Specimen 'A'

Covid-19 Data Analysis and Sentiment Analysis

Project report submitted to Nagpur, in partial fulfillment of the requirements for the award of the degree
Indian Institute of Information Technology,

Bachelor of Technology In
Department of Computer Science and Engineering

by

Arvind Kumar Sahu **Manthan Chaourasia** **Shubham Munale**
BT17CSE087 **BT17CSE105** **BT17CSE088**

Under the guidance of

Dr. Mayuri Digalwar

Department of Computer Science and Engineering
***Indian Institute of Information Technology, Nagpur* 440 006(India)**

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***Technology, Nagpur* 440 006(India)**

Year 2020-21

Specimen- B

Department of
Computer Science and Engineering
Indian Institute of Information Technology,Nagpur

Declaration

We, **Arvind Kumar Sahu, Manthan Chourasia, Shubham Munale**, hereby declare that this project work titled "**Covid-19 Data Analysis and Sentiment Analysis**" is carried out by me in the Department of **Computer Science and Engineering** of **Indian Institute of Information Technology, Nagpur**. The work is original and has not been submitted earlier whole or in part for the award of any degree/diploma at this or any other Institution /University.

Date: 05th Nov, 2020

Arvind Kumar Sahu **BT17CSE087**	**Manthan Chaourasia** **BT17CSE105**	**Shubham Munale** **BT17CSE088**
Arvind Kumar Sahu	Manthan Chaurasia	Shubham

Specimen- C

Department of
Computer Science and Engineering
Indian Institute of Information Technology, Nagpur

Declaration

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Arvind Kumar Sahu	Manthan chourasia	

Specimen- D

Certificate

This is to certify that the project titled "**Covid-19 Data Analysis and Sentiment Analysis**", submitted by **Arvind Kumar Sahu, Manthan Chourasia and Shubham Munale** in partial fulfillment of the requirements for the award of the

degree of **Bachelor of Technology in Computer Science and Engineering**, IIIT Nagpur. The work is comprehensive, complete and fit for final evaluation.

Dr. Mayuri Digalwar
(Supervisor)

(Expert Name and Sign)

(Expert Name and Sign)

Dr. Jitendra Tembhurane
Name and sign of HoD
IIIT, Nagpur

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I am grateful to **Dr. O.G. Kakde** Director, all the faculties, Computer Science and Engineering Department, Indian Institute of Information Technology, Nagpur for extending the departmental facilities for my research work.

I would also like to thank Manthan Chaurasia, Pranay Fating, Pradnyshil Ghajbiye, Aman Priyadaarshi and all those who have helped me directly or indirectly during the completion of this project.

Lastly, I would like to thank my family members specially my mom for helping me realize my own potential and their continuous moral support.

Abstract

COVID-19 has been recognized as pandemic. The number of corona virus positive patient among all countries is more than 63 million and deaths is 1.475 million. In India only more than 9.9 million people infected with this virus and more than 140k led to death. Many govt. agencies and research organization are involved to prevent this pandemic and its impact. The main aim of this project is to draw a statistical model for better understanding of COVID-19 in India and through the world by thoroughly studying the reported cases in the countries till Nov 2020. An Exploratory Data Analysis (EDA) concept has been used for analyzing the COVID cases. The dataset are collected from various institutions like John Hopkins University, WHO, ICMR (Indian Council of Medical Research, India), Twitter Dataset, Git hub respiratory and other sources too. The result of the analysis divulge the impact of COVID-19 in India on daily and weekly manner, analogize India with abutting countries as well as with the countries who are badly affected using machine learning (ML). Also we have analyzed the sentiment of people of India as well as all states about COVID-19 using sentimental analysis, in which we have predicted sentiment of people are positive, negative or neutral.

Keywords: COVID-19, Exploratory Data Analysis (EDA), sentimental analysis, abutting countries analysis, Healthcare sector analysis, Machine Learning (ML).

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1 Introduction

The coronavirus COVID-19 pandemic is great global health crisis of 21 st century time and the greatest challenge we have faced in last century. COVID-19 is pandemic which have been already impacted each and every kind of people of more than 220 countries across the world and continent except Antarctica. Basically this virus is severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; formerly called 2019-nCoV), which was first identified amid an outbreak of respiratory illness cases in Wuhan City, Hubei Province, China on 31st December 2019. The first case outside of China was reported in Thailand . WHO declares COVID-19 outbreak as a Public Health Emergency of International Concern (PHEIC) by WHO on 30 January 2020. Due to this virus we have now reached the tragic milestone of more than 1.5 million deaths, and the human family is suffering under an almost intolerable burden of loss. Not only men but animals has also effect of this.

. Governments and other legislative bodies rely on insights from prediction models to suggest new policies and to assess the effectiveness of the enforced policies. But the crisis is much more than a health disorder, it's also an attack on socio-economic crisis. Stressing every one of the countries it touches, it has the potential to create devastating social, economic and political effects that will have deep and longstanding scars. The novel Coronavirus disease (COVID-19) has been reported to infect more than 64,948,823 people, with more than 1,501,535 confirmed deaths worldwide. This pandemic has impacted people not only physical appearance but also on mental strength, so there is to be analyzed the sentiment of people.

Every day, individuals square measure losing jobs and financial gain, with no approach of knowing once normality can come. little island nations, heavily captivated with touristry, have empty hotels and deserted beaches. The International Labour Organization estimates that four hundred million jobs might be lost. the planet Bank comes a US$110 billion decline in remittances this year, that may mean 800 million individuals won't be ready to meet their basic wants.

The structure of this model is as follows; Section – 1 introduces COVID-19 and explains the significance of this work. Section – 2 describes about previous work done, Section 3 describes about data taken for analysis and mathematical models for analysis. Section 4 describes about Data visualization and EDA for all the data used in this project. Section 5 tells about result of analysis and prediction. Section 6 describes about Conclusion and future work.

1.1 Motivation

It is throughout adversities that real heroes emerge. They are heroes as a result of they see adversity as a chance to unravel a retardant, or to beat a retardant. It’s the courageousness, strength and knowledge to suppose clearly within the times of crisis that creates a private emerge as a hero – to a family, to a community, to a nation and to the planet.

On the opposite hand, the one World Health Organization appearance at adversity as a retardant can ne'er emerge as a hero. as a result of this individual has allowed a retardant to enter into his head and is busy either deciding the way to take away the matter from his head or anticipating restlessly once the matter would finish in order that he will once more live peacefully. These people look into the matter as a roadblock to their goals. They ne'er realise that this downside is so their golden chance to succeed in their goal quicker and conjointly emerge as a hero.

Our society is within the era of unbelievable tries to struggle upon the unfold of this severe condition in terms of infrastructure, finance, business, producing, and a number of {several other} other resources. AI (AI) researchers strengthen their proficiency in developing mathematical paradigms for work this pandemic mistreatment nationwide distributed information. this text intends to use the machine learning models at the same time with the forecast of expected reachability of the COVID-19 over the nations by mistreatment the period information from the Johns Hopkins dashboard.

The recent international COVID-19 pandemic has exhibited a nonlinear and sophisticated nature. additionally, the natural event has variations with different recent outbreaks, that brings into question the power of ordinary models to deliver correct results. Besides the many illustrious and unknown variables concerned within the unfold, the quality of population-wide behavior in numerous government areas and variations in containment methods had dramatically enlarged model uncertainty. Consequently, normal medicine models face new challenges to deliver additional reliable results.

To overcome this challenge, several novel models have emerged that introduce many assumptions to modeling (e.g., adding social distancing within the variety of curfews, quarantines etc.). This pandemic has wedged folks not solely physical look however conjointly on mental strength, therefore there's to be analyzed the sentiment of individuals in order that we have a tendency to might facilitate the people that area unit suffering or may suffer within the future, man must match mentally and physically each.

Do you need to take a seat and still check the amount of covid-19 cases that area unit adding up, or {prepare for|steel oneself once morest|steel onself for|brace oneself for|inure|harden|indurate} this distinctive pandemic with additional vigour and energy to forestall such cases from ever happening again or to reduce the result of it?

1.2 Objective

Currently, solving problem data plays a very important role. In trade to cut back value and maximize profit, information analysis is incredibly helpful. currently we have a tendency to return to the purpose, COVID-19 cases area unit increasing apace on day to day. the aim of this project is to quantitatively analyze the impact of the COVID-19 pandemic on our societies within the style of people's quality, health, countries economy and sentiment of individuals. however the policy manufacturers area unit scuffling with their opinions and doctors area unit busy with their connected work. therefore with the assistance of those analysis, they will higher perceive true and may react consequently.

The main aim of this project is to study and analyze the COVID-19 spread in the world and India the day of spreading virus. We shall understand how the situation changed from epidemic to pandemic. We will analyze the effect of Government rules Lockdown, Partial Lockdown and No Lockdown.

At first we collected data from various resources kaggle.com github.com WHO, worldometer.com, John Hopkins University, from various other sources. The datasets are varies for different-different analysis. In this project detailed visualization have been done, graphing number of different-different visualization for active cases, deaths, recoveries, mortality rate (CFR) and recovery rate, country specific graph. Prediction for confirmed cases world-wide. For specific India, where a detailed analysis for states and city wise. Mental health of people of India have been analyzed using twitter dataset. We have done analysis for each and every states in India and for India giving positive or negative sentiment of people.

2 Literature Review

The transmission trend of COVID-19 from China to other countries, confirmed cases on daily basis, surveillance strategy of India, China, America, South Korea, Japan, Italy, Brazil, Iran Spain and many other countries from the first day of outbreak. Along with the effect of government policies of the above countries in controlling the COVID-19 outbreak by finding the linear relation between outbreak condition and "case fatality rate (CFR)". And these were analyzed by taking global statistics such as confirmed, death and recovered cases and making prediction with respect to China using "Linear Regression". However these days confirmed cases are increasing in some other manner like exponentially, polynomial or the other way.

Many researchers and different organization collected knowledge from dong Xiang Yuan, John Hopkins University and United Nations agency, then they did analysis and prediction for COVID-19 cases everywhere the globe. the info sets ar uploaded on corona huntsman web site and lots of different organization and authorities too. For prediction, the Susceptible-Exposed-Infected-Removed (SEIR) model was used. They conjointly offer sentiment analysis of stories on Covid-19, and that they found 561 positive articles and 2548 negative articles.

