

COVID-19 INDIA :

Modeling, Forecasting, Effects And Analysis

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ABSTRACT

COVID-19 outbreak is the worst crisis seen by the world in 21st century so far. COVID-19 transfers from person to person via touch. The disease which was generated from China has affected peoples' health, economy of countries and challenged the health facilities of every nation whether it is developed like USA, Italy or under development like India. Vaccine or antidote of this disease is not available yet and developed countries are putting their all efforts to find a cure but till now prevention is the only technique to avoid this disease. In this study we find and discussed the effects of outbreak on people and economy of India along with predicting next 30 days total cases, recoveries and deaths due to the disease in India using both mathematical and machine learning models. In addition to this, analysis of medical facilities like different types of hospitals and public health centers and occupancy of beds in them, along with control measures done by government in order to reduce rapid spread of disease and analysis of economical effects on Indian stock markets is also done. This study and finding and analysis of this research will help understanding the overall current COVID-19 situation of India and its states and how much worse situation can become in future so that government can take measures in accordance to that.

1. INTRODUCTION

The world is currently suffering from a new disease called SARS-CoV-2(COVID-19) which is taking lives of ,many people everyday all over the world. Many countries witnessed rise in coronavirus positive cases from December onwards. The disease is very deadly for people those have low immunity like kids and old age people and those having medical problems mostly related to lungs. Symptoms of the disease are quiet similar to that of flu like cold, cough and breathing problem. Recovery period of COVID-19 disease is 14 to 16 days as observed by doctors. Also it takes around 2 weeks to show symptoms of this virus. It can prevented by washing the hands more frequently with a sanitizer, maintaining a social distancing of 1 to 3 feet from people and by avoiding touching your face.Avoid going out unless its urgent.Wear a mask and gloves when going out and avoid touching anything. World Heath Organization has declared the Covid-19 as pandemic now. [1].Number of positive cases are rising rapidly worldwide as there is no vaccine available right now and disease is contagious. Health workers cannot operate efficiently if hospitals are under-prepared. Reportedly, Covid-19 has two important stages. Stage-II having person-to-person transmission and Stage-III having community transmission. Various countries can decide their plan of action against the disease by determining their current Covid-19 stage.

India has higher risk from this infectious disease due to its large population and dense populated areas like Mumbai, Delhi etc.The very first positive COVID-19 case in India was detected in Kerala on 30th January[2]. India started seeing upward trend in number of cases from the fist week of march and since then, the rate of cases per day is only rising despite lockdown and maintaining social distancing.Hence, it becomes important to model and observe the effects of COVID-19 situation in India and to predict the future trend[3]. The predictions and analysis can provide insights into disease's epidemiology, which could be helpful for checking health system capacities by policymakers[4].Analysis can help understanding the market and people's reaction on this outbreak so that government can take better decisions keeping these trends and predictions in mind.For examples, for how many days should lockdown be extended? Or Which states should be given relaxation on some services. Also, a prediction model can be updated to estimate the trends and the risk of other countries too.

Following are the main objectives of this paper :-

1. Modeling and forecasting COVID-19 India data on SEIR model.
2. Prediction of future deaths, recovered and confirmed cases in India using regression model
3. Analysing the hospital data of India
4. Analysing control measures taken by Indian government so far
5. Analysing and plotting NIFTY50 stock prices since 30th January, when first COVID-19 positive case was reported in India..
6. Sentiment analysis of Indians regarding coronavirus outbreak.

2. METHODOLOGY

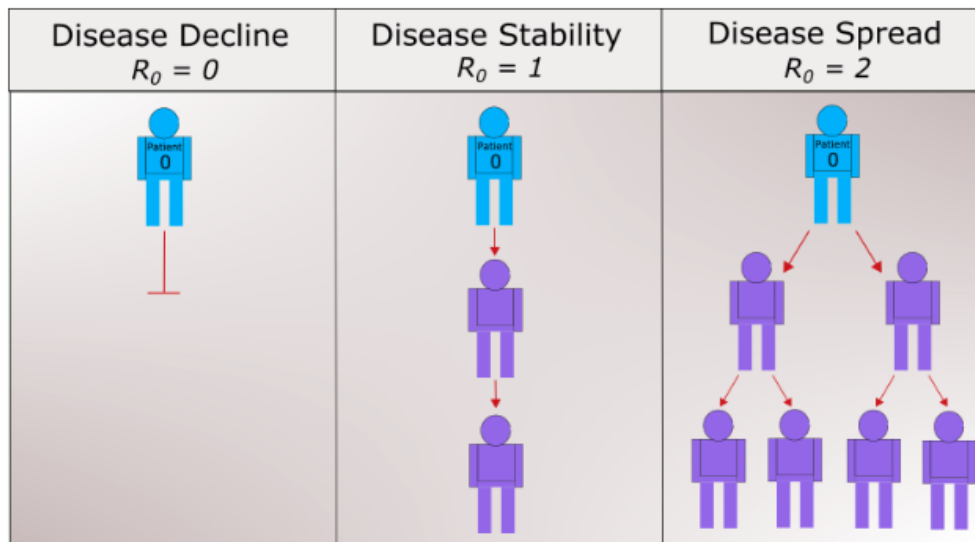
2.1 MODELLING AND PREDICTION

For analysis in this research paper, time series data provided by John Hopkins University, USA has been used.[5]. The time period of data is from 30th January to 4th May. Data include whole world's deaths, recovered and confirmed cases but since this paper's area of interest is only India so data only related to India is being used for prediction. Following models are used to complete the objectives.

2.1.1 SEIR MODEL

SEIR(Susceptible Exposed Infected Recovered) model is a widely used mathematical model and an extension of SIR model. It is mostly used for infection disease like HIV or Pneumonia. It is also being adopted for characterizing the COVID-19 epidemic in all over the world[6]. Disease can be evaluated from within the host using SEIR model i.e geographical spread of infection.

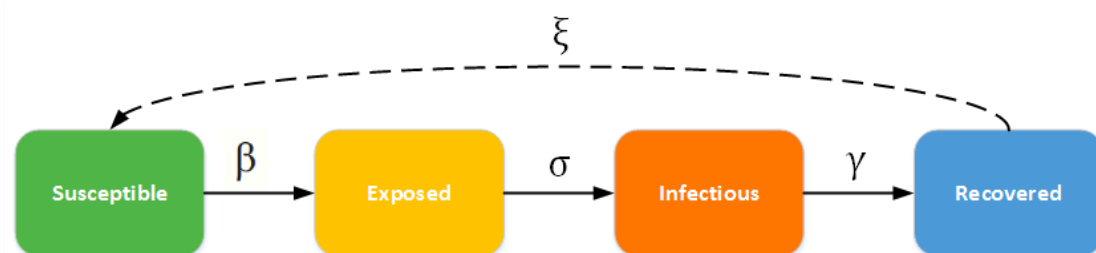
Calculating the R_0 (The reproduction number) is the essential part of this model. The basic reproduction number of an infection can be defined as number of new cases generated by one infected person in a population where all people are susceptible to the infection[7]. Determining how much proportion of total population needs vaccine for virus eradication is one of the main purpose of R_0 . The virus starts spreading in population when $R_0 > 1$ and if it keeps increasing, the epidemic control become more harder so target should be to maintain R_0 value less than 1. $1/R_0$ is the population proportion which is susceptible to infection in equilibrium state of endemic so $1 - 1/R_0$ is the population proportion that required to be recovered to put a control to virus spread.



