

## Predicting COVID-19 Cases in Near Future in India Using Logistic Function

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### ABSTRACT

On 27th August, the day of conducting this study, India reported the highest single-day increase of over 75,000 COVID-19 cases [8]. With the exponential increase in the number of COVID-19 cases in India, our lives are at risk. There is subsequent stress on our health professionals and administration as the number of cases is increasing every day and a large number of people are being unable to afford a bed in a hospital. It will be helpful for the administration if they have a predicted value of COVID-19 cases that we might see in future. Making important decisions by the government and other professionals will be easy if they have an overview of how much the disease is likely to spread in the near future. We used a dataset that has daily recorded COVID-19 data, from 30th January 2020, when the first COVID-19 case was reported in India, to 27th August 2020. I used Logistic function to predict the number of COVID-19 cases we might see in future, in India. The prediction is based on only the recorded increment in COVID-19 cases daily in India.

**Keywords:** *Logistic Function, COVID-19, COVID-19 in India*

### 1. INTRODUCTION

India is the 3rd worst-hit country by the Coronavirus [9] with more than 3.25 million confirmed cases on 27th August 2020. It is very likely that India will soon become the 2nd worst-hit country by COVID-19, crossing Brazil. Currently, with more than 731 thousand active cases [10] India is struggling to return to stability. With more than 60 thousand deaths, our lives are at stakes. The recovery rate is promising, but our health systems are struggling to provide everyone with proper treatment. In this time, predicted data on how many COVID-19 cases India will see soon, it will be helpful for individuals, corporates and even the government to plan their next steps. India's economy got a massive hit by the Coronavirus pandemic, but taking quick steps to reboot the economy might make the pandemic uncontrollable. This paper discusses how many new cases of COVID-19 India is likely to see in the upcoming months, as well as how much recovery rate we can see.

The first COVID-19 case in India was reported on 30th January 2020, the origin of which was China [7]. After 90 days, around 30 thousand confirmed COVID-19 cases were reported [10]. COVID-19, being highly transmissible, spread rapidly even during the three-phase lockdown India went through. Within two weeks on 'Unlock 1', a massive spike is seen in the number of cases reported daily. In another 90 days, the number of confirmed COVID-19 cases rose to around 1.5 million and in about 24 days, the number almost doubled [10]. In this situation, the right prediction will help the administrations and health officials a lot.

In this paper, how the logistic function is used to predict the number of COVID-19 cases India might see, the number of patients who will be recovered and the number of deaths that will occur in near future is predicted and the relevance of the predictions are discussed.

The paper has been organised in 6 sections. In section 2, the related works on this field are discussed. In section 3, the theoretical base of this study is presented. In section 4 the

methodologies and resources of the research are elaborated. In section 5, the results obtained from the predictions are presented discussed in detail and in section 6 the paper is concluded.

### 2. RELATED WORK

[1] is the paper on 'CoronaTracker' that does COVID-19 outbreak data analysis and prediction on a global scale. Prepared by CoronaTracker community research group, the paper discusses how CoronaTracker analyses data and predicts future scenarios. Published on 19 March 2020, [1] is one of the major and impactful works in this field. Anuradha Tomar and Neeraj Gupta [2] worked on prediction for COVID-19 spread in India and also discussed the preventive measures and their effectiveness in their paper. They have used LSTM based techniques to predict the number of COVID-19 cases we might see and how much the preventive measures will be effective against the pandemic. The paper was published on 20 April 2020. [3] is a paper on a prediction of the number of COVID-19 cases using social media search index that might be helpful for governments' health departments to locate outbreak areas. The paper was published on 31 March 2020. [4] is a research work published in March 2020, on the topic of modifier SEIR and AI prediction of COVID-19 epidemics trend in China under public health interventions. The paper was based on how different control measures impacted the containment of the epidemic.

### 3. THEORETICAL BASE

The logistic function has several applications in fields like artificial neural networks and predicting future scenarios. A logistic function or logistic curve is a sigmoid curve (S-shaped curve) which follows a particular equation. The logistic equation is given below.

$$f(x) = \frac{L}{1+e^{-k(x-x_0)}} \quad (1)$$

Here, the  $x$  value of the sigmoid's midpoint is  $x_0$ , the curve's maximum value is  $L$  and the logistic growth rate is  $k$ , which is also known as the steepness of the curve [5]. For values of  $x$  in the domain of real numbers from  $-\infty$  to  $+\infty$  [5], the S-curve of logistic regression is obtained, "with the graph of  $f$  approaching  $L$  as  $x$  approaches  $+\infty$  and approaching zero as  $x$  approaches  $-\infty$ " [5]. A standard logic function is given below.

$$f(x) = \frac{L}{1+e^{-x}} \quad (2)$$

Here, the parameters  $k=1$ ,  $x_0 = 0$  and  $L=1$ .

