Mathematical Modelling of the Number of Transmitted Cases of COVID19

DR. Hemlata Pande

Assistant Professor
Department of Mathematics
Govt. P. G. College Bageshwar, Uttarakhand, India

Abstract — *Present paper is an attempt in the direction to represent the relation between time and the number of transmitted COVID cases in the form of mathematical equation.*

Keywords — *COVID19, equation, cumulative total frequency, time, transmission.*

I. INTRODUCTION

Neumaier [1] has mentioned the mathematical modelling (MM) as “ the art of translating problems from an application area into tractable mathematical formulations whose theoretical and numerical analysis provides insight, answers, and guidance useful for the originating application”. Applications of Mathematical modelling in diverse kind of problems are quite popular, for instance the use of mathematical modelling can be found in the following works : in [2] the mathematical modelling has been used as a tool to model a complex disease; researcher in the paper [3] had applied it (MM) in ‘Rotating Biological Contactor’ and in the paper [4] , MM has been utilized for the purpose to Study Stability of Biological Interaction. We have earlier applied the technique MM in case of various language and linguistic components e.g. for letters [5] and words (of various lengths)[6] etc. .

. At present situation the whole world is badly affected with the *Coronavirus* disease (COVID -19). It is an infectious disease due to which the number of people infected with the disease is increasing rapidly. The vaccination for the cure of this disease has not been discovered till now. In order to stop the spread the *Coronavirus*, social distancing is must. Social distancing coupled with other preventive measures lead towards the COVID free society.

In the direction for the application of mathematical modelling for the COVID cases the works [7], [8] and [9] etc can be cited to mention only a few. In the present paper an attempt has been made to explain mathematically that how the number of COVID infection cases continues to get increase until the chain of transmission is broke. I have tried to represent the relation between the cumulative total number of infected cases and time in the form of a mathematical equation.

II. METHOD

Data of cumulative total number of infected cases at a the end of a day in the case of : Worldwide, USA, Italy and UK have been obtained from the date wise cumulative data available in the web page of ‘*STATISTA*’ < https://www.statista.com/>. In the case of Germany the cumulative total data for various dates have been obtained with the help of date wise data for the ‘number of confirmed cases at the day’ available in the website of ‘*STATISTA*’; and in the case of the cumulative total data for the COVID cases in INDIA web page of COVID19INDIA < https://www.covid19india.org/> have been used. Following Table1 represents the duration period for which the data in various considered cases have been utilized for the purpose of research and the total number of confirmed cases at the starting day and upto the final day of the considered duration have also been depicted in the table .

TABLE I

S. No.	Territory	Total cumulative confirmed cases at starting date and upto the last date of considered duration		Considered Duration
		At starting date	At final date	
1	USA	1	665330	22 JAN 2020 TO 18 APRIL 2020
2	ITALY	3	175925	15 FEB 2020 TO 18 APRIL 2020

3	GERMANY	1	134732	28 JAN 2020 TO 15 APRIL 2020
4	UK	2	114217	31 JAN 2020 TO 18 April 23, 2020
5	INDIA	1	14353	30 JAN 2020 TO 17 APRIL 2020
6	WORLDWIDE	1	1995983	08 JAN 2020 TO 16 APRIL 2020

This is clear from the table that in the case of all considered territories at the starting day of the considered duration there are only minor number of cases (1, 2 or 3) have been confirmed and for all the considered regions the duration is a subset of time period between dates : 08 Jan. 2020 and 18 April 2020.

III. DETERMINATION OF THE MODEL

In order to represent the mathematical model which expresses the relationship between time and cumulative total number of COVID cases reported, I have assumed the time variable T, where one unit of *T* is equal to 3 days and at the starting date (which has been mentioned in the Table 1), I have assumed T = 1. I have converted the data in the form of the table of values of *T* and *F(T)* , *F(T)* = the cumulative total number of cases reported till time *T*. For example in the case of INDIA the obtained table is TableII.

TABLE II

T	Corresponding date	F(T)	T	Corresponding date	F(T)
1	30-Jan-20	1	15	12-Mar-20	81
2	2-Feb-20	2	16	15-Mar-20	112
3	5-Feb-20	3	17	18-Mar-20	171
4	8-Feb-20	3	18	21-Mar-20	334
5	11-Feb-20	3	19	24-Mar-20	571
6	14-Feb-20	3	20	27-Mar-20	883
7	17-Feb-20	3	21	30-Mar-20	1326
8	20-Feb-20	3	22	2-Apr-20	2545
9	23-Feb-20	3	23	5-Apr-20	4293
10	26-Feb-20	3	24	8-Apr-20	5914
11	29-Feb-20	3	25	11-Apr-20	8452
12	3-Mar-20	6	26	14-Apr-20	11484
13	6-Mar-20	31	27	17-Apr-20	14353
14	9-Mar-20	48			

After obtaining such table for each considered territory I have tried to express the relationship between *T* and *F(T)* in the form of a equation with two parameters. For the purpose, I have used the DataFit software and it has been determined that if the results of fitness of various equations are compared with the help of 'coefficient of multiple determination' R^2 then the best results for each considered territory were obtained corresponding to the equation :

$$F(T) = \frac{A}{e^{\left(\frac{B}{T}\right)}}, \qquad (1);$$ where A>0 and B>0 are constants.