Disease Spread with respect to value of R_0 [8]

$$\text{No. Of People need Vaccine} = (1 - (\text{Target}R_0/\text{Present}R_0)) * \text{Total People... (1)}$$

The current value of R_0 varies between 1.5 to 4 and India requires R_0 of 0.5 to control the endemic so upper limit of people requiring vaccine will be 1.06 billion and lower limit will be 605 million.



SEIR model Illustration[9]

There are total four components in SEIR model. Susceptible(S) includes people who are able to come in contact with the virus[10]. Exposed(E) are those who got infected but did not showed symptoms yet. Infectious(I) belongs to those who have capability of disease transmission and Recovered(R) are those who are now immune from the virus.

β is called infectious rate and defined as disease transmitting probability from a susceptible individual to an infectious one. σ is called incubation rate and defined as latent period in which an individual start showing symptoms i.e becomes infectious.

γ is defined as recovery rate at which patient becomes immune to virus. It can be obtained by calculating $1/D$ (where D is infection duration). Atlast, ϵ is rate to which immune people again get infected due to issue related to health or low immunity. Differential equations of all these components are shown below in figure 3.

$$\frac{dS}{dt} = \frac{-\beta SI}{N}$$

$$\frac{dE}{dt} = \frac{\beta SI}{N} - \sigma E$$

$$\frac{dI}{dt} = \sigma E - \gamma I$$

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

SEIR model components differential equations[11]

Now, Total population $N = S + E + I + R$ and R_0 can be calculated using these equations by finding out values of $\alpha, \mu, \beta, \gamma$ where μ is death rate[12].

$$R_0 = \frac{\beta_0 \alpha}{(\mu + \alpha)(\mu + \gamma)}$$

2.1.2 SEIR RESULTS

Some assumptions and considerations have to be made for describing spread of COVID-19 using SEIR model as availability of data is limited[13]. These assumptions are following :-

1. Total population remain same i.e death and birth numbers remain constant.
2. COVID-19 latent period is $1/\alpha$ & infectious period is $1/\gamma$
3. People who got recovered did not went sick again during the calculation.
4. R_0 of some states is not available due to few number of positive cases there.
5. Assuming α is 5 days so $1/\alpha = 0.2$ and $\gamma = 2$, so $1/\gamma = 0.5$ and β can be calculated by knowing R_0 and infectious period.

Now, the basic reproduction number of most of states of India can be taken from PRACRITI [20]. From the R_0 , we can calculate how many days will it take to infect the whole population of a specific state by using the formula below :-

$$\text{Days to get infected} = \log(N) / \log(1 + R_0)$$

Where N is the total population. Now we will make two tables, one for each state of India and one for Whole India also because as we know R_0 of India varies from 1.5 to 4 so we will try different R_0 values based on following scenarios[21] :-

- **Baseline** – Spread of disease when there is no lockdown, or social distancing and no transmission rate change $R_0 = 2.66$
- **Moderate Lockdown** – Transmission reduction to $R_0 = 2$ in the time of lockdown, after that transmission resumes at $R_0 = 2.4$.
- **Hard Lockdown** – Transmission reduction to $R_0 = 1.5$ in the time of lockdown, after that transmission resumes at $R_0 = 2.4$.
- **Hard Lockdown with Continued Social Distancing** – Transmission reduction to $R_0 = 1.5$ in the time of lockdown, after that transmission resumes at $R_0 = 2$ through social distancing.

Country	R0	Days to get infected
India	2.66	16
India	2	19
India	2.4	17
India	1.5	23

Days to infect whole India with different R0 values

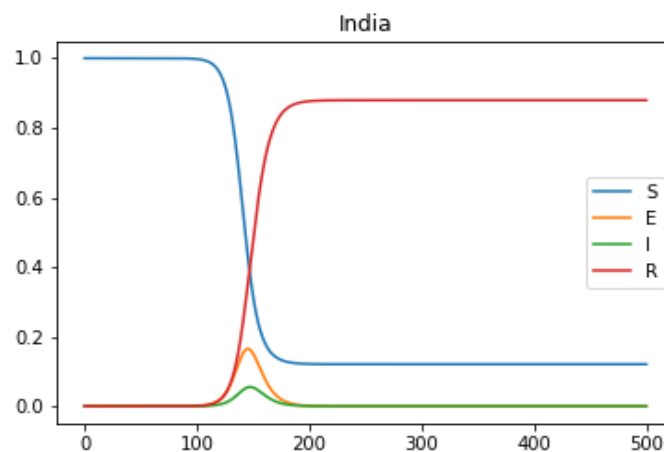
STATE/UT	R0	Days to get infected
Andaman and Nicobar Islands	N/A	N/A
Andhra Pradesh	1.63	18
Arunachal Pradesh	N/A	N/A
Assam	0.61	36
Bihar	2.95	13
Chandigarh	N/A	N/A
Chhattisgarh	0.07	252
Dadra and Nagar Haveli	N/A	N/A
Daman and Diu	N/A	N/A
Delhi	0.94	25
Goa	N/A	N/A
Gujarat	1.79	17
Haryana	0.73	31
Himachal Pradesh	0.3	60
Jammu and Kashmir	1.31	19
Jharkhand	2.13	15
Karnataka	1.08	24
Kerala	0.98	25
Ladakh	N/A	N/A
Lakshadweep	N/A	N/A

Madhya Pradesh	1.51	20
Maharashtra	1.88	18
Manipur	N/A	N/A
Meghalaya	N/A	N/A
Mizoram	N/A	N/A
Nagaland	N/A	N/A
Odisha	1.98	16
Puducherry	N/A	N/A
Punjab	1.49	19
Rajasthan	1.15	24
Sikkim	N/A	N/A
Tamil Nadu	0.95	27
Telangana	0.79	30
Tripura	N/A	N/A
Uttar Pradesh	1.47	21
Uttarakhand	0.78	31
West Bengal	1.95	17

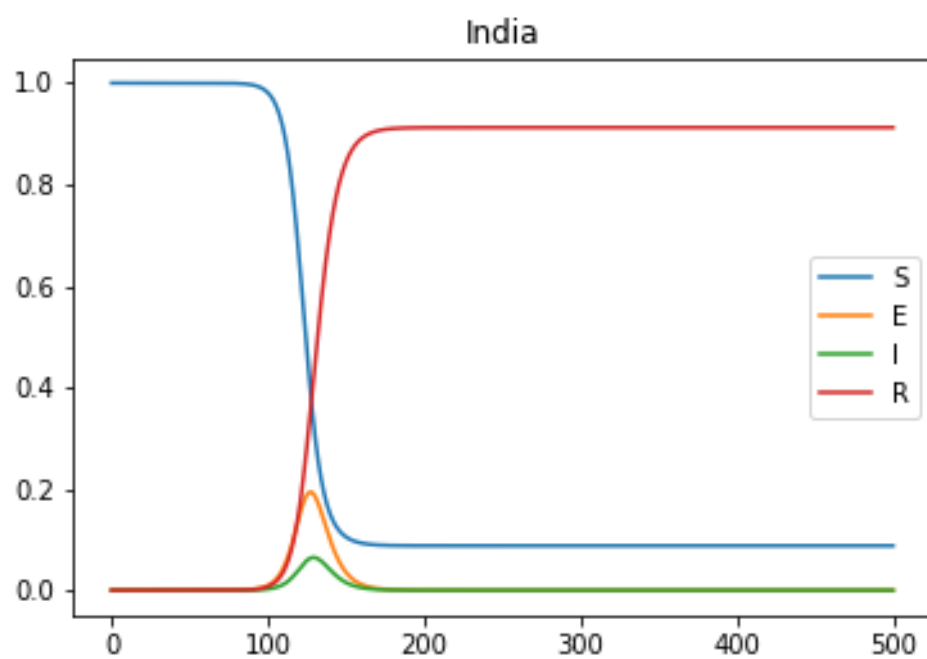
Days to infect whole population of each Indian state