#### 4. METHODOLOGY

In this study, the logistic equation and logistic curve are used to predict the amount of COVID-19 cases we might see in future. The dataset available at [6] is used, which is prepared from the data available to the general public by the Indian Ministry of Health & Family Welfare. Data from covid\_19\_india.csv file is used in predicting future scenarios for this particular research.

Sno	Date	Time	State/Union Territory	Confirmed	ConfirmedForeign	National	Cured	Deaths	Confirmed
1	30-01-2020	06:00 PM	Kerala	1			0	0	1
2	31-01-2020	06:00 PM	Kerala	1			0	0	1
3	01-02-2020	06:00 PM	Kerala	2			0	0	2
4	02-02-2020	06:00 PM	Kerala	3			0	0	3
5	03-02-2020	06:00 PM	Kerala	3			0	0	3
6	04-02-2020	06:00 PM	Kerala	3			0	0	3
7	05-02-2020	06:00 PM	Kerala	3			0	0	3
8	06-02-2020	06:00 PM	Kerala	3			0	0	3
9	07-02-2020	06:00 PM	Kerala	3			0	0	3
10	08-02-2020	06:00 PM	Kerala	3			0	0	3
11	09-02-2020	06:00 PM	Kerala	3			0	0	3
12	10-02-2020	06:00 PM	Kerala	3			0	0	3
13	11-02-2020	06:00 PM	Kerala	3			0	0	3

Fig. 1. Dataset Used in this Paper.

Steps:

- Step 1: The logistic function is created.
- Step 2: The CSV file is opened as a dataframe.
- Step 3: The pre-existing data in the dataframe is described through several graphical representations to get an overview of the current situation of COVID-19 in India. The results are presented with discussions in the fifth section of this paper.
- Step 4: The rows in the dataframe are sorted by 'Date' in ascending order. This sorting is done so that we get a constantly incrementing value of confirmed COVID-19 cases, recovered patients and number of deaths.
- Step 5: The data of the number of confirmed COVID-19 cases is fit on the logistic function/ logistic curve. From the logistic function, the number of cases we might see in future days is predicted. The number of days is calculated from 30 January 2020. First, the number of confirmed COVID-19 cases we might see in India is predicted.
- Step 6: In the same manner, the number of recovered patients and the death toll is predicted.

#### 5. RESULTS AND DISCUSSION

The primary solution of COVID-19 is testing more and more people to isolate those who are COVID-19 positive from people who are not affected. In the following graphical representation, we get an overview of how many tests different states have performed till 27<sup>th</sup> August 2020.

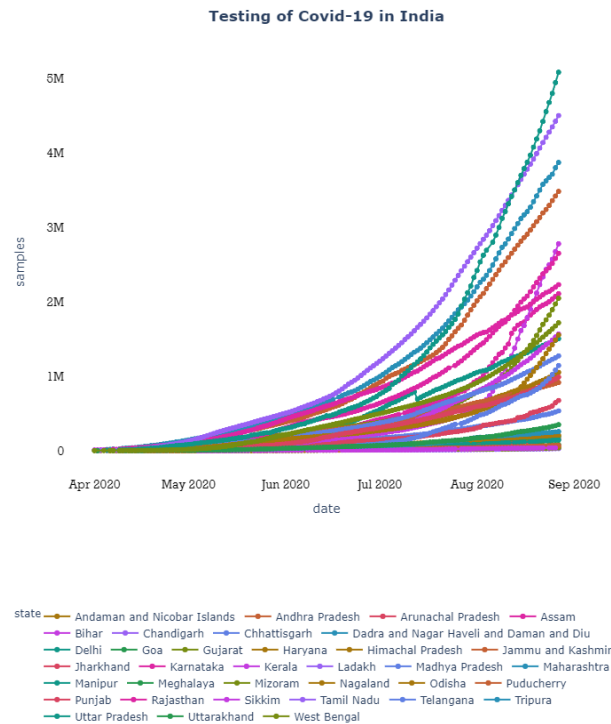


Fig. 2. The number of COVID-19 tests performed by different states in India till 27 August 2020.

