Prediction of the Date of Flex and of the Date of Substantial Reduction in the Number of COVID – 19 Confirmed Cases and Fatalities in Delhi (India)

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Research Article

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Abstract

In this paper, we analyse the covidCovid-19 data of the number of confirmed positive infectious cases (I) in Delhi - the capital of India – a city with a population of nearly 20 million - from April 1, 2020 to July 27th 2020 to find the flex in the I-t curve, where the second derivative of the I - t curve becomes negative. i.e. the date from which the rate of growth of the number of infections starts decreasing. The data isare fitted to the Gauss error function formula

a + b erf(cx-d)

with four parameters a, b, c and d as was done by Ciufolini and Paolozzi [1] for analysis of the covid-19 data of Italy and China. The date of flex is also found by plotting the second derivative of I evaluated numerically and agrees with the date found by the Gauss error function method. We also determinedetermined the date at which the number of new daily infections iswas sufficiently reduced to aboutapproximately 100. An estimate of the number of future cases is calculated using the Gauss error function. The data for the number of fatalities in the city isare also fitted to the Gauss error function with four parameters, and we estimate the date at which the number of fatalities reduces in proportion to a sufficient reduction in the number of new Covid-19 cases, which in this case is approximately 3. The data for the analysis hashave been taken from the website covid19India.org and Aarogya Setu App [6] of the Government of India.

Main Text

Various data driven mathematical models (SIR Model, SEIR model, SEIRU model, Bailey's model etc.) have been used recently to analyse the COVID-19 pandemic in different countries of the world and predict the number of confirmed positive cases and fatalities for future [2, 3, 4, 5]. Some of these models and their predictions are outlined in a recent paper by Nin Wang et al. [2]. Ignazio Ciufolini and Antonio Paolozzi [1] fitted the COVID-19 data using Gauss error function to predict the date of flex and the date of substantial reduction in the number of confirmed positive COVID-19 cases in Italy and China.

We follow the approach of Ciufolini and Paolozzi [1] and and have fitted the number of cumulative positive infectious cases (I), to a cumulative distribution function (CDF) of the type of a Gauss error function (GEF) with four parameters, of the type

$$a + b \, \mathrm{erf}\,(cx - d)$$

that is the integral of a normal Gaussian distribution. The Covid – 19 data for the cumulative number of positive infectious cases for the city of Delhi, having a population of nearly 20 million people, has been taken from the website covid19India.org and Aarogya Setu App [6] of the Government of India. Using this approach, we calculate the dates of flex for the cumulative positive COVID – 19 infectious cases (I), and for the fatalities which occurred in the city of Delhi. We have also calculated the approximate dates on

which there is sufficient reduction in the number of confirmed positive cases (to approximately 100) and in fatalities (to about 3).

Fit of cumulative positive cases of COVID-19 in Delhi, India

Following Ignazio Ciufolini and Antonio Paolozzi [1], we approximated the number of cumulative positive infectious cases (I), to a cumulative distribution function (CDF) of the type of a Gauss error function (GEF) with four parameters, of the type

$$a + b \, \mathrm{erf}\,(cx - d)$$

that is the integral of a normal Gaussian distribution. The fit of the observed data with the Gauss error function is shown in figure (1).

The date of flex, where the second derivative of the I-t curve becomes negative. i.e. the date from which the rate of growth of the number of infections starts decreasing using the fit has been found using the data for the number I from the above sources and is found to be June 28, 2020.

The date of flex was calculated using data from April 1 to July 9 (both dates included), then from April 1 to July 10 and so on, till from April 1 to July 23 (included). As the final date of analysis is increased, the date of flex quasi- oscillates with a decreasing amplitude. We thus got 14 values for the date of flex. The average date for these values is June 28, 2020. The standard deviation of these 14 points has a 1-sigma value of 3 days. The 2-sigma uncertainty and the 3-sigma uncertainties in the date of flex are thus 6 days and 9 days respectively.