India's SEIR models with Different R0 Values

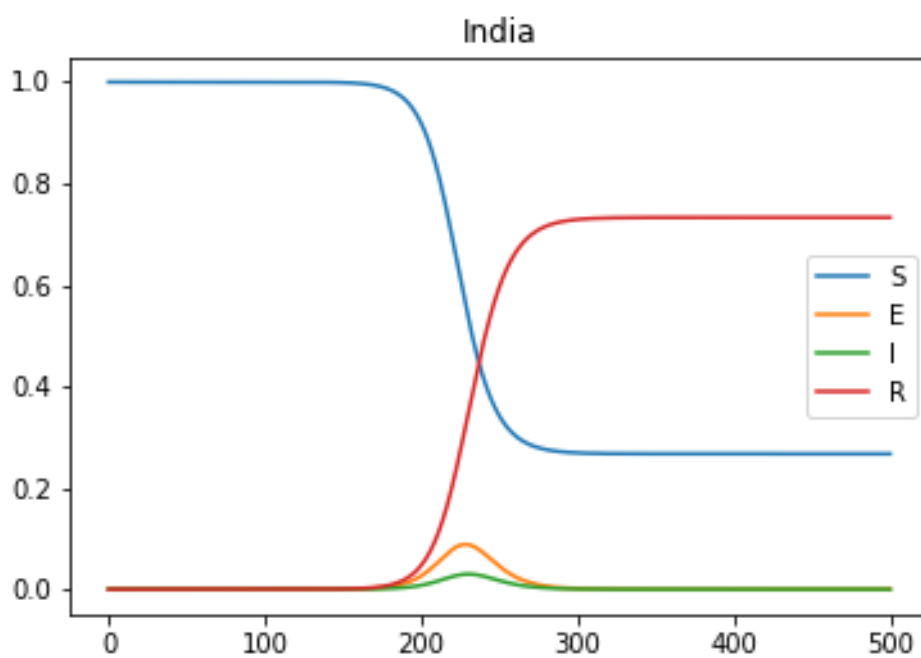
$$R_0 = 2.4$$



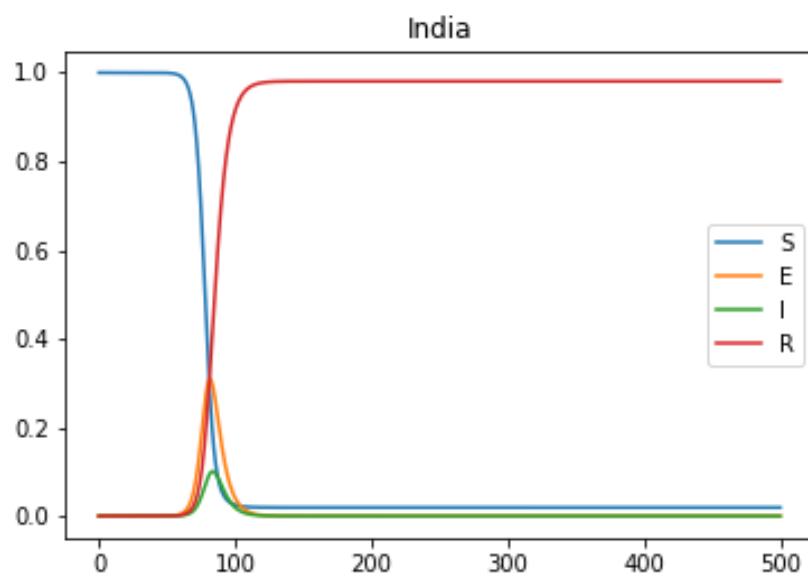
$$R_0 = 2.6$$



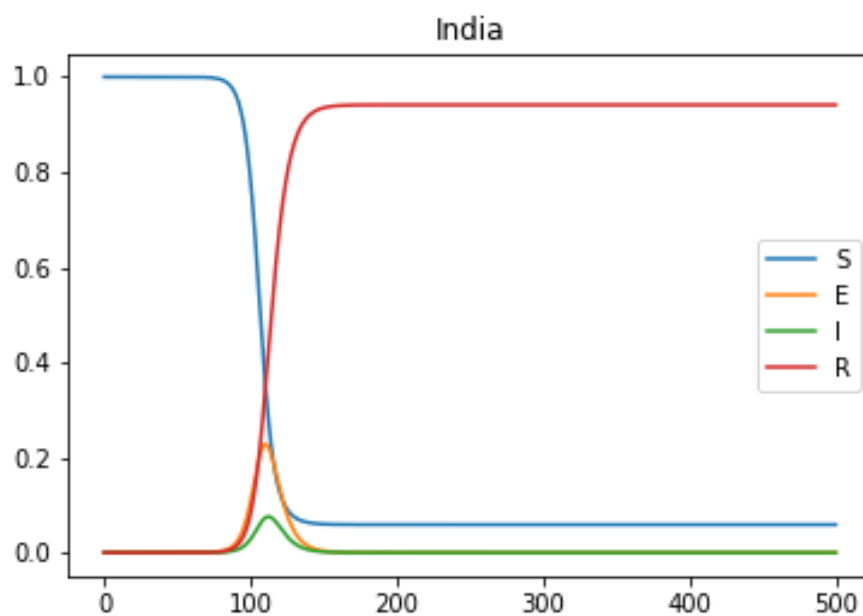
$$R_0 = 0.5(\text{Target})$$



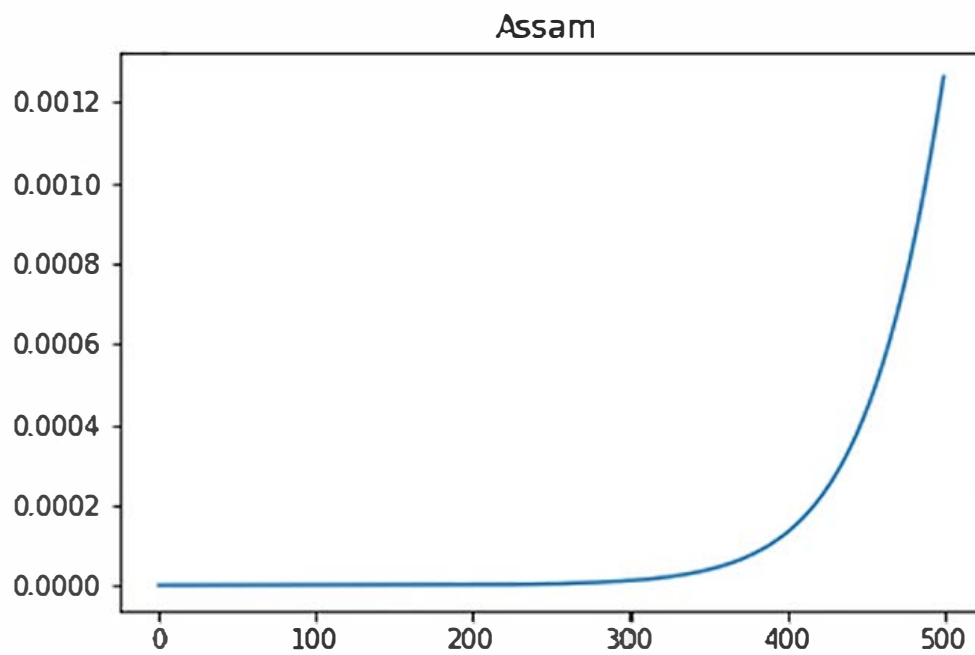
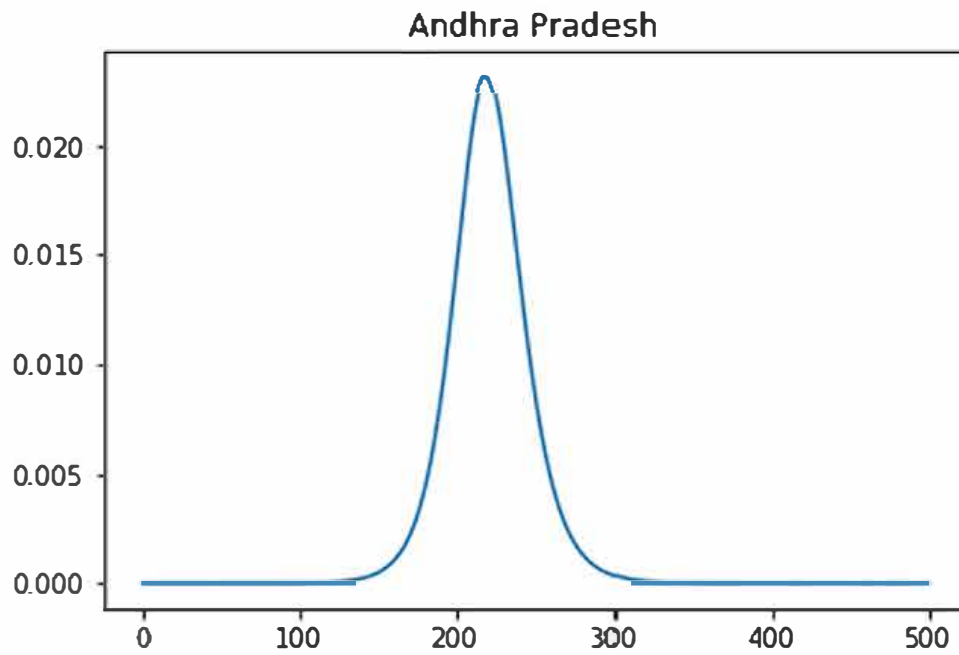
$$R_0 = 4$$