The number of confirmed cases of COVID-19 till 27 Aug 2020 in different states of India is presented below.

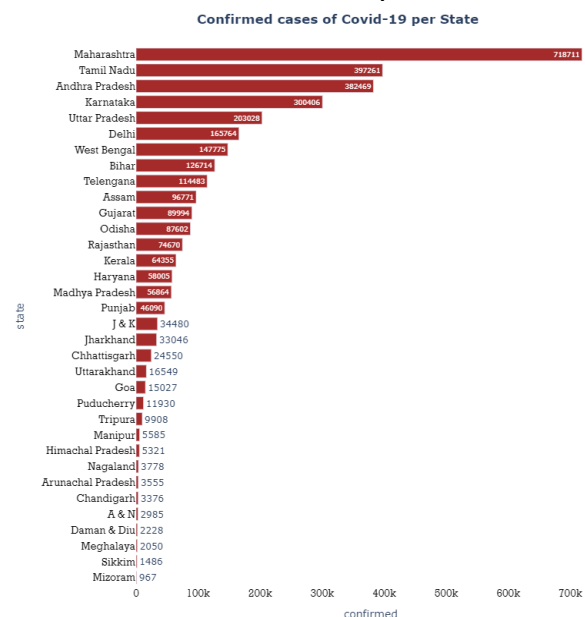


Fig. 2. The number of confirmed COVID-19 cases in different states of India till 27 August 2020.

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For a better overview, the data is presented on a map to get an overview of how badly each state is affected.

The fatality rate of COVID-19 till 27 Aug 2020 in different states of India is presented below.

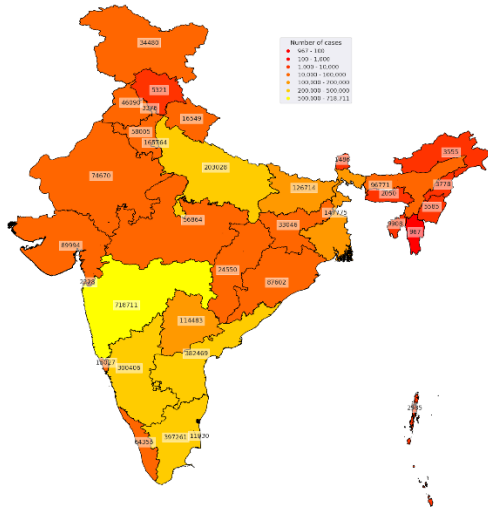


Fig. 3. Representation of the number of confirmed COVID-19 cases in different states of India till 27 August 2020.

The number of deaths due to COVID-19 till 27 Aug 2020 in different states of India is presented below.

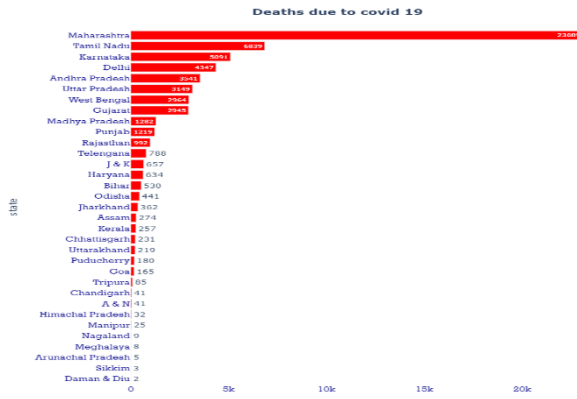


Fig. 4. The number of deaths due to COVID-19 in different states of India till 27 August 2020.

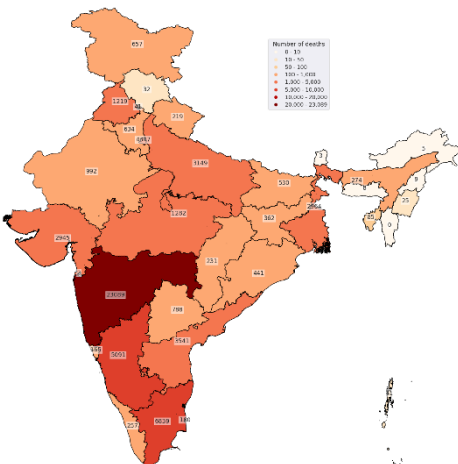


Fig. 5. Representation of the number of deaths due to COVID-19 in different states of India till 27 August 2020.

