Plant Archives Vol. 20, Supplement 2, 2020 pp. 1561-1564 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

AN EPIDEMIC MODEL TO PREDICT THE EFFECT OF INFECTION ON POPULATION OF INDIA BY COVID-19 CORONA VIRUS

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Abstract

The Covid-19 outbreaks in India is a great concern. A detailed scientific analysis of this epidemic is still to come, but now it is necessary to calculate the parameters of the pandemic dynamics in order to create the appropriate quarantine place, to estimate the number of beds in hospitals, etc. In this paper, we have discussed Polynomials Approximation Model for estimation of number of infected peoples in India.
Keywords**:** Forecasting, Covid-19 Outbreak, SARS Cov2

Introduction

Currently, SarsCov2 virus is one of the most venomous pathogens for humans. SarsCov2 virus is deadly, less understood and have capability of causing a large-scale threat to Public Health. In this time of pandemic, everyone is talking about the growth of infected peoples during this epidemic. For the country like India, various predictions have been made by various researchers by using different-different models. The main aim of this work is to understand the dynamics of the Indian population infected by Corona virus and how many peoples will be infected in near future by using an appropriate mathematical model. We investigated a mathematical model that provides a good approximation of the covid19 outbreak in India. Before proceeding, we observe that the size of this outbreak in its starting stage was discussed by (Milan *et al.*) and (Dhanwant *et al.*) and (Ranjan *et al.*) and they used SIR Model and Logistic Models. In past years, at the time of other epidemics various models were established, a few of them are analytical, stochastic and phenomenological.

The Logistic Model: The logistic growth model was introduced by Haberman in 1998 from population dynamics. The basic assumption of the model is that the rate of change in the number of new cases per capita linearly decreases with the number of cases. Hence, if I is the number of Infected peoples, and t is taken as the time, then the model is written as

$$\frac{1}{I}\cdot\frac{dI}{dt} = \omega\left(1 - \frac{I}{P}\right)$$

where ω is infection rate, and P *is* the final epidemic size. This Model can be solved easily by differential equations.

SIR Model: If $S(t), I(t)$ and $R(t)$ are the Susceptible, Infected and Recovered peoples at any given time t The equations of this compartmental model are

$$\frac{dS}{dt} = -\frac{\omega}{P}IS$$

$$\frac{dI}{dt} = \frac{\omega}{P}IS - \tau I$$

$$\frac{dR}{dt} = \tau I$$

In the above equations, ω is rate of infection and τ is recovery rate. It can be noticed that P is total population and $S + I + R = P$

In this article, we have tried to estimate the future infected peoples in India using Polynomials Approximation Model. Generally, In the cases of pandemics the data is fitted by some exponential functions. But at the present time the data is fitted by the polynomial of degree three. The data used for calculation is taken from the

As future work, we plan to include in our study other factors. We are planning to include the study of treatment of infected peoples in the mathematical model. Another interesting line of research is to investigate vaccination strategy.

Materials and Methods

Data Collection: The data was collected from the website of Ministry of Health and Family Welfare from 27-03-2020 to 15-04-2020 and from website. The collected data is given the table 3.1 below:

Table 3.1

Date	Infected	Recovered	Death
27-03-2020	887	73	20
28-03-2020	987	84	24
29-03-2020	1,024	95	27
30-03-2020	1,071	100	29
31-03-2020	1,251	102	32
01-04-2020	1,590	148	45
02-04-2020	2,032	148	58
03-04-2020	2,567	192	72

04-04-2020	3,082	229	86
05-04-2020	3,588	229	99
06-04-2020	4,314	328	118
07-04-2020	4,858	382	136
08-04-2020	5,360	468	164
09-04-2020	5,916	506	178
10-04-2020	7,600	645	249
11-04-2020	8,446	840	288
12-04-2020	9,205	951	331
13-04-2020	10,453	1,052	358
14-04-2020	10,541	1,205	358
15-04-2020	12,456	1,513	423

The growth of infected peoples, Recovered and Deaths between the date 27-03-2020 to 15-04-2020 are being shown with the help of graph plotted below:

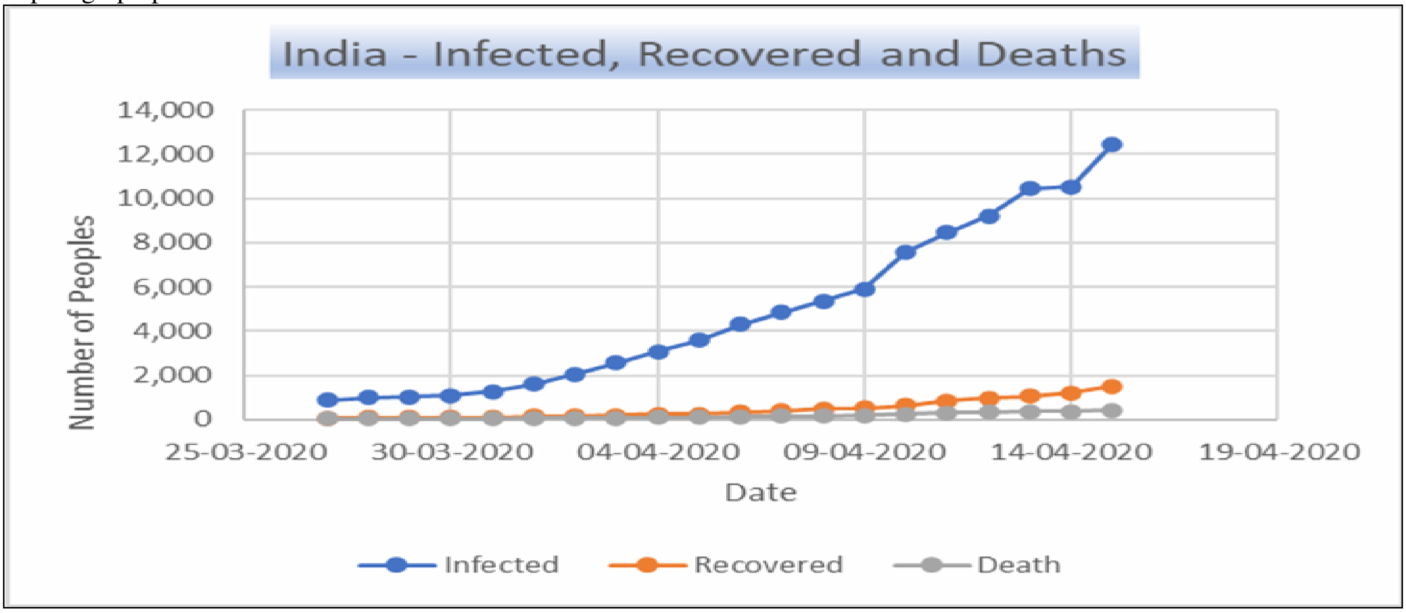

Figure 3.2

Model Formulation:

In this article we have created Polynomial Approximation Model with the help of statistical tools, we have tried to fit the data with the polynomial of degree three. We have considered that $I(t) = a + bt + ct^2$. Where t is the time in days and $I(t)$ is number of infected peoples at time t. The constants a, b and c are real in above polynomial.

Result and Discussion

After analysing the data, we have found that the curve of Infected Individuals in best fitted with the polynomial $I(t) = a + bt + ct^2$ when the estimated values of coefficients are given by $a = 955.30$, $b = -88.11$, $c = 33.74$

The table 4.1 shows the calculation for Approximation of cases and the squared Normalized Error. Where squared normalized error is given by

$$\left(\frac{\text{Confirmed Cases} - \text{Estimated Cases}}{\text{Confirmed Cases}}\right)^2.$$

Table 4.1

Date	Days	Confirmed Cases	Approximation of Cases	Normalized Error^2
27-03-2020	1	887	900.9279495	0.000246563
28-03-2020	2	987	914.0352972	0.005465015
29-03-2020	3	1,024	994.6232611	0.000823014
30-03-2020	4	1,071	1142.691841	0.004480851
31-03-2020	5	1,251	1358.241038	0.007348647
01-04-2020	6	1,590	1641.270851	0.001039793
02-04-2020	7	2,032	1991.78128	0.00039175
03-04-2020	8	2,567	2409.772325	0.003751511
04-04-2020	9	3,082	2895.243987	0.003671841
05-04-2020	10	3,588	3448.196265	0.001518213
06-04-2020	11	4,314	4068.629159	0.003235084

07-04-2020	12	4,858	4756.542669	0.000436166
08-04-2020	13	5,360	5511.936796	0.000803519
09-04-2020	14	5,916	6334.811539	0.005011652
10-04-2020	15	7,600	7225.166898	0.002432477
11-04-2020	16	8,446	8183.002874	0.000969616
12-04-2020	17	9,205	9208.319466	1.30044E-07
13-04-2020	18	10,453	10301.11667	0.000211124
14-04-2020	19	10,541	11461.3945	0.007624027
15-04-2020	20	12,456	12689.15294	0.000350368
Sum of Squared Normalized Error				0.049811362