In this analysis, researchers provided a control of comorbidity on Covid-19 patients. They analyzed 1590 confirmed cases in China hospitalized in several hospitals. a complete of 686 feminine patients, 399 patients had comorbidities. during this analysis, they found that comorbidity plays an important role in clinical treatment, and patients with comorbidities have poor clinical outcomes. Another study showed that the foremost common symptoms of covid-19 were fever, cough, expectoration, headache and pain or fatigue.

In a performed a clinical prediction of mortality of covid-19 based on 150 patients in Wuhan city, China. Of these 150 cases, 68 and 82 were deaths and discharges, respectively.

In this study, they found that there is a significant difference between age in death cases and discharge cases. Forty-three out of 68 deaths had comorbidities, and in discharge cases, 34 out of 82 had comorbidities. Sixty-three patients died due to respiratory failure or myocardial damage. Only 5 patients died without any known cause.

3 Data and Model

3.1 Data Source

For COVID-19 data analysis, data is collected from verified source such as WHO, Ding Xiang Yuan (https://dataconomy.com/2020/04/apis-to-track-coronavirus-covid-19/), John Hopkins University [20], ICMR (Indian Council of Medical Research, https://www.icmr.gov.in/) [21], Kaggle.com [22].For sentiment analysis data collected from IBM competition.

3.2 Data Description

(A) Time series covid-19 confirmed case:- In this data set, there are 316 columns containing date starting from 22nd Jan 2020 and in row there are names of countries in which corona positive patient found.

NAME OF COUNTRY			
AFGHANISTAN	0	0	0
CHINA	444	444	549

22/01/2020 **23/01/2020 24/01/2020**

Table 3.1 Confirmed positive cases country wise

(B) Time series covid-19 death case:- In this data set, there are 316 columns containing date starting from 22nd Jan 2020 and in row there are names of countries in which corona dead patient found.

NAME OF COUNTRY	22/01/2020	23/01/2020	24/01/2020	25/01/2020
AFGHANISTAN	0	0	0	0
CHINA	17	17	24	40
INDIA	0	0	0	0
US	0	0	2	1

Table 3.2 Confirmed death cases country wise

(C) Time series covid-19 recovered case:- In this data set, there are 316 columns containing date starting from 22nd Jan 2020 and in row there are names of countries in which corona dead patient found.

NAME OF COUNTRY	22/01/202	23/01/2020	24/01/2020	25/01/2020
AFGHANISTAN	0	0	0	0
CHINA	28	28	31	32

Table 3.3 Recovered cases country wise

For visualization in India

(D) covid_19_india dataset: It contains all states with their states and how much corona positive (Indian, Foreign), deaths, recovered and confirmed (both Indian and Foreign positive patient)

DATE	***STATE/ UNION***	***CONFIRMED(I)***	***CONFIRMED(F)***	***CURED***	***DEATHS***	***CONFIRMED***
31/01/2020	*Kerala*	*1*	*0*	*0*	*0*	*1*
01/02/2020	*Kerala*	*1*	*0*	*0*	*0*	*1*
02/02/2020	*Kerala*	*2*	*0*	*0*	*0*	*2*

Table 3.4 Covid-19 India state wise

(E) COVID-19_Cases_Summarized_by_Age_Group: This data contains age group in one column and other columns consist of confirmed New and Cumulative

DATE	AGE-GROUP	CONFIRMED NEW	CONFIRMED CUMULATIVE
12/03/2020	51-60	2	6
13/03/2020	51-60	3	9
14/03/2020	51-60	1	10

Table 3.5 COVID-19_Cases_Summarized_by_Age_Group

(F) State wise Testing Details: This table of data contains date on which testing performed and columns consisting of Total Sample tested, Negative and positive found patient.

DATE	STATE	TOTAL SAMPL	NEGATIVE	POSITIVE
02/04/202	AP	1800	1175	132
10/04/202	AP	6374	6009	365
11/04/202	AP	6958	6577	381

Table 3.6 State wise Testing Details

3.3 Statistical Models

Machine Learning

We all know, this decades and next coming decades are of Machine Learning (ML) and Artificial Intelligence (AI) which have capability of automatically learn and improve from experience without being explicitly programmed. [10] This is tool to focus on the development of computer programs that can access data and use it learn for themselves. Thus, it is widely used for data analysis in various domains like financial sector, business sector, education sector, medical engineering and these days even in sports. It comes under Artificial Intelligence which teaches machines from training datasets. Through machine learning, we are able to establish patterns, analyze **information**, and build correct selections with no human intervention or less human intervention. Machine learning is loosely classified into 3 components that area unit given below:

1. Supervised Learning
2. Unsupervised Learning
3. Reinforcement Learning

Superior learning means that a machine or model teaches the teacher, or in other words, we can say that the machine or model learns through a training dataset. In supervised learning, class-level information is available in the training datasets.

Whereas unsupervised learning means-learning without a teacher or in other words learning algorithms learn dynamically with help partitioning or clustering algorithm. Most of the clustering algorithms are available in literature such as KMeans, Fuzzy C-Means, hierarchical clustering methods, and so on.

Reinforcement learning is a combination of supervised and unsupervised learning methods. it's concerning taking appropriate action to maximize reward during a explicit state of affairs. within the absence of a coaching dataset, it's guaranteed to learn from its expertise. Example: The problem is as follows: We have an agent and a reward, with many hurdles in between.

3.4 Predictive Algorithm/Model Selection

3.4.1 Regression Analysis

Regression analysis is a part of machine learning , regression analysis is a subset of machine learning algorithms. It is the first machine learning algorithm. Regression analysis inventor says that "Regression analysis consists of a different types of machine learning methods that allow us to predict a continuous outcome variable (Y) based on the value of one or multiple predictor variables (X). It gives a linear relation between the outcome and the predictor variables". Let us consider equation straight line connecting any two variables *X* and *Y* can be stated algebraically as:

$$Y = a X + b \qquad \text{- - - (1) (Linear Regression)}$$

Where *b* is called the intercept on the y-axis and '*a'* is called the slope of the line. Here '*a'* and '*b'* are also called the parameters of regression analysis. These parameters should learn through proper learning methods. This is called Linear Regression Analysis.

In this proposed, we have developed six regression analysis based models known as exponential, quadratic, 3 degree, 4 degree, 5 degree polynomial. The description of these models is given below:

$$\boldsymbol{Y = ae^{bx} + b} \qquad \text{- - - (2) (Exponential Reg.)}$$

$$Y = aX^2 + bX + c \qquad \text{- - - (3) (Polynomial Reg.)}$$

$$Y = a\,X^3 + bX^2 + cX + d \qquad \text{- - - (4)}$$

3.4.2 SIR Predictive Modeling

In this section we will discuss about another simplest predictive modeling which is Susceptible-Infected-Removed (SIR) that will describe the COVID-19 outbreak.

What is in it?

- S : Susceptible = (Total – Confirmed)
- I : Infected = (Confirmed – Recovered – Deaths)
- R : Recovered or fatal = (Recovered + Deaths)

Note: SIR model is not the general model

Here Recovered is sum of recovered and fatal, means the people having immunity either they died or get rid of decease. And so mortality rate can't be ignored in real data.

Procedure of conversion:

$$\mathbf{S} \xrightarrow{\boldsymbol{\beta}\mathbf{I}} \mathbf{I} \xrightarrow{\gamma} \mathbf{R}$$

Where $\boldsymbol{\beta}$: is effective contact rate [1/min]

and γ: Recovery (+mortality) rate [1/min]

Ordinary Differential Equation (ODE) will be like

$$\frac{dS}{dT} = \frac{\beta SI}{N}$$

$$\frac{dI}{dT} = \frac{\beta SI}{N} - \gamma \mathbf{I}$$

$$\frac{dS}{dT} = \gamma \mathbf{I}$$

Where N = S + I + R is total population of data set and T is elapsed time from beginning of decease.

3.4.3 SIR-D predictive Modeling

In this modeling we consider fatality rate and recovered cases as different situation. Like in previous mathematical modeling where recovered was sum of recovered and death.

What is in it?

- S : Susceptible = (Total – Confirmed)
- I : Infected = (Confirmed – Recovered – Deaths)
- R : Recovered (Only Recovered and no Deaths)

- D: Deaths

Procedure of conversion:

$$\mathbf{S} \xrightarrow{\boldsymbol{\beta}\mathbf{I}} \mathbf{I} \xrightarrow{\gamma} \mathbf{R}$$

$$\mathbf{I} \xrightarrow{\alpha} \mathbf{D}$$

Where α: is Mortality Rate (Fatality Rate)

β: is Effective contact rate

γ: is Recovery Rate

and Ordinary Differential Equation (ODE) will be like

$$\frac{dS}{dT} = \frac{\beta SI}{N}$$

$$\frac{dI}{dT} = \frac{\beta SI}{N} - (\gamma + \alpha)\, I$$

$$\frac{dR}{dT} = \gamma \mathbf{I}$$

$$\frac{dD}{dT} = \alpha \mathbf{I}$$

Where N = S + I + R + D is total population of data set and T is elapsed time from beginning of decease.

3.4.4 SIR-F predictive Modeling

In the case of any decease some patient die before clinical diagnosis and that too happened in the case of COVID-19 pandemic. So we will consider this issue as

"S + I → Fatal + I" and this will be summed in this model than previous one.

What is in it?

- S : Susceptible
- S*: Confirmed and Uncategorized
- I : Confirmed and Categorized as I
- R : Recovered
- F: Fatal with the confirmation

So here equation will be like

Confirmed = I + R + F

Recovered = R

Deaths = F

Procedure of conversion:

$$S \overset{\beta I}{\to} S* \overset{\alpha 1}{\to} F$$

$$S \xrightarrow{1-\alpha 1} I \overset{\gamma}{\to} R$$

$$I \overset{\alpha 2}{\to} F$$

Where α1: Mortality rate of S^* cases

α2: is mortality rate of I cases β: effective contact rate γ: is recovery rate

Here Point to consider is: If (α1= 0) then this SIR-F model is same as SIR-D model

Ordinary Differential Equation (ODE) will be like

$$\frac{dS}{dT} = \frac{\beta SI}{N}$$

$$\frac{dI}{dT} = (1 - \alpha 1)\frac{\beta SI}{N} - (\gamma + \alpha 2)\ I$$

$$\frac{dR}{dT} = \gamma I$$

$$\frac{dF}{dT} = N^{-1} \alpha_1 S\ I + \alpha_2 I$$

Where N = S + I + R + F is total population of data set and T is elapsed time from beginning of decease.