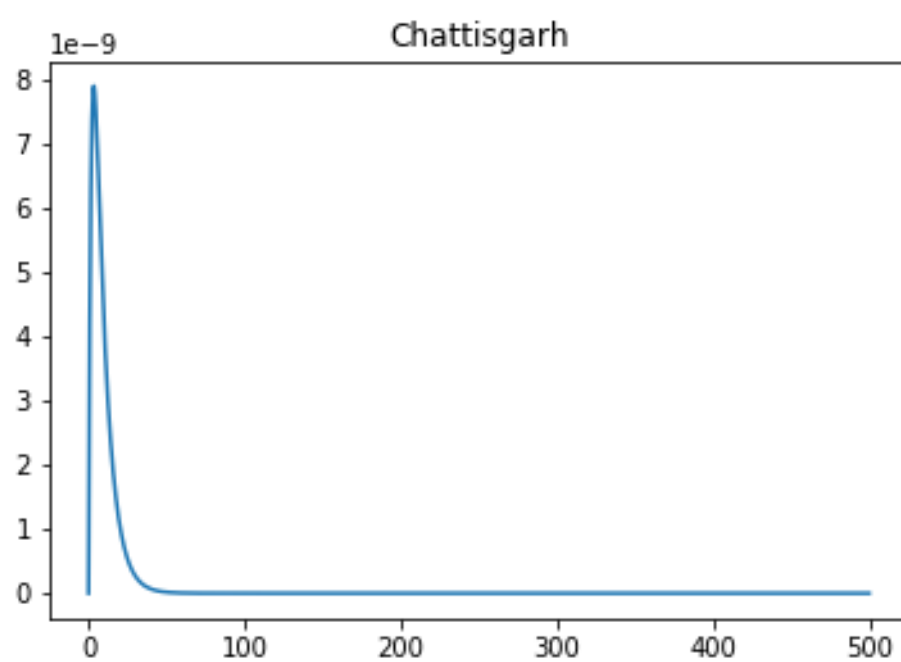
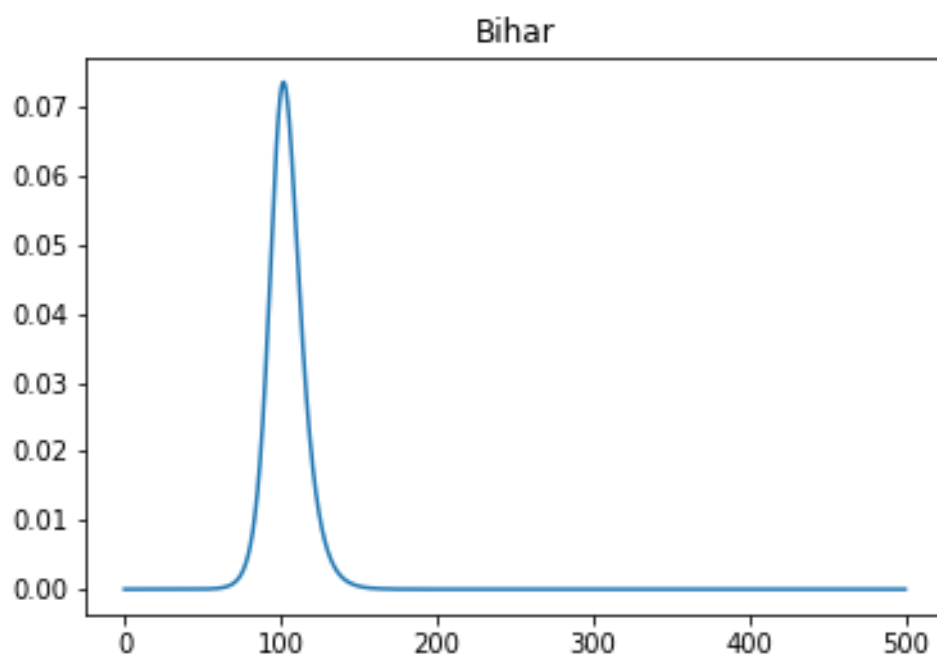