Fatality Rate per State

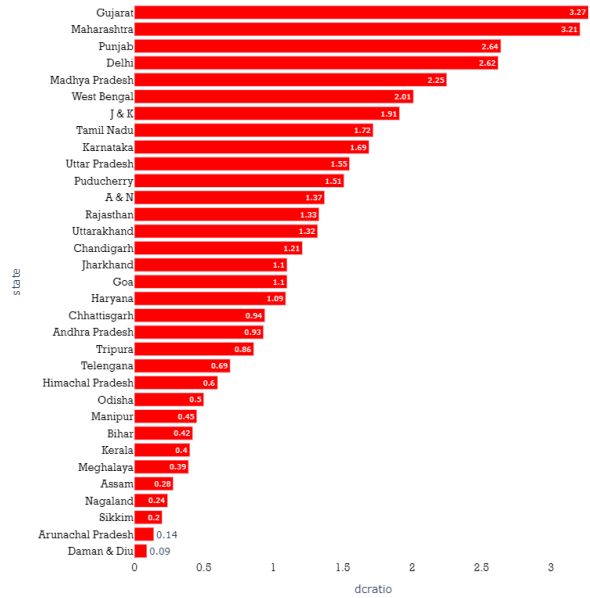


Fig. 6. The fatality rate of COVID-19 in different states of India till 27 August 2020.

Fatality Rate Per State

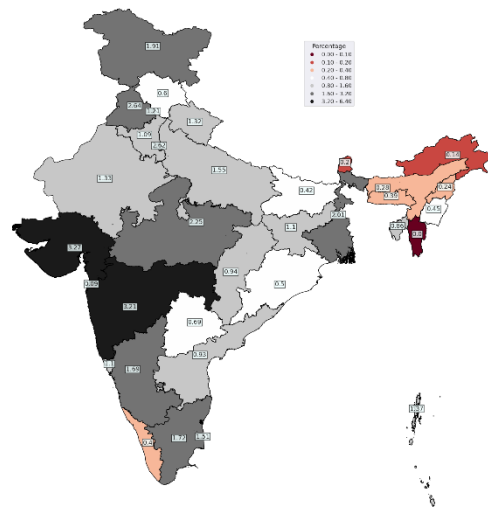


Fig. 7. Representation of the fatality rate of COVID-19 in different states of India till 27 August 2020.

From this data, it is clear that Maharashtra is the worst-hit state by COVID-19 in India. It is the third state which has done the most number of COVID-19 tests till 27 August 2020, after Uttar Pradesh and Tamil Nadu. Till 27 August 2020, Maharashtra has registered over 7 lakh COVID-19 cases, which is nearly twice than that of Tamil Nadu and Andhra Pradesh. Also, Mizoram has recorded the lowest number of COVID-19 cases till 27 August 2020. But Mizoram is a tiny state, so this data might not be enough to draw a conclusion if Mizoram handled COVID-19 properly, or did it fail. Further, from this, we get an overview of how much treatment and help a state needs right now.

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With the increasing number of COVID-19 cases in India, the only light of hope is the recovery rate. A graphical representation of different recovery rates in different states of India is presented below.

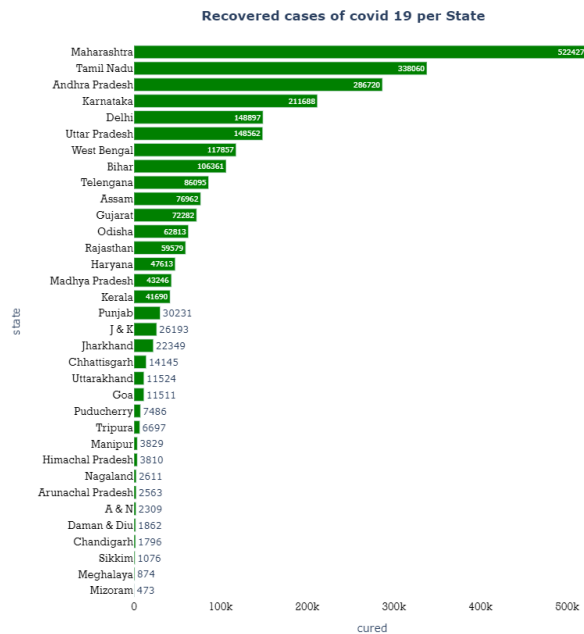


Fig. 8. The number of recovered cases of COVID-19 in different states of India till 27 August 2020.