After we have stored the news inside the Corona Tracker database, we extract news description as it contains a summary of the news that is neither too short nor too long, which can be bad for the model we are going to use otherwise. We only select descriptions that are at least more than 8 words, and discard non-English descriptions because the pre-trained model we use have been trained on SST-2 [25], which is a dataset for sentiment analysis for English language. We use a library called transformers by hugging face [26]. The input sentences will be separated by their respective polarity for further analysis like topic modelling and generating word cloud for each

4 Data Visualization

5.1 World data visualization

Figure 4.1 shows the Increasing number of COVID-19 positive cases over time starting from the 22nd Jan 2020 to 10th Dec 2020. Where blue line show continuous increase by every day and the doted yellow line shows the number of positive patient increased in 7 days. And figure 5.2, 5.3 and 5.4 shows the same on deaths, recovery and active cases respectively.

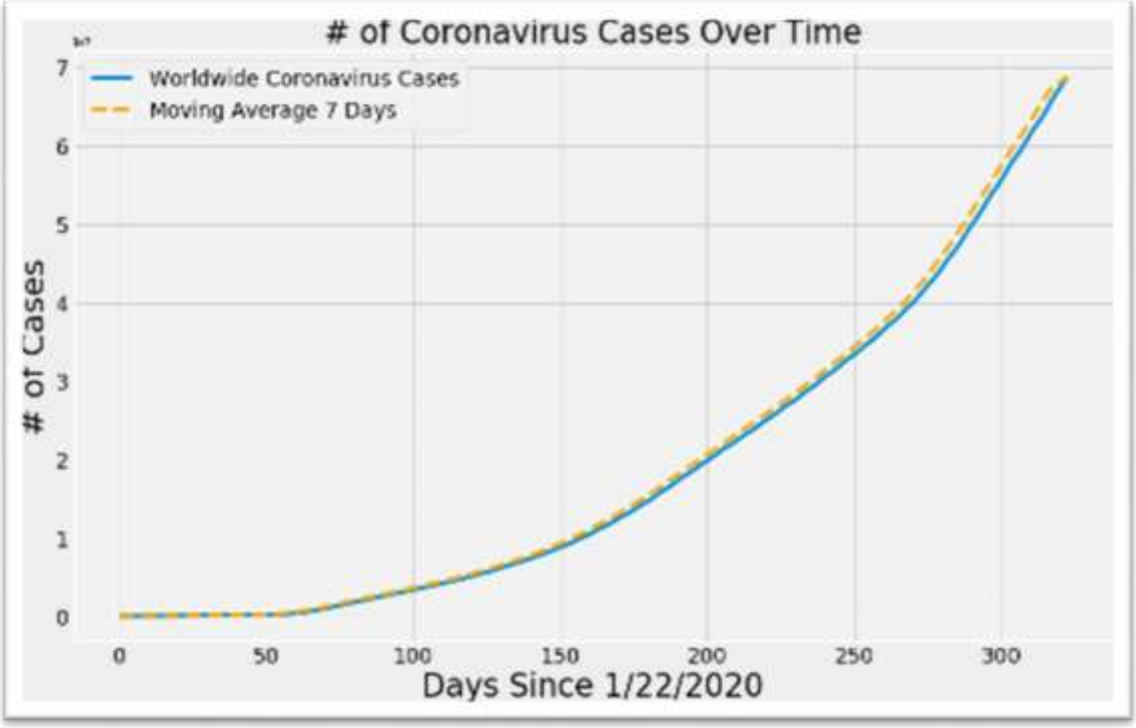


Figure 4.1 COVID-19 cases over time

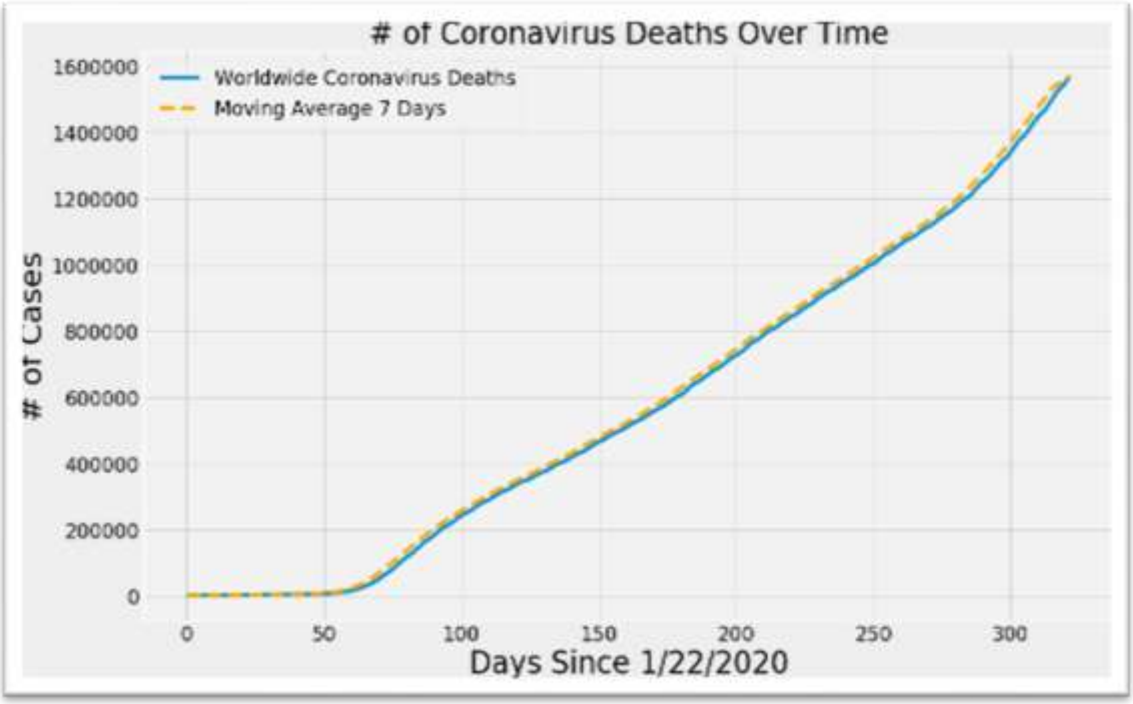


Figure 4.2 COVID deaths over time

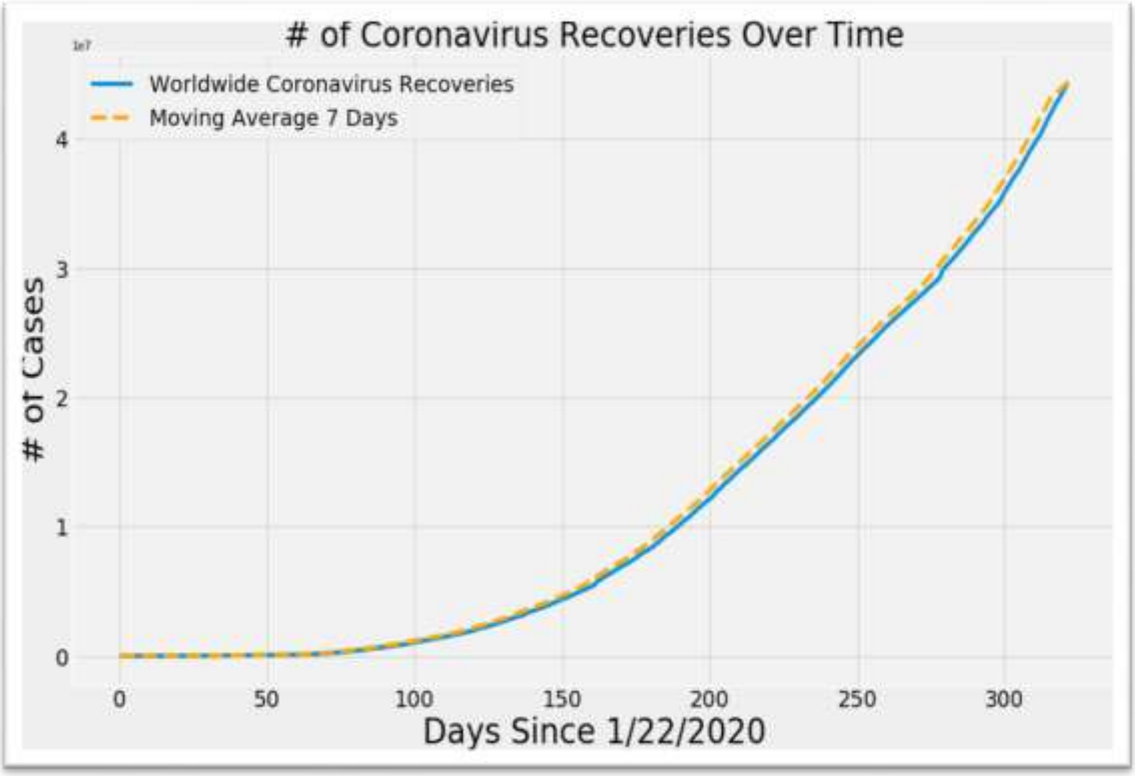


Figure 4.3 COVID-19 recovery over time

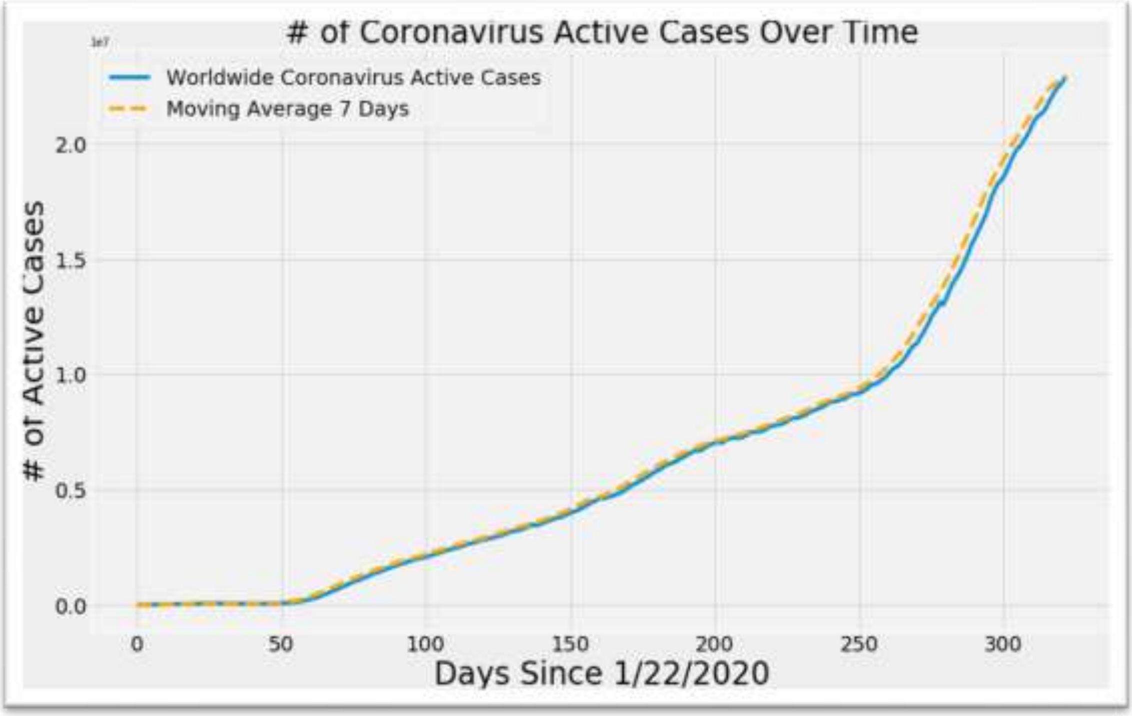


Figure 4.4 COVID-19 active cases

5.2 Top five countries in World

In the world United States of America stands with recored number of COVID19 cases in the world with more than 16 million confirmed cases and on the 2nd position, India is with approximately 10 million cases then Brazil (6880,595), Russia (2625848) and

France (2365319) are on the 3rd, 4th and 5th position respectively.