From table 4.1, We have observed that sum of squared normalized error is 0.049811362, which is very low. So, with the same coefficients we have approximated the growth of infected peoples and tried to explain the same with the graph (Figure 4.2) plotted below:

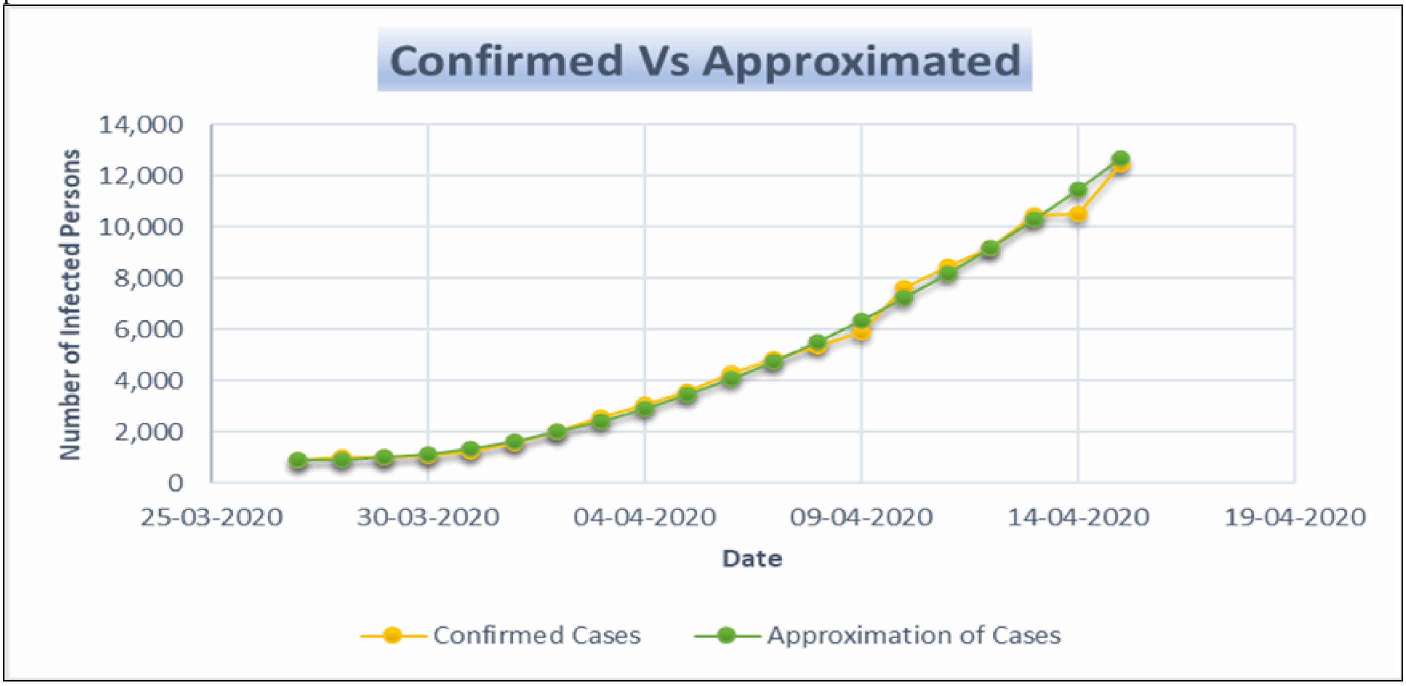

Figure 4.2

The table 4.3 provides the approximated cases of Infected individuals by the dates. This table is prepared by substituting the values of time in polynomial.

Table 4.3

Date	Days	Estimated Cases
31-03-2020	5	1358.241038
05-04-2020	10	3448.196265
10-04-2020	15	7225.166898
15-04-2020	20	12689.15294
20-04-2020	25	19840.15439
25-04-2020	30	28678.17124
30-04-2020	35	39203.20351
05-05-2020	40	51415.25118
10-05-2020	45	65314.31425
15-05-2020	50	80900.39274
20-05-2020	55	98173.48663
25-05-2020	60	117133.5959
30-05-2020	65	137780.7206
04-06-2020	70	160114.8607
09-06-2020	75	184136.0163
14-06-2020	80	209844.1872
19-06-2020	85	237239.3735
24-06-2020	90	266321.5753
29-06-2020	95	297090.7924
04-07-2020	100	329547.025

Figure 4.4 shows the future growth in the infected individuals in India.