The date of flex was also estimated by plotting the graph of the second derivative of the 7-day rolling average of I (obtained numerically) versus t and was found to be June 25 (corresponding to the June 22 – June 28 data) as can be seen from the graph Figure (2).

Using this fit of the above data using the Gauss error function, we also calculated the date from which the increase in the number of daily cumulative positive COVID -19 cases is sufficiently reduced in Delhi to around 100 cases.

This date was calculated using data from April 1 to July 14 (both dates included), then from April 1 to July 15 and so on, till from April 1 to July 27 (included). We thus got 14 values for the date of sufficient reduction in the number of daily cumulative positive cases to 100 cases, with a standard deviation of 3 days. This date was found to be around August 18, 2020, plus or minus 6 days (2-sigma) uncertainty (for 95.5% probability) or 9 days (3-sigma) uncertainty for 99.7% probability.

We then did a similar analysis using the data on cumulative number of fatalities due to COVID-19, again taking the data from the Web sites of covid19India.org, and the AarogyaSetu App of the Government of

India [6]. The curve for the number of fatalities in Delhi is shown in Figure (3).

The analysis of data on the number of fatalities gives the date of flex in this case to be June 19, 2020 with a standard deviation of 1-day. For the number of substantial reduction in the number of fatalities (to nearly 3 fatalities), proportional to the threshold of 100 positive cases done in the analysis of cumulative positive Covid-19 cases, times the ratio of number of fatalities to number of total positive cases, the corresponding date is found to be August 26 with a standard deviation of 4 days (the analysis was done for the same dates as in the case of substantial reduction in the cumulative number of positive cases, i.e. from April 1 to July 14, then from April 1 to July 15, ... and so on till from April 1 to July 27). Thus, there is 2-sigma uncertainty (95.5% probability) of 8 days and 3-sigma uncertainty (99.7% probability) of 12 days. As observed in [1] in the case of Italy, both the dates of flex and dates of a substantial reduction in the number of cases have a quasi-oscillating behaviour. Thus, there is consistency in the results of dates of flex and the substantial reduction in the number of confirmed positive cases and the number of fatalities.

Declarations

Competing interests: The author declares no competing interests.

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Figures

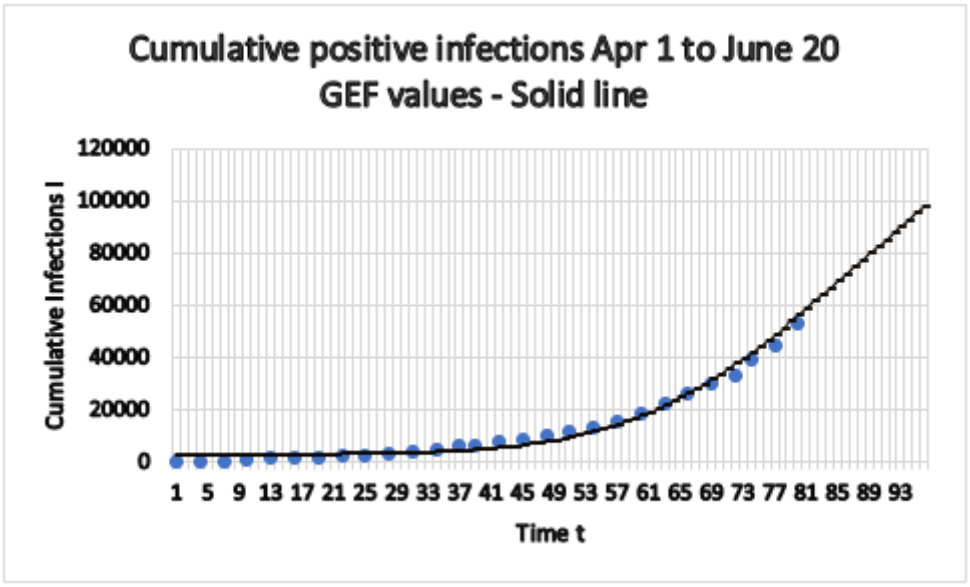

Figure 1

Cumulative Positive COVID-19 Cases in Delhi (India). The dots represent the reported cases.