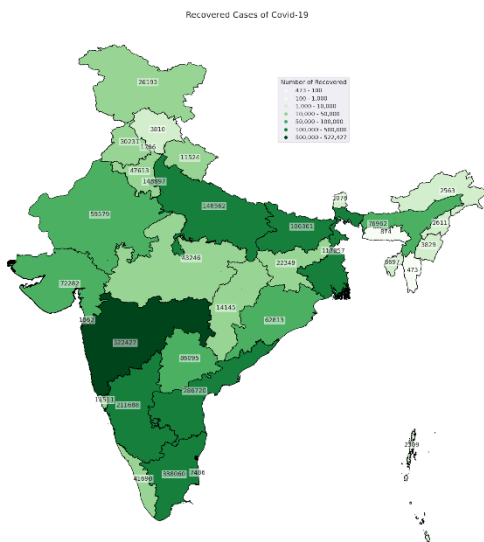


Fig. 9. Representation of the number of recovered cases of COVID-19 in different states of India till 27 August 2020.

From this representation, we can see that Maharashtra has reported the maximum number of COVID-19 cases till date, but it has also reported the maximum number of recovered patients till date.

Graphical representation of how the number of daily cases increased during and after lockdown in India will help us understand how effective the lockdown period was. We can also find out how much the unlock phase has affected the increment of COVID-19 cases. With a better insight of the available data, it will be easier for our health professionals,

administrations and corporations to plan their next steps to fight this pandemic.

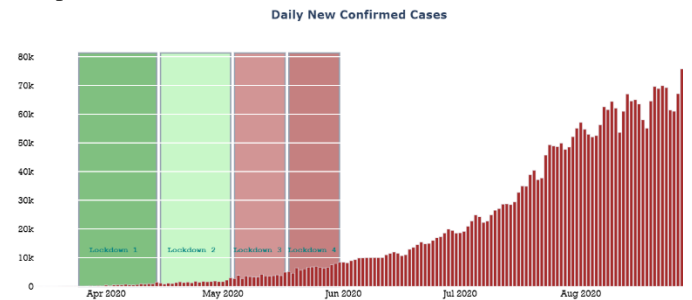


Fig. 10. The number of daily new confirmed cases of COVID-19 in India till 27 August 2020.

From this graph, we can come to a conclusion that during the four phases of lockdown, the spread of COVID-19 was very low but within one month of the unlock period, the spread of COVID-19 increased rapidly. With more than 75,000 new confirmed COVID-19 cases, on 27<sup>th</sup> August 2020, India recorded the highest number of new confirmed COVID-19 cases in a single day till date.

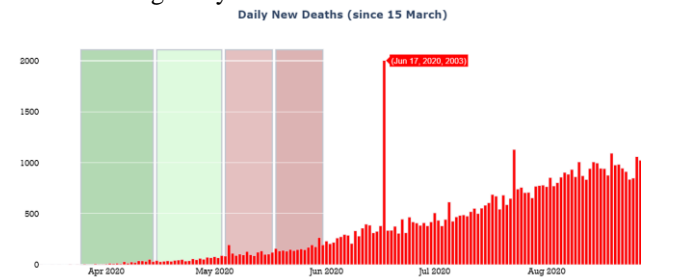


Fig. 11. The number of daily deaths due to COVID-19 in India till 27 August 2020.

From this graph, we can see that with the number of COVID-19 cases increasing daily, the number of deaths is also increasing daily. On 17 June 2020, India recorded the highest number of deaths in a single day due to COVID-19.

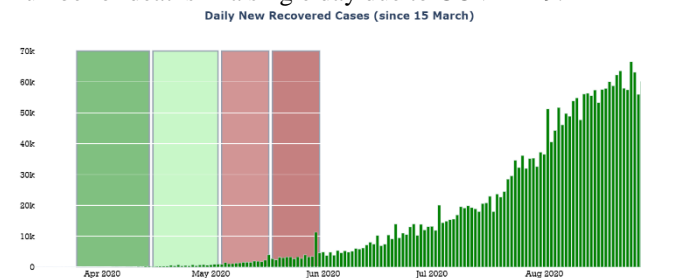


Fig. 12. The number of daily new recovered cases of COVID-19 in India till 27 August 2020.