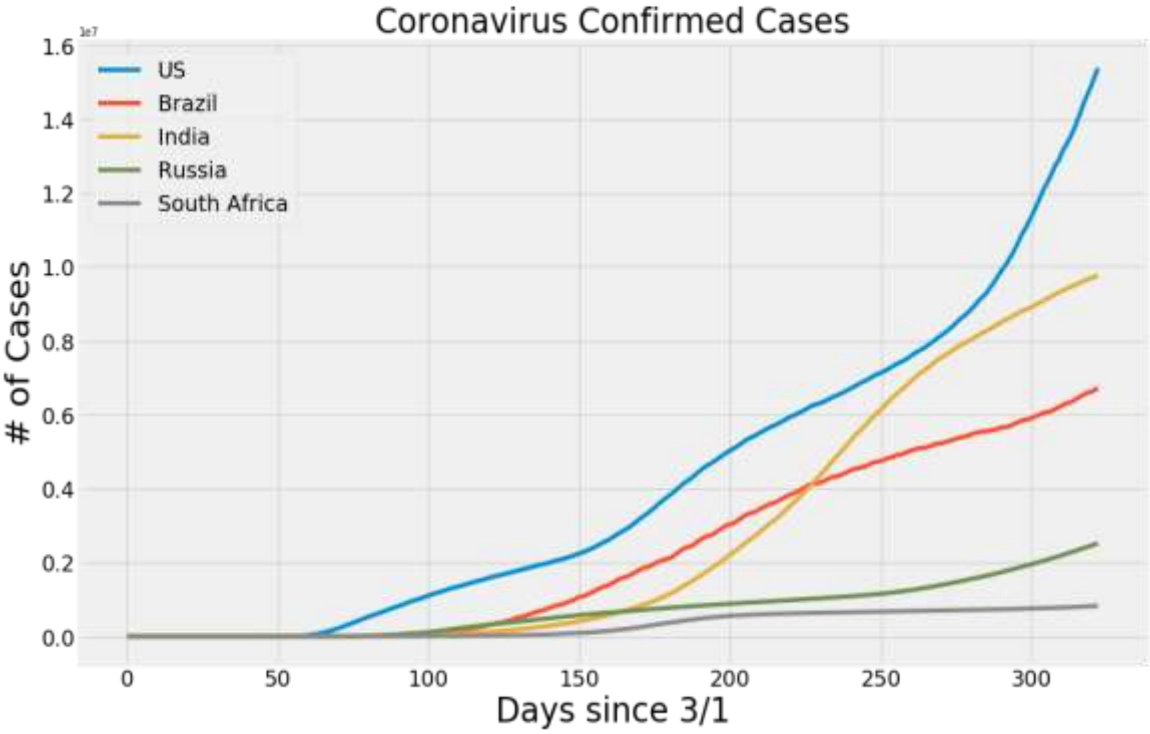


Figure 4.5 Top five countries in Confirmed cases

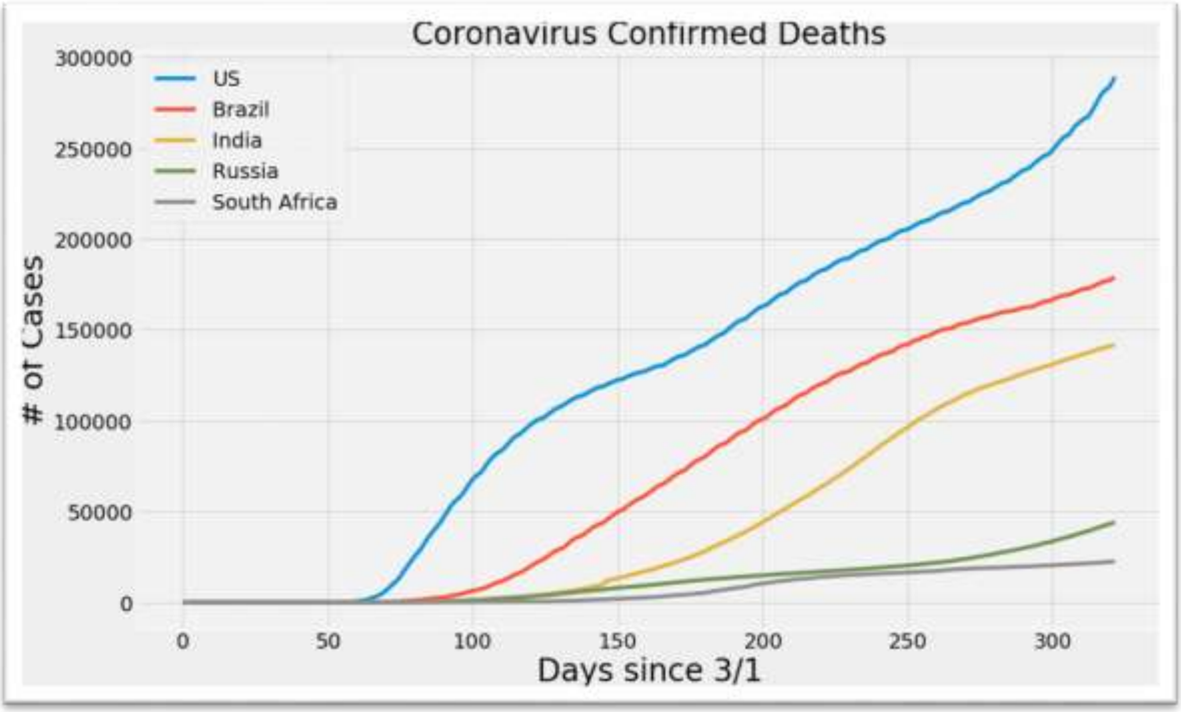


Figure 4.6 Top five countries in confirmed deaths

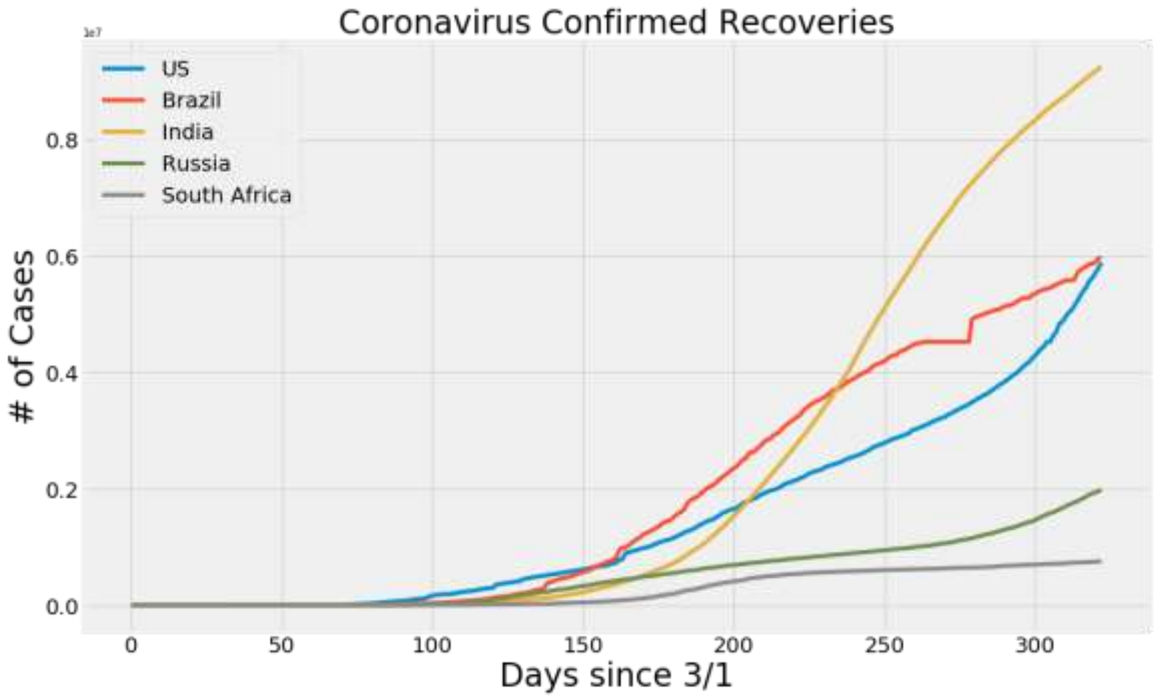


Figure 4.7 COVID-19 confirmed recoveries

5.3 US data visualization

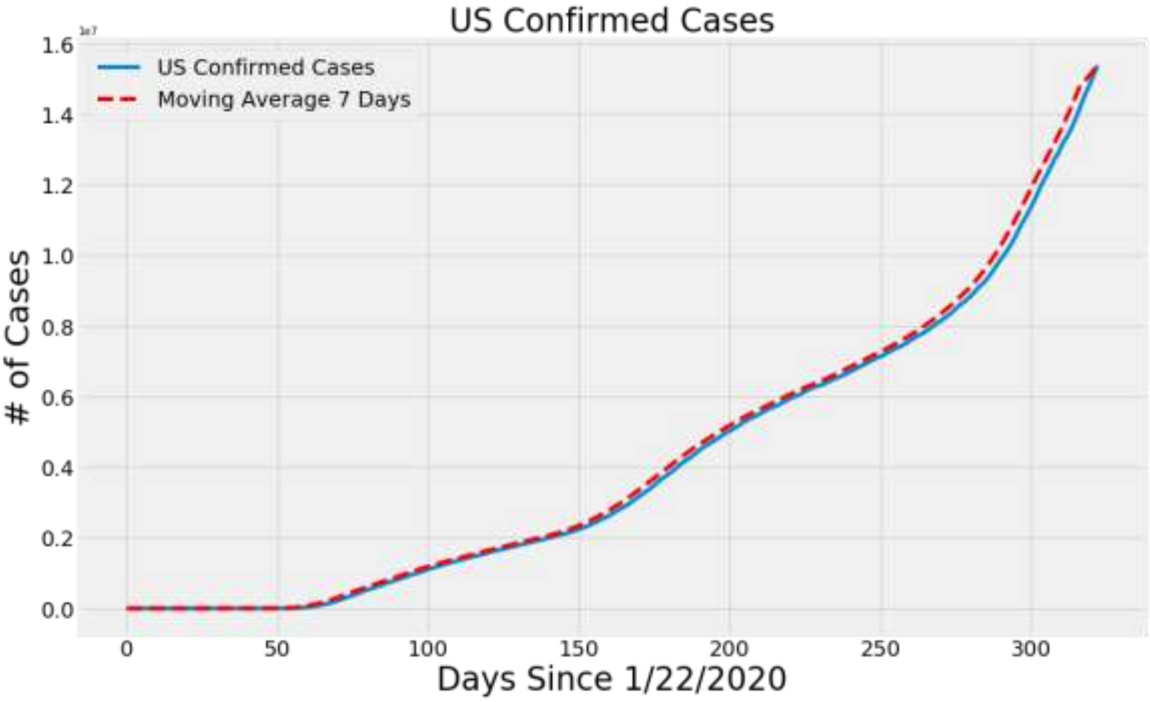


Figure 4.8 US confirmed cases over time

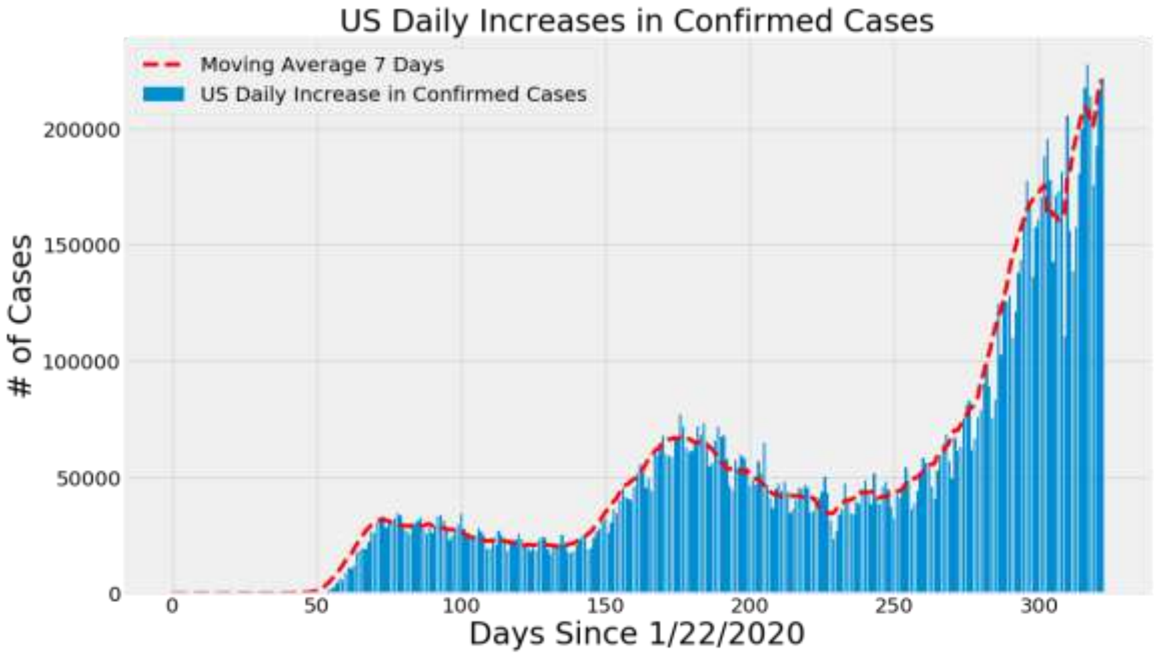


Figure 4.9 US daily increase in Confirmed cases

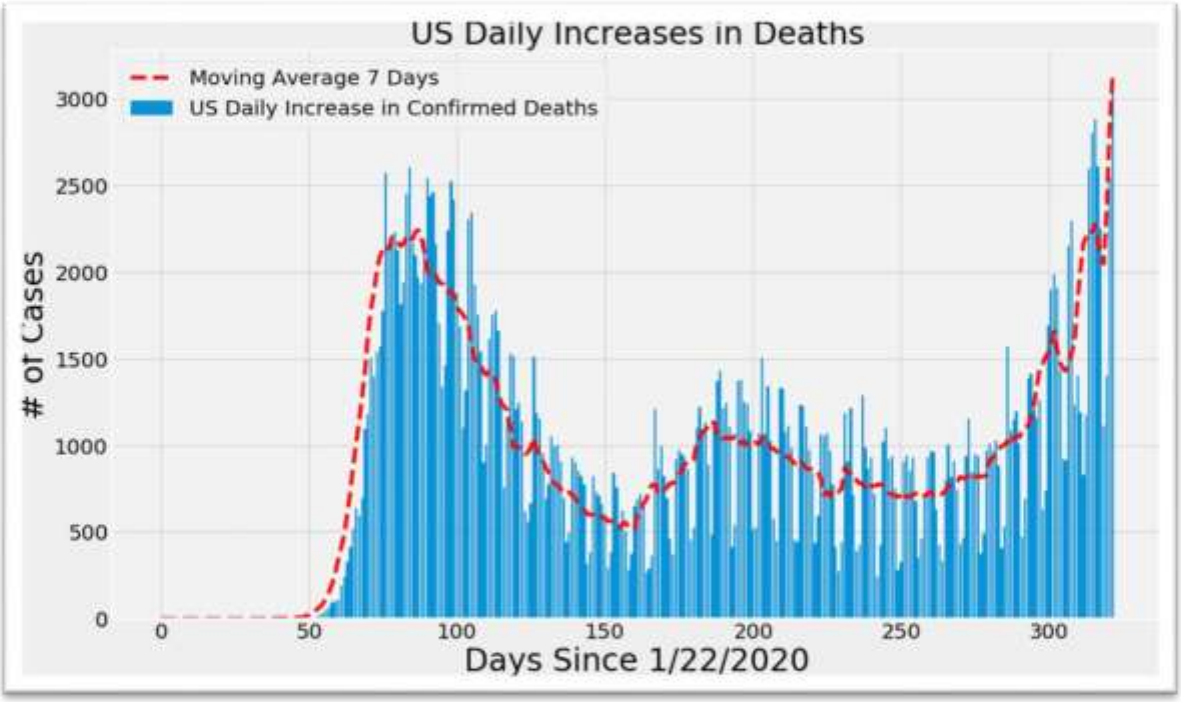


Figure 4.10 US daily increase in Deaths

5.3 India Data Visualization

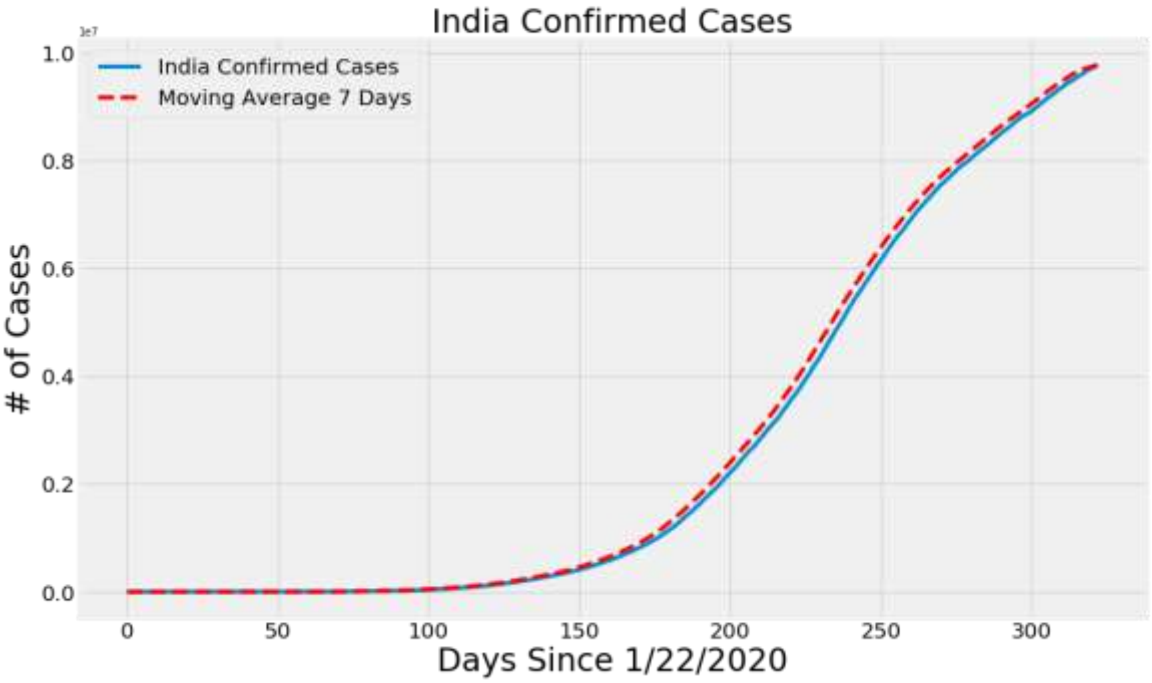


Figure 4.11 India Confirmed cases

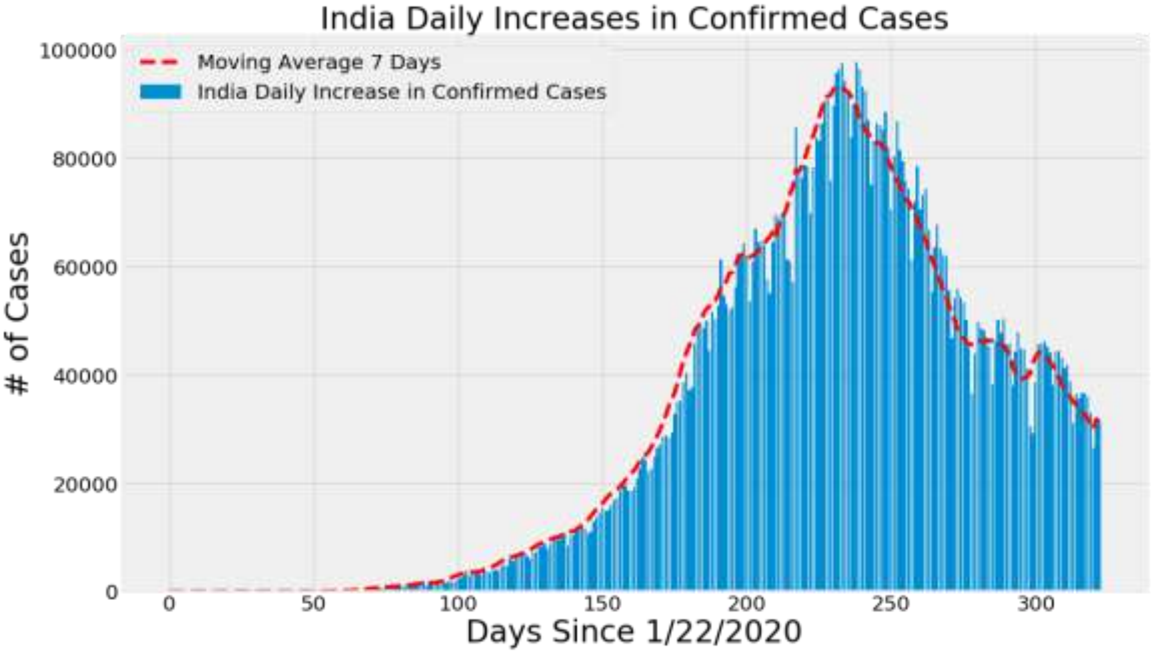


Figure 4.12 India Daily Increases in confirmed cases

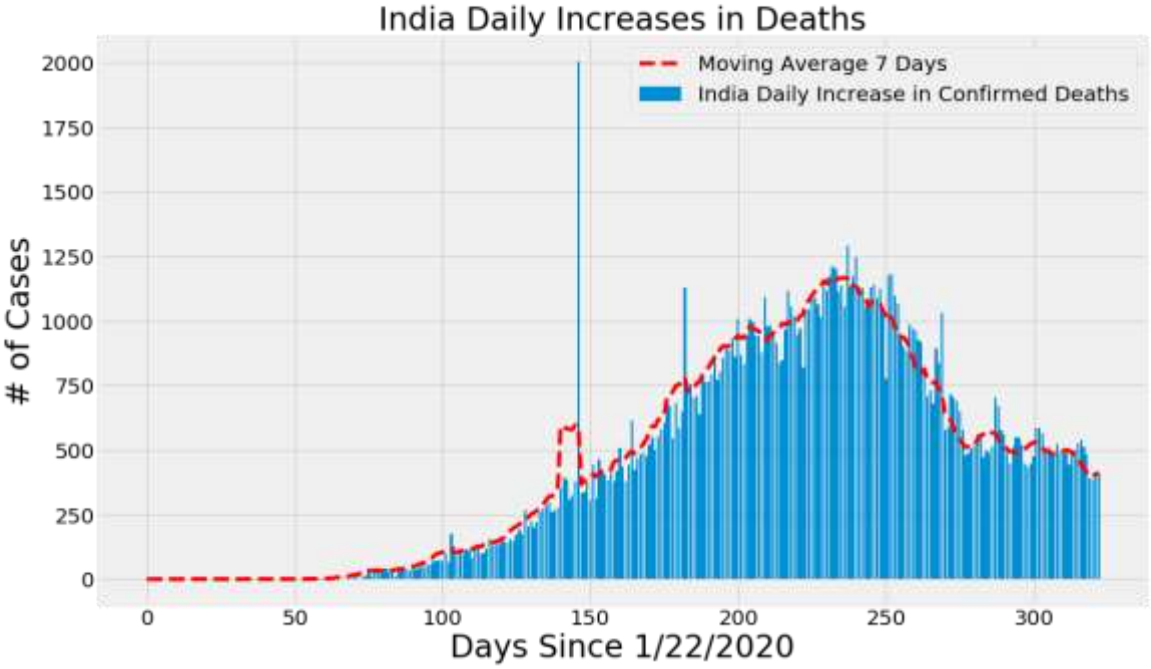


Figure 4.13 India Daily Increases in Deaths

5.4 India: A State Level Analysis

Here we can visualize that Maharashtra tops among all States/UT and then Andhra Pradesh but we can clearly see that incidence rate of Delhi, AP and Maharashtra is still high and that has to be lowered and preventive measure should be raise immediately.

	State Name	Number of Confirmed Cases	Number of Deaths	Number of Active Cases	Incidenc e rate	Mortality rate
0	Maharashtra	1617658	42633	159346.000000	1313.628817	0.026355
1	Andhra Pradesh	793299	6508	32376.000000	1471.705130	0.008204
2	Karnataka	782773	10696	100459.000000	1158.587745	0.013664
