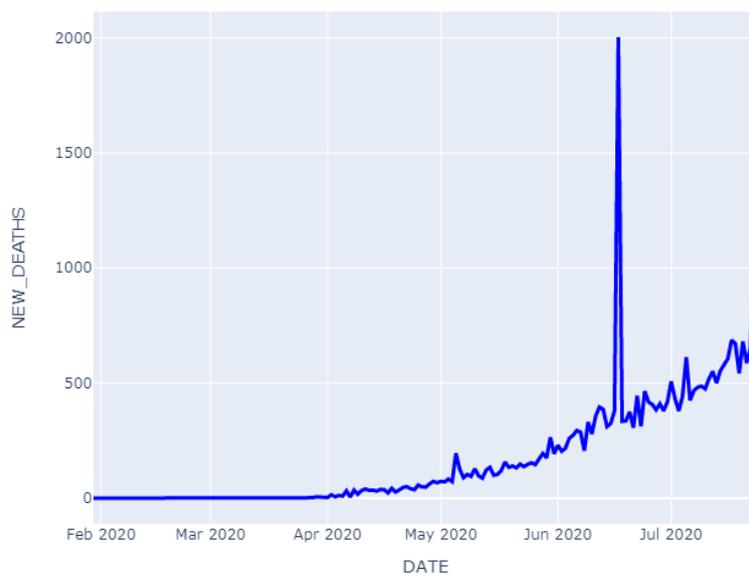


Figure 9 - Day-wise death cases from 30 January to 24 July 2020

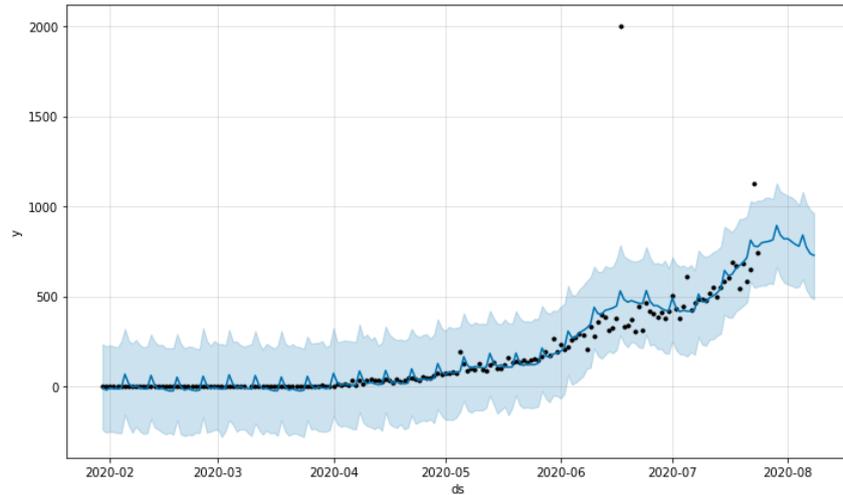


Figure 10 - Day-wise death cases from 30 January to 08 August 2020 | forecasted from 25 July to 08 August 2020

### 3. Observations

In Figure 7 and Figure 10, we can see that the original values are out of the forecast range, these are called outliers [26]. An outlier is an information point that falls outside of the normal scope of the information for example anomaly can either be excessively high or excessively low contrasted with other information focuses on the information arrangement. In the dataset the observed outliers are at 2020-06-17 there observed 2003 deaths and again at 2020-07-23 there observed 1129 deaths, so these are higher than the other values in the dataset. In most cases, these outliers will be removed, but on the other hand, removing outliers may also cause bigger problems than we think. Outlier removal was an essential purpose of the consequences of Hurricane Katrina. This is because the Army Corp of Engineers expelled storms of a much more awful level than Katrina when they played out the underlying arranging, which was done purposely to normalize the model [27].

Table 3 - Forecasted values in figure 10 with an upper and lower threshold

DATE	yhat	yhat_lower	yhat_upper
25-07-2020	798	560	1032
26-07-2020	802	560	1048
27-07-2020	806	573	1047
28-07-2020	814	568	1040
29-07-2020	893	664	1129
30-07-2020	840	609	1082
31-07-2020	819	575	1071
01-08-2020	820	566	1057
02-08-2020	804	559	1051
03-08-2020	789	549	1033
04-08-2020	778	554	1004
05-08-2020	840	596	1081
06-08-2020	772	535	1015
07-08-2020	738	499	980
08-08-2020	728	485	962

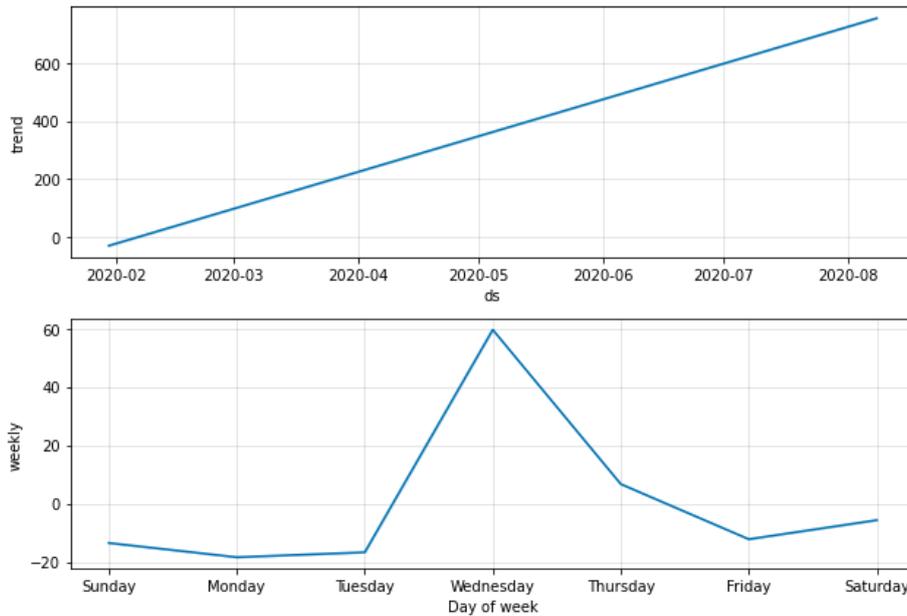


Figure 11 - Trends observed in day-wise death cases from 30 January to 08 August 2020

## Conclusion

The COVID-19 pandemic has shown the interconnected idea of our reality – and that nobody is protected until everybody is safe. Sadly, this number makes certain to develop significantly more later on. In this study, a machine learning data-driven Prophet Time series forecast algorithm has been used in analyzing the effect of COVID-19 in India in terms of daily newly confirmed cases, recoveries, deaths, with the forecast values for the next 15 days. This analysis can help government agencies or even an individual to be pandemic ready. This work can likewise be utilized to verify whether different preventive estimates taken like physical distancing, isolated quarantines, contact following activities are successful or not.

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