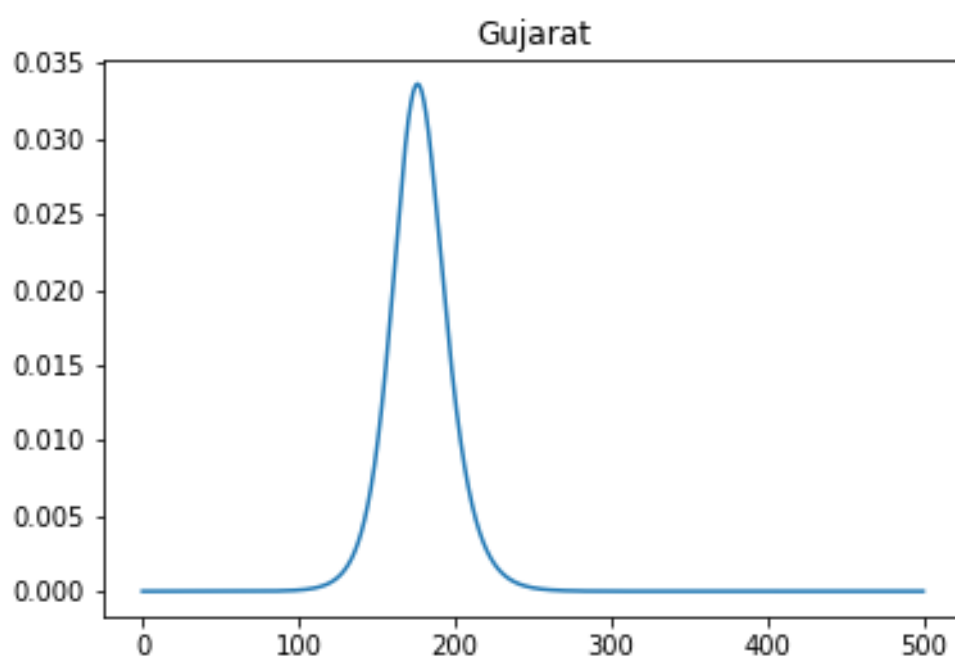
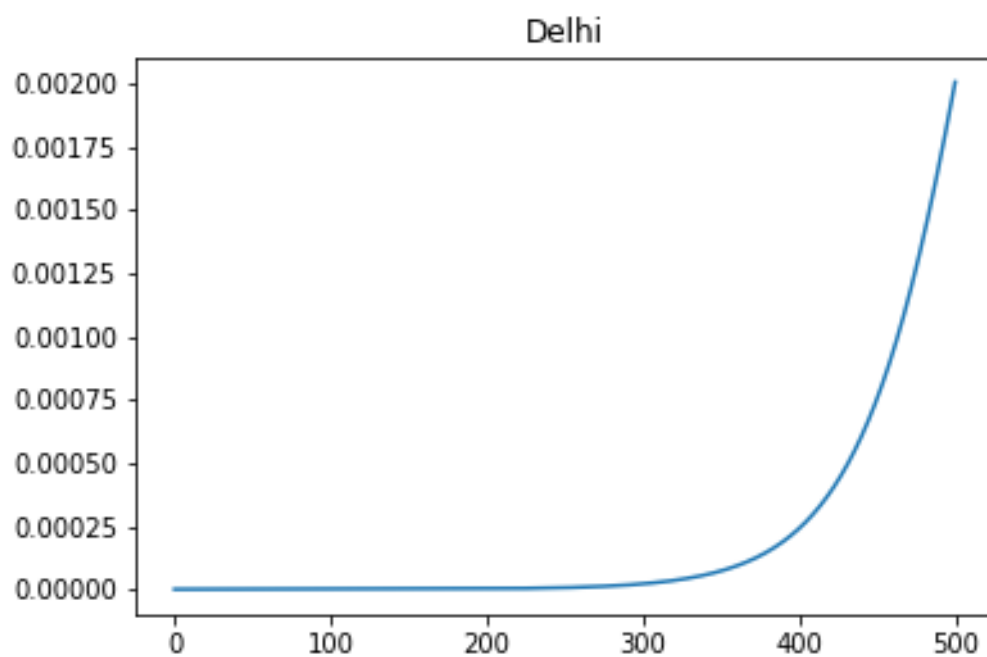
$$R_0 = 1.8$$

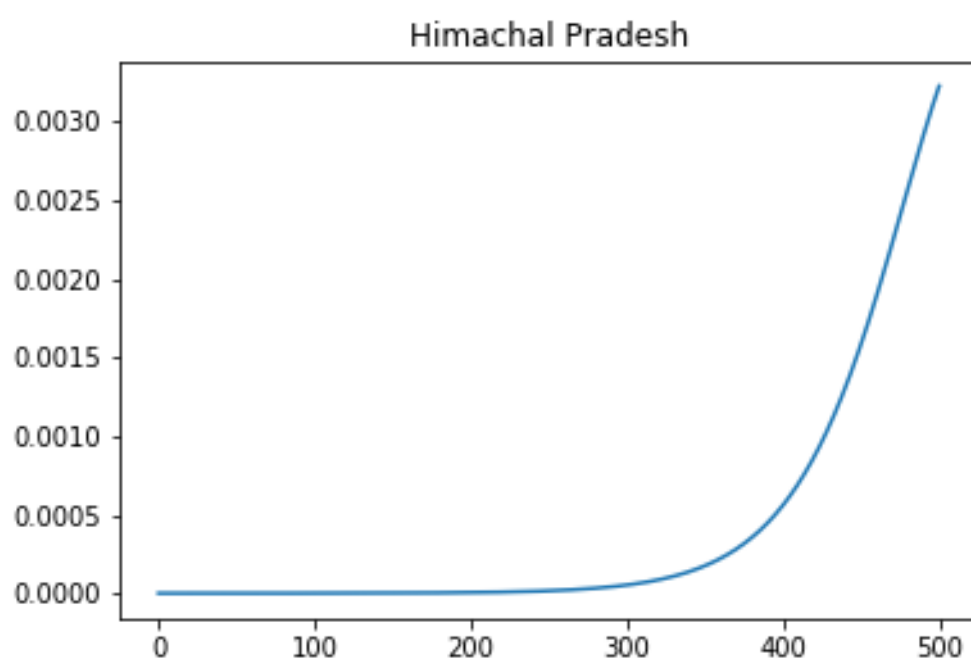
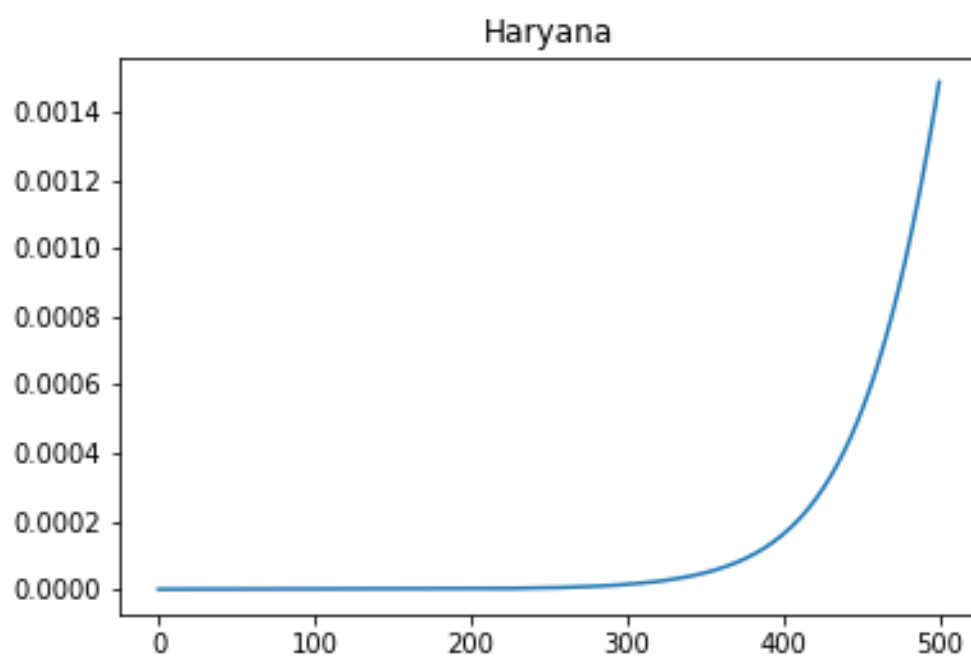