3	Tamil Nadu	697116	10780	35480.000000	895.560963	0.015464
4	Uttar Pradesh	461475	6755	29364.000000	193.992649	0.014638
5	Kerala	361841	1232	93527.000000	1013.576038	0.003405
6	Delhi	340436	6128	24117.000000	1819.450693	0.018000
7	West Bengal	333126	6244	35579.000000	334.432618	0.018744

8	Odisha	274181	1181	18087.000000	591.463941	0.004307
9	Punjab	231195	6383	7303.000000	521.089163	0.027609
10	Telangana	227580	1292	20183.000000	578.161089	0.005677
11	Bihar	208377	1019	11118.000000	166.968849	0.004890
12	Assam	202774	889	25807.000000	569.477288	0.004384
13	Rajasthan	178933	1788	19185.000000	220.815824	0.009993
14	Chhattisgarh	167639	1628	25795.000000	569.498860	0.009711
15	Madhya Pradesh	163296	2828	12386.000000	191.305037	0.017318
16	Gujarat	162823	3660	14193.000000	254.919187	0.022478
17	Haryana	153367	1674	10187.000000	543.764137	0.010915
18	Jharkhand	98061	851	6206.000000	254.083879	0.008678
19	Jammu and Kashmir	89582	1402	8088.000000	658.385221	0.015650
20	Uttara Khand	59106	960	5085.000000	525.346600	0.016242
21	Goa	41339	557	3099.000000	2606.083530	0.013474
22	Puducherry	33622	580	4026.000000	2378.563920	0.017251
23	Tripura	29925	334	2339.000000	717.661352	0.011161
24	Himachal Pradesh	19621	279	2636.000000	263.300033	0.014219
25	Manipur	16267	124	3846.000000	526.177041	0.007623
26	Arunachal Pradesh	13912	31	2682.000000	885.856228	0.002228
27	Chandigarh	13795	209	744.000000	1190.791671	0.015150