The light of hope in this situation is the recovery rate. With the pandemic spreading more and more, the number of recovered cases of COVID-19 is also increasing rapidly.

The predictions we got from the data is presented below. All the predictions are done up to 420 days, counting from 30<sup>th</sup> Jan 2020.

Prediction of the number of confirmed COVID-19 cases we might see in future:

- Predicted maximum number of confirmed cases: 6771043

- Predicted growth rate: 0.04099849952583304
- Predicted day of the inflexion: 211

Logistic Curve Projection on Confirmed Covid-19 Cases in India

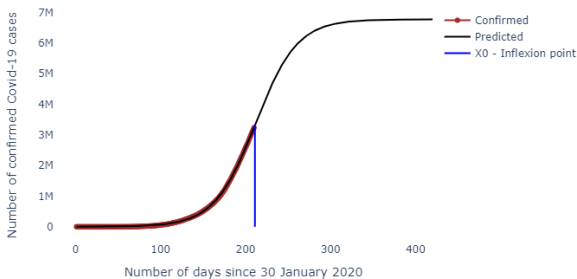


Fig. 2. Logistic Curve Projection on Confirmed Covid-19 Cases in India

Prediction of the number of cured COVID-19 patients we might see in future:

- Predicted maximum number of Cured Covid-19 patients: 6469554
- Predicted growth rate: 0.04362639876481734
- Predicted day of the inflexion: 220

Logistic Curve Projection on Cured Covid Cases in India

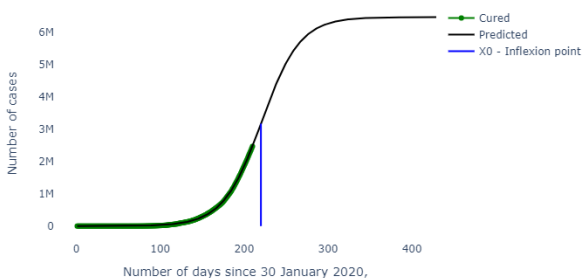


Fig. 3. Logistic Curve Projection on Cured Covid-19 Cases in India.

Prediction of the number of deaths from COVID-19 we might see in future:

- Predicted maximum number of deaths from Covid-19: 90814
- Predicted growth rate: 0.03772840610794798
- Predicted day of the inflexion: 194

Logistic Curve Projection on Covid-19 Deaths in India

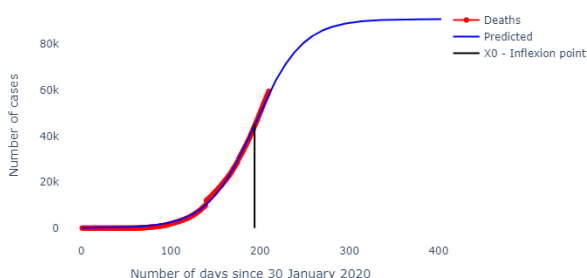


Fig. 4. Logistic Curve Projection on Deaths Because of Covid-19 in India

Logistic curve's steepness decreases at the end of the curve, but in the real growth rate of COVID-19 transmission might not decrease for a long time. So the predicted maximum number of confirmed COVID-19 cases is unreliable. But we still get an overview of what might happen in the next couple of months. From the predicted data, we can suggest that, in the next 50 days, the number of COVID-19 cases will rise to 60,000. We can predict that the number of recovered patients will also rise rapidly, up to 55,000 or more. In the next 50 days, we might see 84,000 or more deaths because of COVID-19, in India. After predicting the number of confirmed COVID-19 cases, the number of cured COVID-19 patients, the number of deaths from COVID-19, for the next 50 days, the steepness of the curve decreases, so predictions after that are quite unreliable.

## 6. CONCLUSION

In this paper, forecasting/estimation method using logistic function has been used to predict the possible number of confirmed COVID-19 cases, the number of cured COVID-19 patients, and the number of deaths from COVID-19 in upcoming months. It an estimation, if the number of COVID-19 cases keeps growing in the rate it is growing today, how many cases we might see in upcoming months. Comparing the predicted data with the data that will be recorded in future, will give us an overview of how much success or failure India gets in controlling the pandemic. One of the future plans with this is to compare this predicted data with actual data that will be recorded in future and figuring out what factors paved India's path towards successfully controlling COVID-19 or completely failing in the same.

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