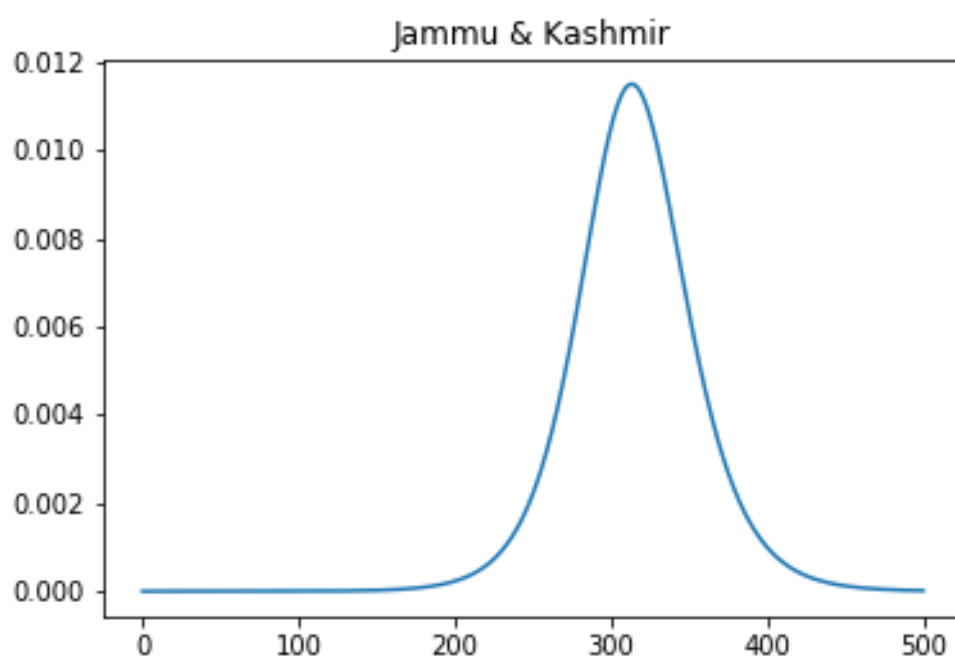
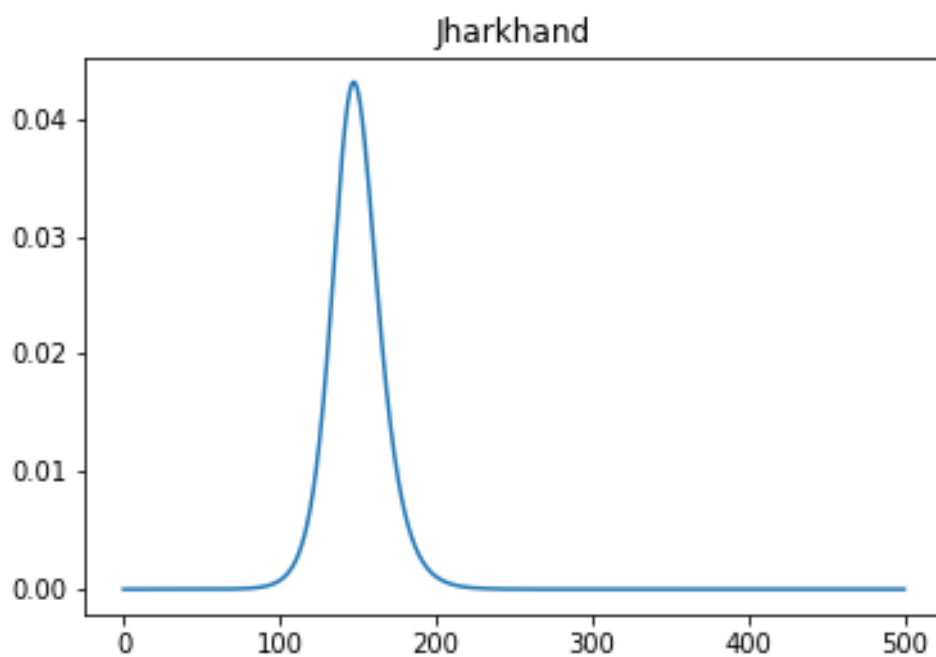
- According to these SEIR models, around 0.03 to 0.05% of Indian population will get infected from the COVID-19 disease in 150 to 200 days.
- The greater the R_0 , the earlier will it take to reach those numbers
- External effects like government's control measures or violating the social distancing with public gatherings can results in fall or rise in final numbers.
- Also, there are not many testings happening in India at this time so it might be possible that cases are under reported as some people are hiding their symptoms or travel history.
- As per current situation, COVID-19 cases in India will only rise in near future.

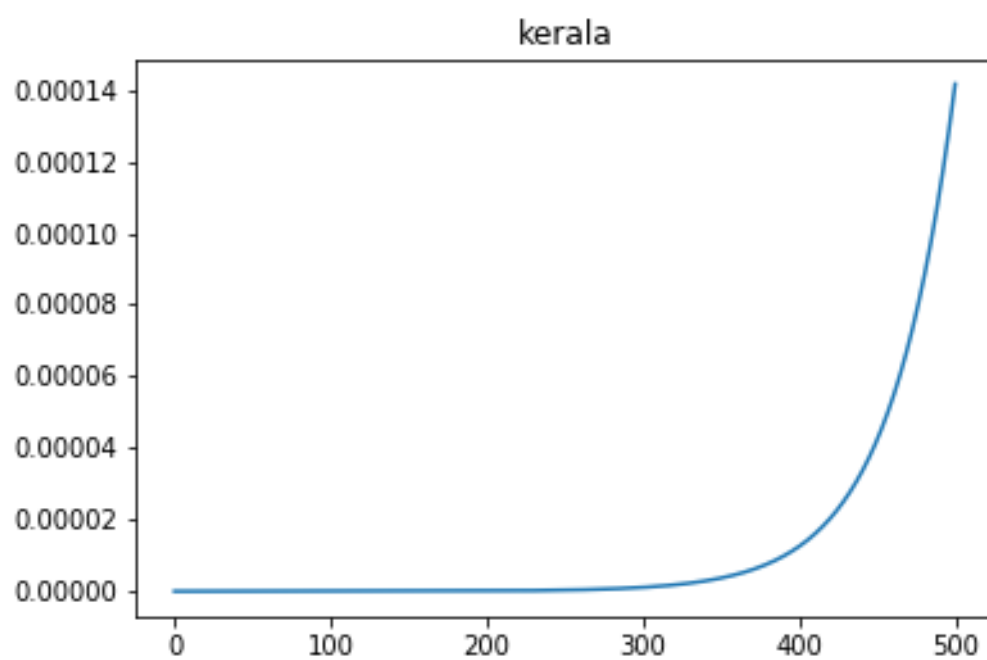
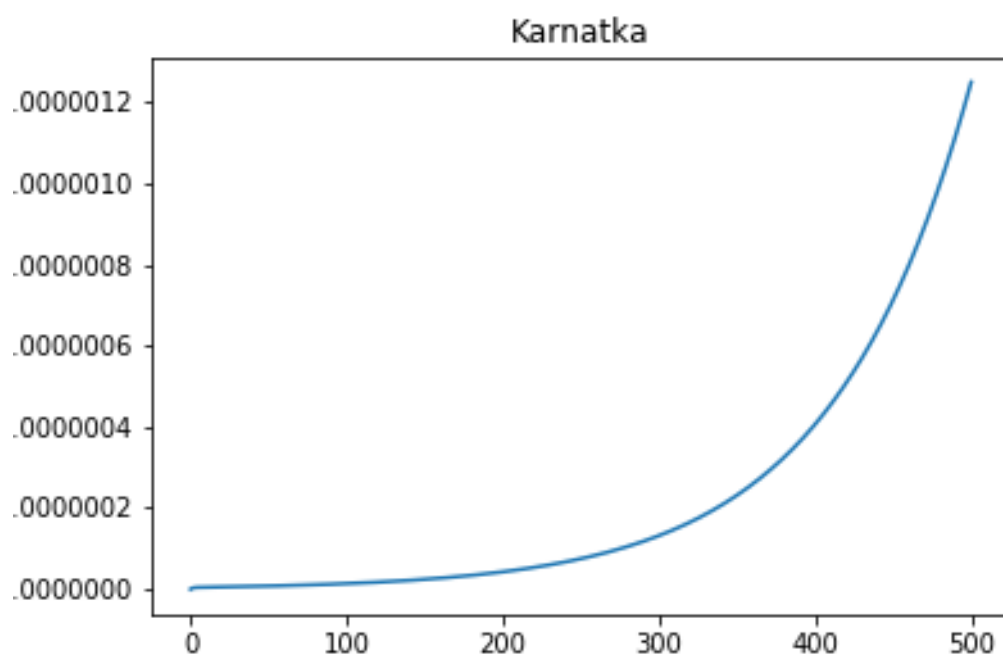
Indian States Infection Curves(From SEIR model)