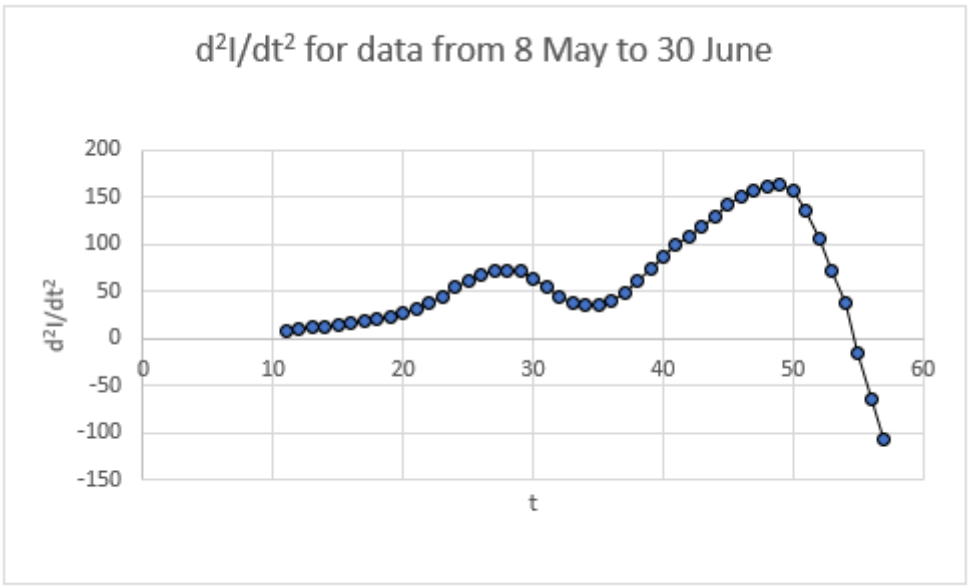

Figure 2

Variation of second derivative of positive COVID-19 Cases with Time

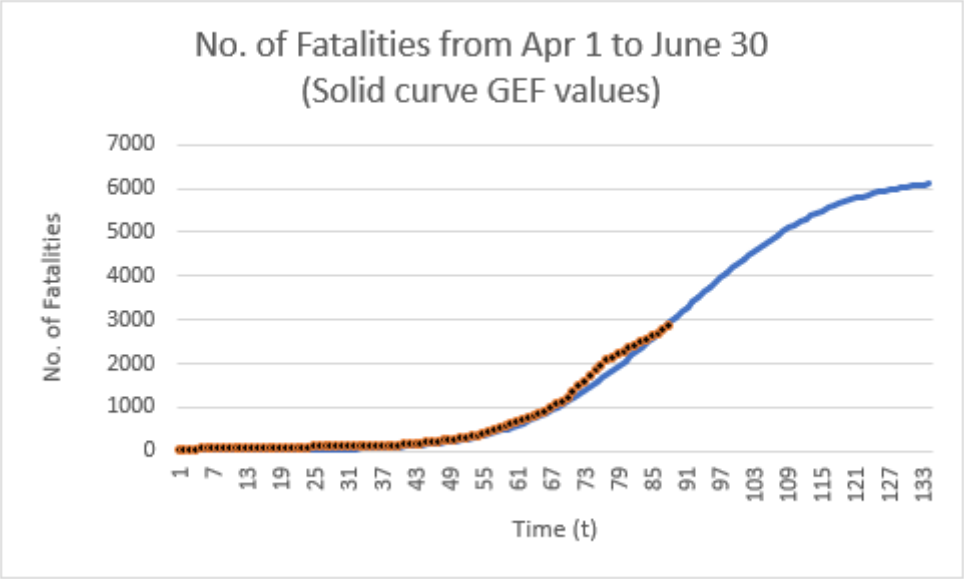

Figure 3

Comparison of observed Fatalities with the Calculated values (solid curve)