28	Meghalaya	8621	77	1870.000000	256.066011	0.008932
29	Nagaland	8139	28	1683.000000	361.782375	0.003440
30	Unknown	7541	22	781032.000000	0.000000	0.002917
31	Laddakh	5781	68	848.000000	2107.631002	0.0117

Table 4.1 State Level Analysis

5 Results

5.1 Outbreak Prediction for world

COVID-19 cases are increasing continuously instead of many rules and regulation of government, also different modes of lockdown and social distancing measure world-wide by government of countries. Many guidelines have been given by World Health Organization (WHO) to reduce the impact of COVID-19 and irrespective of these rules more than 1.61 million people died due to this pandemic. If we have earlier information that how many people are going to be affected by this pandemic, we and our government will have specific plans to deal with this pandemic.

5.1.1 World Prediction using SVM

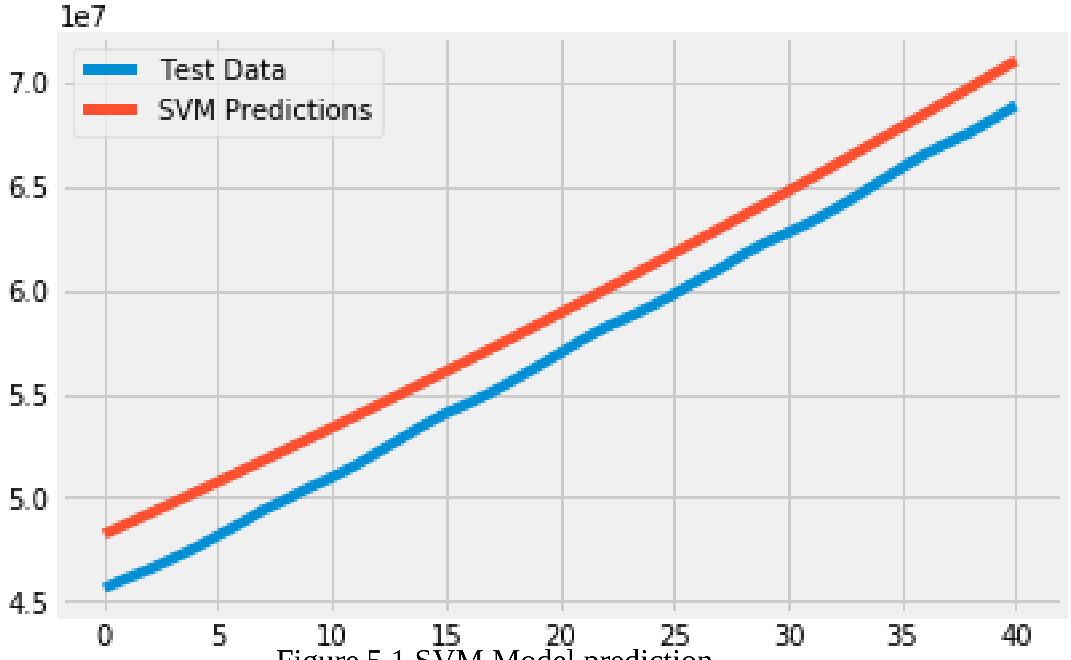


Figure 5.1 SVM Model prediction

And prediction for next 10 days:

DATE	SVM PREDICTED # OF CONFIRMED CASES

12/10/2020	**WORLDWIDE** 71698804.000000
12/11/2020	72352435.000000
12/12/2020	73010114.000000
12/13/2020	73671853.000000
12/14/2020	74337664.000000
12/15/2020	75007560.000000
12/16/2020	75681553.000000
12/17/2020	76359655.000000
12/18/2020	77041880.000000
12/19/2020	77728239.000000

Table 5.1 SVM Prediction for world data

We can see that by this model slightly over fits the expected over predicted.