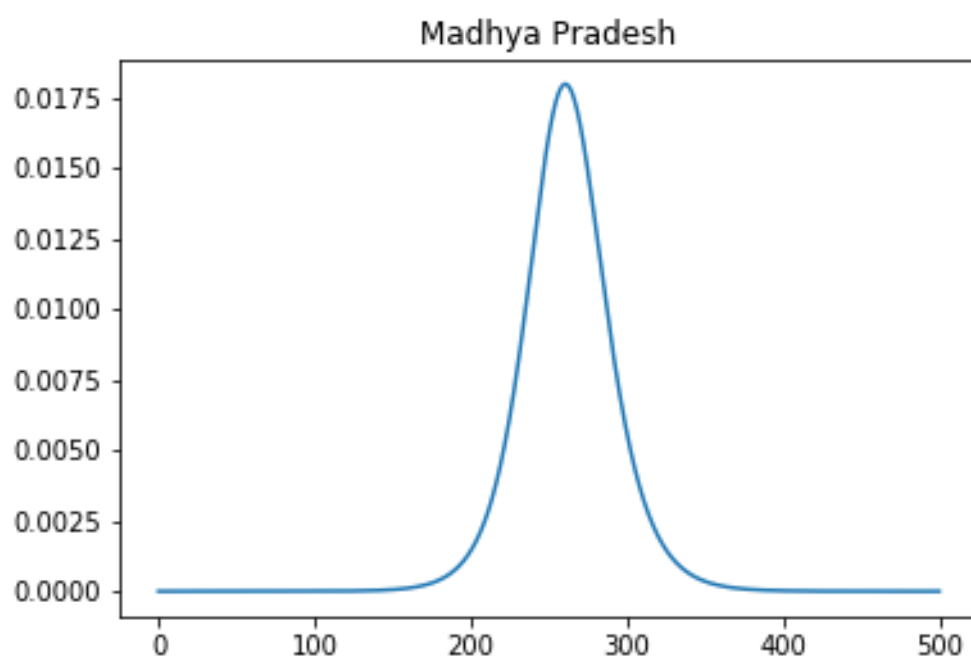
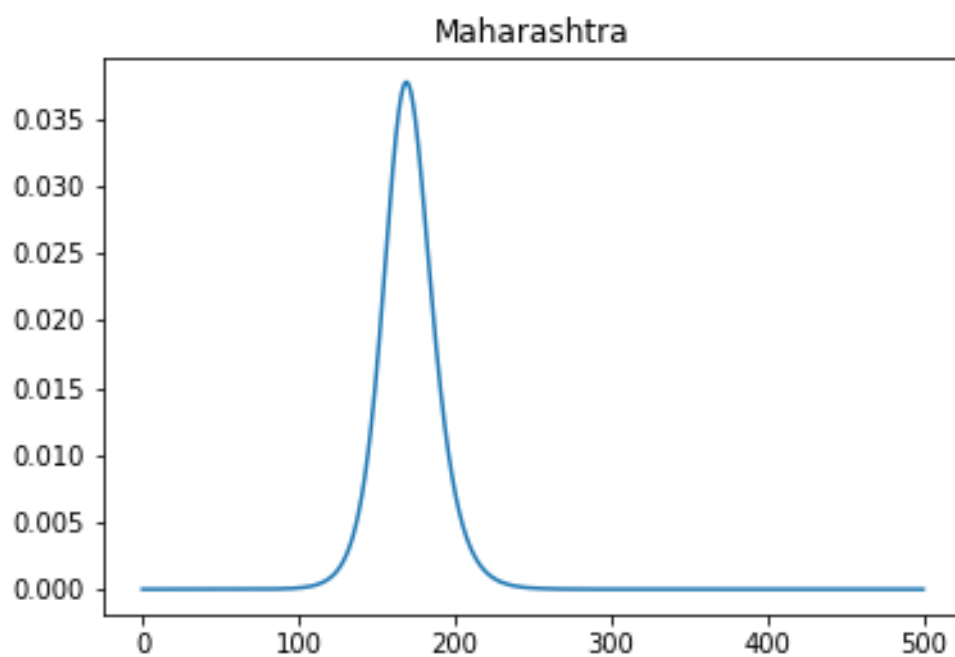


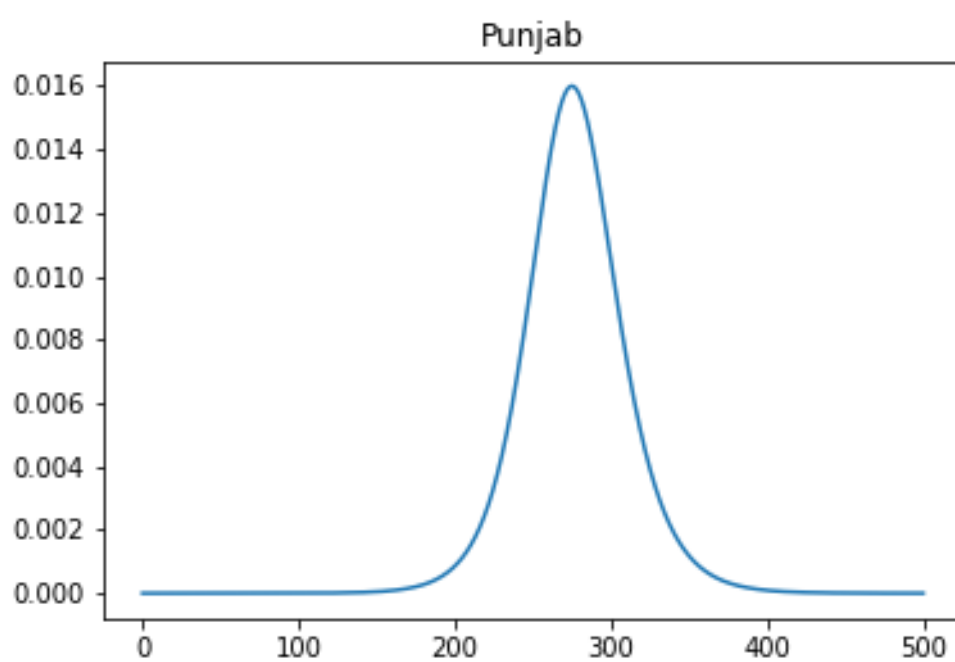
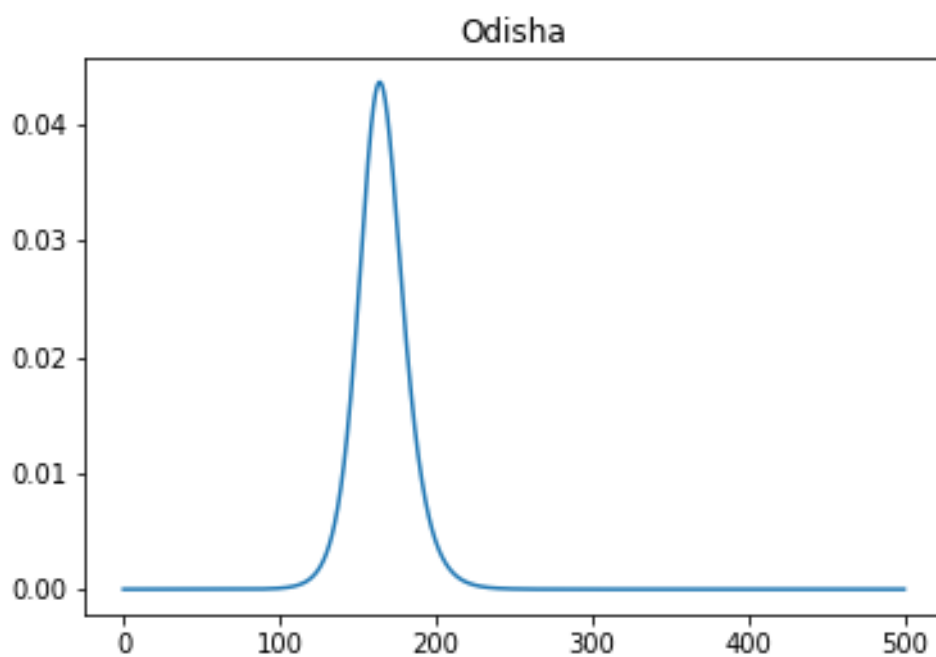