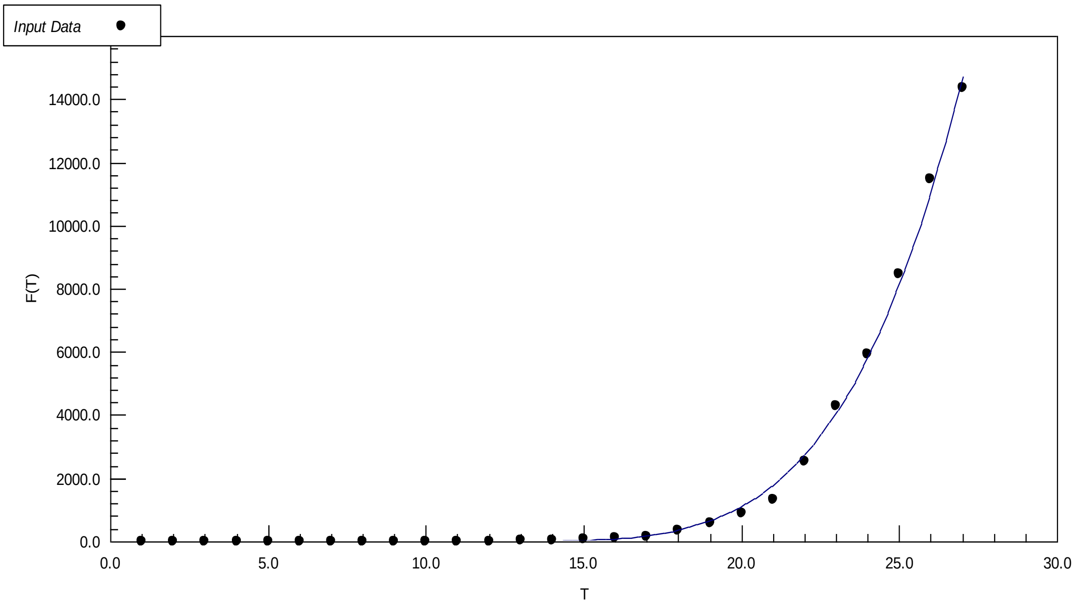
The determined values of *A* and *B* and R^2 corresponding to the equation (1) when data between *T* and *F(T)* was fitted with the help of DatFit for different considered cases have been determined as mentioned in the Table III:

TABLE III

Territory	A	B	R^2
USA	298493389.40	181.40359	0.991
ITALY	951240.63	36.16844	0.994
GERMANY	5757177.69	98.6645	0.983
UK	20561057.05	139.0499	0.996
INDIA	23162150.3733	198.7161	0.998
WORLDWIDE	450317720.74	182.69998	0.993

Thus from the tableIII it can be seen that the value of determination coefficient for the fitted and observed data of *F(T)* (when fitted with the help of equation (1)) in the case of each territory is greater than 0.98, therefore the relation given by equation (1) can be considered as the relation between *T* and *F(T)*. The fitted and actual data in the case of India for different values of *T* have been shown in the FIGURE I where dots are for the actual data and the fitted data is along the curve for different values of *T*.

FIGURE I



IV. DISCUSSION AND PREDICTION

We know that once the chain of transmission of COVID cases will break, the cumulative total number of cases will cease to increase and it will remain constant (or it can be said that then the equation for F(T) will be represented as:*F(T)=k* where *k* is a constant)after the day of crash of the chain. Thus it has been concluded that upto the day when the chain of transmission of COVID cases could not be broken, the cumulative total number of COVID cases will be determined in the form of equation

$$F(T) = \frac{A}{e^{\left(\frac{B}{T}\right)}}, \ A,B>0,$$

where in the present case time *T* depends on *t*, t^{th} day (t = 1,2,3…) as :

$$T = \begin{cases} 1 & if\ t = 1 \\ \frac{t+2}{3} & if\ t > 1 \end{cases};$$ as I have been taken one unit of *T* as 3 days . Similarly other units can also be taken to determine the required model. Therefore from the pattern of dependency of *F(T)* on *T* in the equation it is clear that the number cumulative total cases of transmission will continuously continue increase with time as F(T) is inversely proportional to $e^{\left(\frac{B}{T}\right)}$.

I have predicted the cumulative total cases of transmissions at various dates for the country INDIA with the help of the above mentioned equation (1) as under:

TABLE IV

Date	Predicted cumulative total number of transmitted cases
20 April 2020	19169
23 April 2020	24483
26 April 2020	30766
29 April 2020	38095
02 May 2020	46544
05 May 2020	56181
08 May 2020	67066

V. CONCLUSIONS

On the basis of the above research it has been concluded that the cumulative total number of cases of transmission of COVID19 on t^{th} ($t > 1$) day are inversely proportional to $e^{\left(\frac{k}{t+a}\right)}$, k and a are +ve constants. Therefore the number of infected cases will be continuously continue increase until the chain of infections will be crashed. So it is necessary that the chain of infection must be broke at the earliest by preventive measures and by strictly following the instructions by the government provided to combat with COVID19.

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