5.1.2 World Prediction Using Polynomial Regression

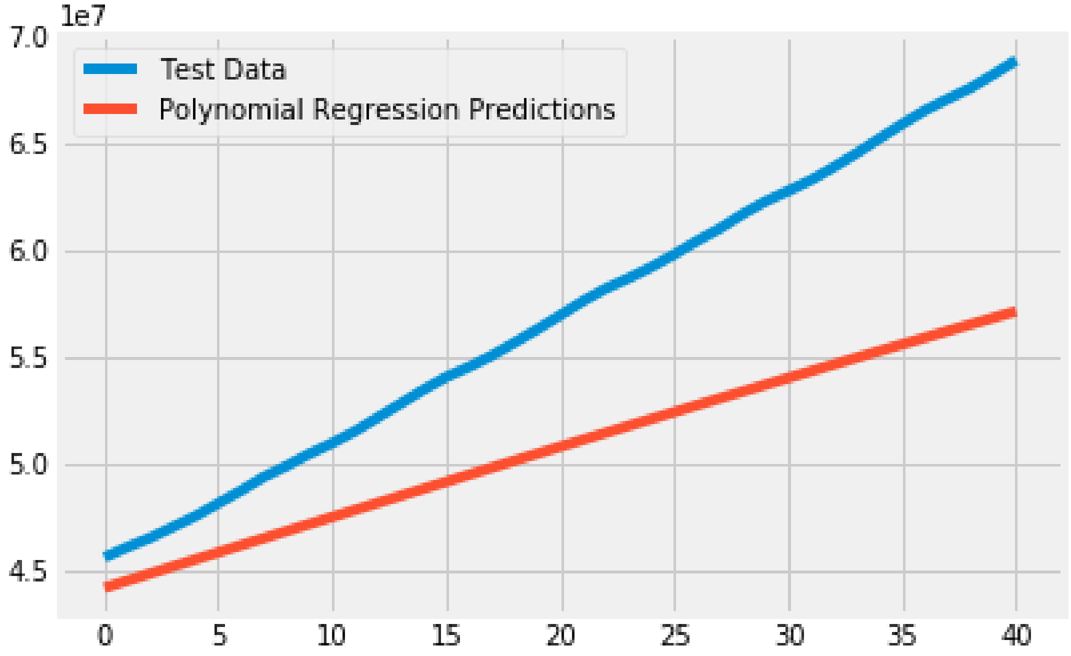


Figure 5.2 Polynomial model prediction

DATE	**POLYNOMIAL PREDICTED # OF CONFIRMED CASES**
12/10/2020	**WORLDWIDE** 57444875.000000
12/11/2020	57747538.000000
12/12/2020	58048668.000000
12/13/2020	58348223.000000
12/14/2020	58646159.000000
12/15/2020	58942434.000000
12/16/2020	59237002.000000
12/17/2020	59529821.000000

12/18/2020	59820847.000000
12/19/2020	60110034.000000

Table 5.2 Polynomial prediction

We can see that prediction curve over fits the expected and difference is increasing with time, so not so good algorithm.

5.1.3 World Prediction Using Bayesian Ridge Regression

DATE	**SVM PREDICTED # OF CONFIRMED CASES WORLDWIDE**
12/10/2020	59214049.000000
12/11/2020	59582370.000000
12/12/2020	59950760.000000
12/13/2020	60319198.000000
12/14/2020	60687665.000000
12/15/2020	61056143.000000
12/16/2020	61424610.000000
12/17/2020	61793047.000000
12/18/2020	62161434.000000
12/19/2020	62529752.000000

Table 5.3 Bayesian Ridge Regression Prediction

5.2 Outbreak Prediction for India

5.2.1 Prediction Using SIR Model

This is a potential SIR model, if lockdown had not been imposed from 14th March to 14th April, *i.e.* for 30 days then

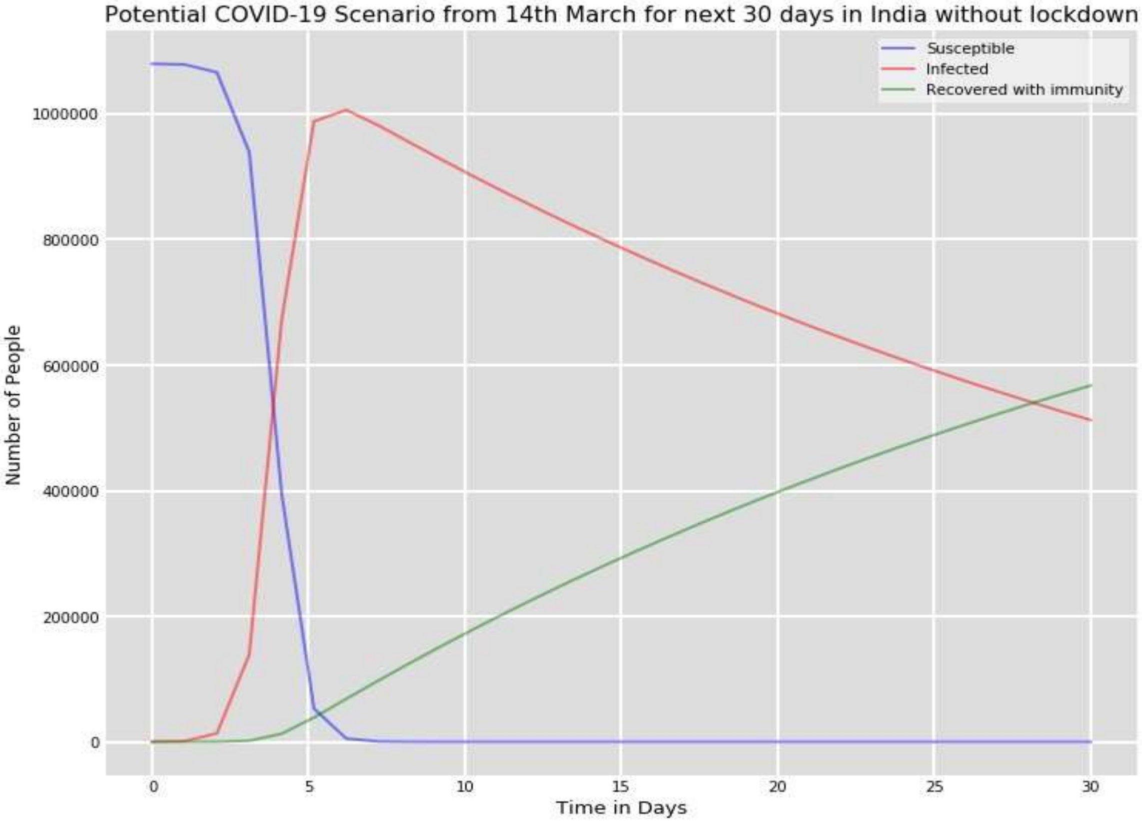


Figure 5.3 SIR prediction in April without lockdown

Here beta (□) = 0.22807272 and gamma (□) = 0.01422848

Now estimating beta (□) and gamma (□) during lockdown period and using it to predict the figures for the next three months from 5th may 2020 onwards

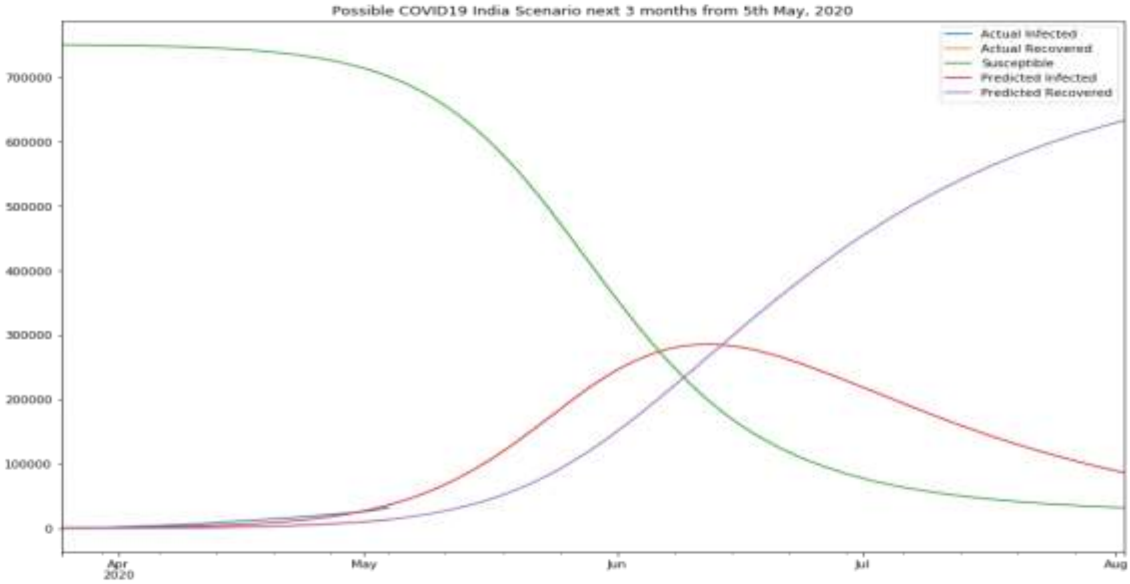


Figure 5.4 SIR prediction in May without lockdown

Here beta (□) = 0.14268499 and gamma (□) = 0.03824572

Now estimating beta ( ) and gamma ( ) throughout internment amount and exploitation it to predict the figures for future 3 months from fifth might 2020 onward in best case situation