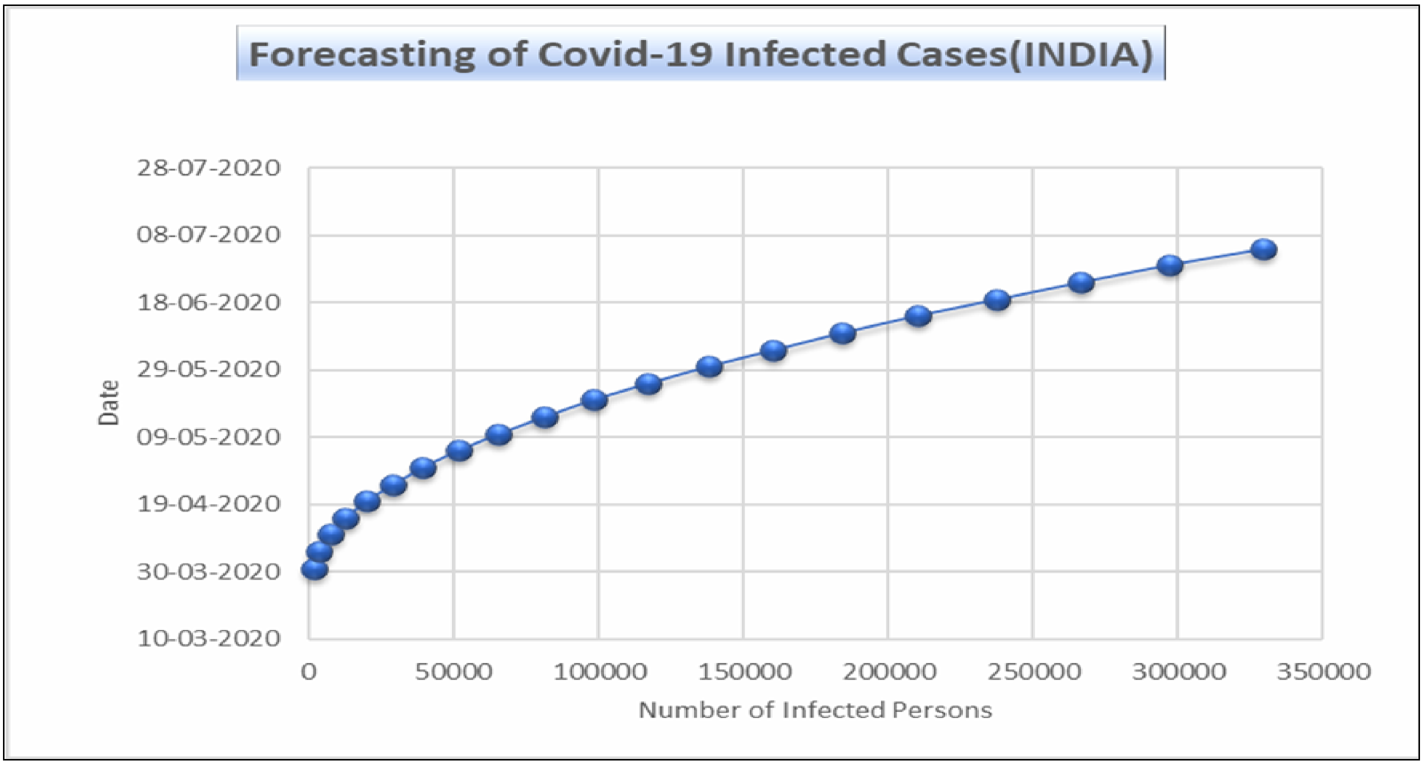

Figure 4.4

Conclusion

This paper presents an overview of the mathematical epidemic models of population disease. Here the Polynomial Approximation model tells a basic investigation of this spread of epidemic. Here we defined the Polynomial Approximation Model by the help of polynomial and found the coefficients with the help of data, using the statistical tools. It is also being made clear that the approximation may not be correct because it may have dependency on some other factors as well. The data is taken during lockdown and after lockdown it may grow faster.

In this model, we have approximated the size of epidemic with the data. Usually, such type of approximation is done by usual exponential curve or SIR model and Logistic Models.

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