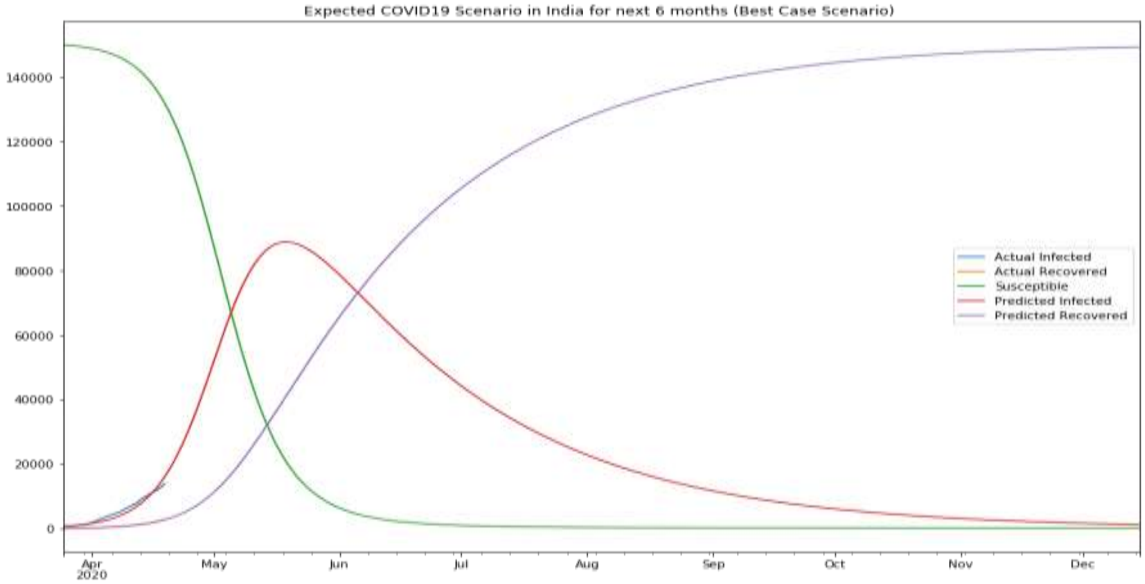


Figure 5.5 SIR prediction in best case

Here beta (□) = 0.15858943 and gamma (□) = 0.02195618 Same

as above in worst case scenario:

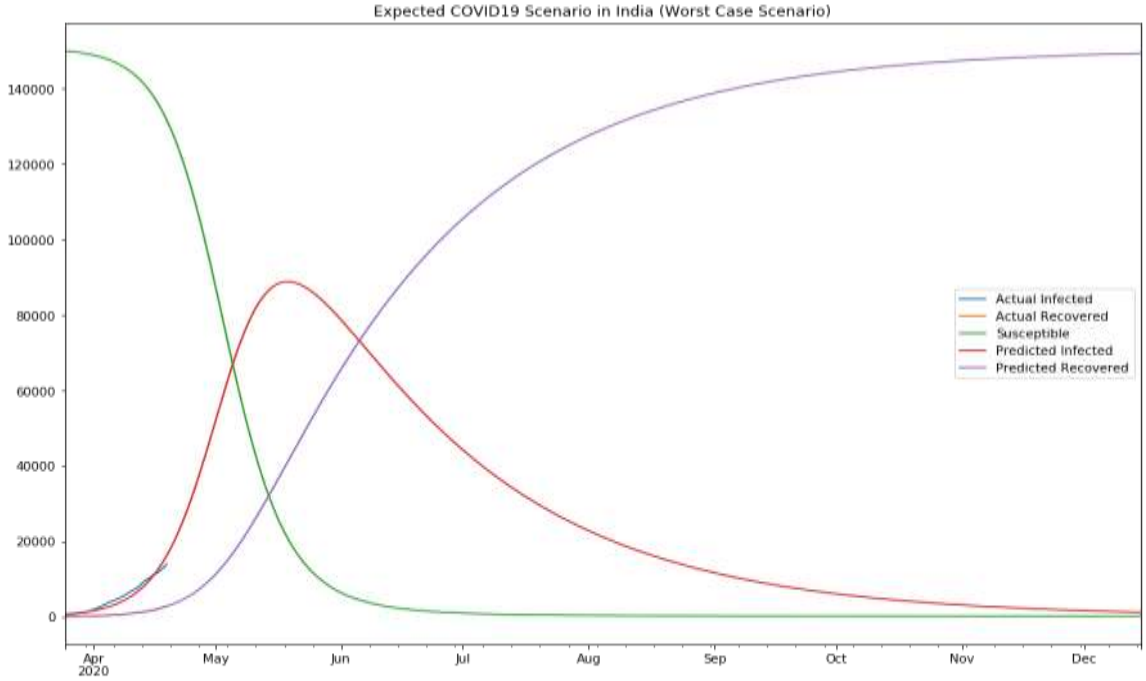
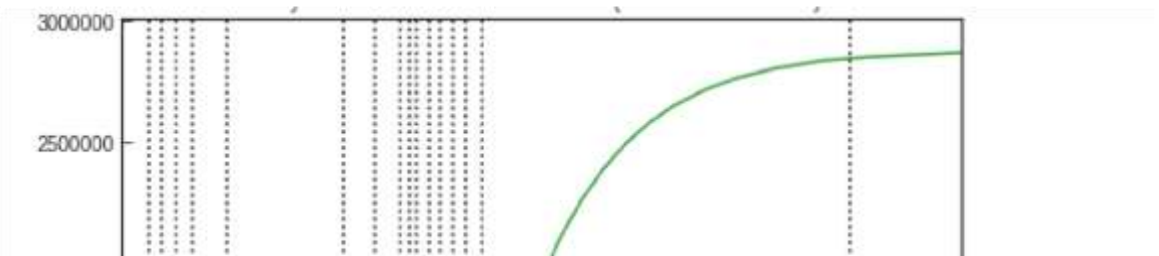


Figure 5.6 SIR prediction in worst case



India prediction using SIR

Figure 5.7 SIR prediction

DATE	INFECTED	RECOVER
12/10/2020	30796	**ED** 30080
12/11/2020	28640	32802
12/12/2020	26987	27640
12/13/2020	30394	32549
12/14/2020	28653	30643
12/15/2020	30122	29891
12/16/2020	29874	30498
12/17/2020	30123	32501
12/18/2020	28640	29845
12/19/2020	27899	30145

With beta (□) = 0.21774528 and gamma (□) = 0.17736864

5.2.2 Prediction using SIR-D model for India

DATE	INFECTED	DEATH	RECOVER
12/10/2020	28996	361	298**ED**80
12/11/2020	28640	328	31862
12/12/2020	27987	354	33120
12/13/2020	29399	389	32549
12/14/2020	30658	403	3231
12/15/2020	30123	413	31231
12/16/2020	29871	379	32498

12/17/2020	29148	358	33501
12/18/2020	28657	381	31845
12/19/2020	27819	401	30145

Here beta (□) = 0.15858943 and gamma (□) = 0.21765473 and alpha (□) = 0.02195618

5.2.3 System with social distancing:

Social distancing includes avoiding giant gatherings, physical contact, and different efforts to mitigate the unfold of communicable disease. in step with our model, the term this is often aiming to impact is our contact rate, β.

Let’s introduce a brand new price, ρ, to capture our social distancing result. this is often aiming to be a relentless term between 0–1, wherever zero indicates everyone seems to be latched down and unintegrated whereas one is adore our base case on top of. To introduce this into our model, we’ll modify Equations of SIR-D and SIR-F on top of by multiplying this with our β.

If we tend to set ρ to one, 0.8, and 0.5, we are able to visualize the flattening result as we tend to increase our efforts to contain the illness through straightforward, a day actions.

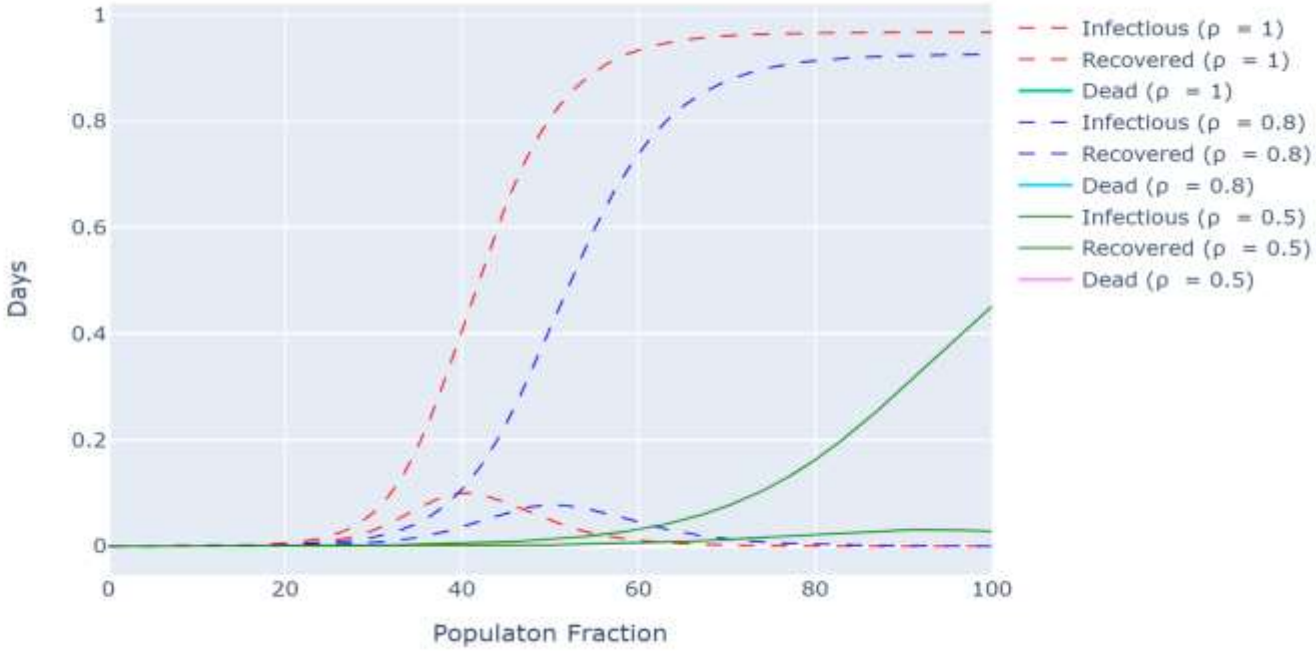


Figure 5.8 Effect of rho (ρ)

From above graph we can clearly see that if rho (□) is 1 then approximately whole population tend to getting infected but still more than 90% people will recovered reason behind it is, most of population will have Herd Immunity and COVID-19 will not effect. But still number of deaths will increase for getting Herd Immunity.

6 Conclusion and Future Work

This paper presented outbreak visualization and trend of COVID-19 from 22nd Jan to Oct-Nov 2020 due to high impact on people and all government and organization. Mathematical model based on Regression (Linear, polynomial and exponential) and Support Vector Machine (SVM) were proposed to predict for world, and polynomial regression performed better than all other.

Mathematical model SIR, SIR-D and SIR-F were projected to predict the Bharat information wherever SIR model showed a major distinction between each model and SIRD with (beta ( ) = .15858943 and gamma ( ) = .217654735 and alpha ( ) = .021956181) performed higher than SIR with (beta ( ) = .217745281 and gamma ( ) = .177368641). optimisation of parameter of each SIR and SIR-D models improved the prediction accuracy considerably.

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