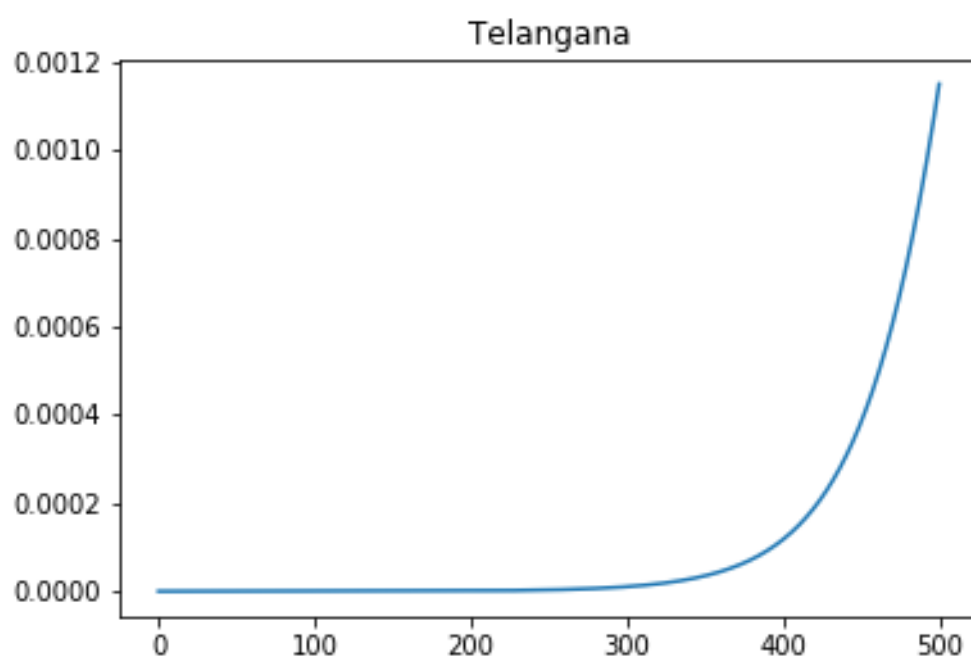
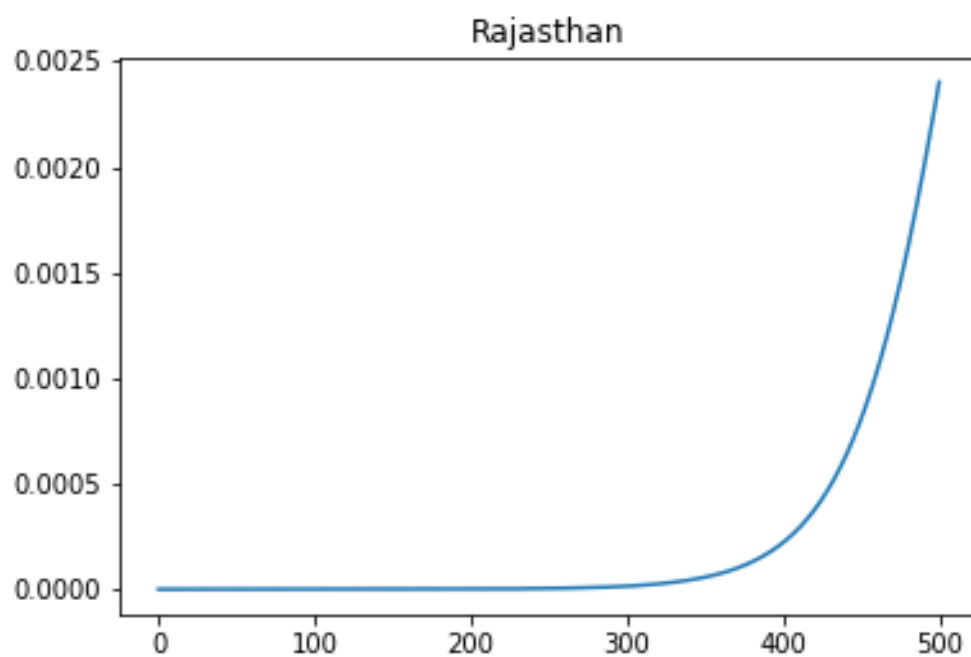


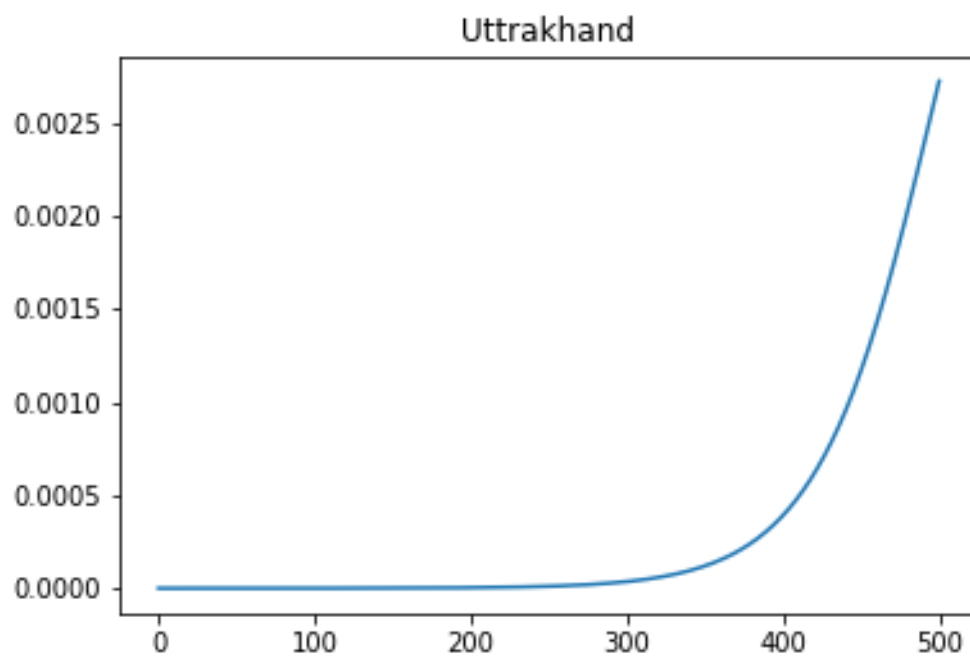
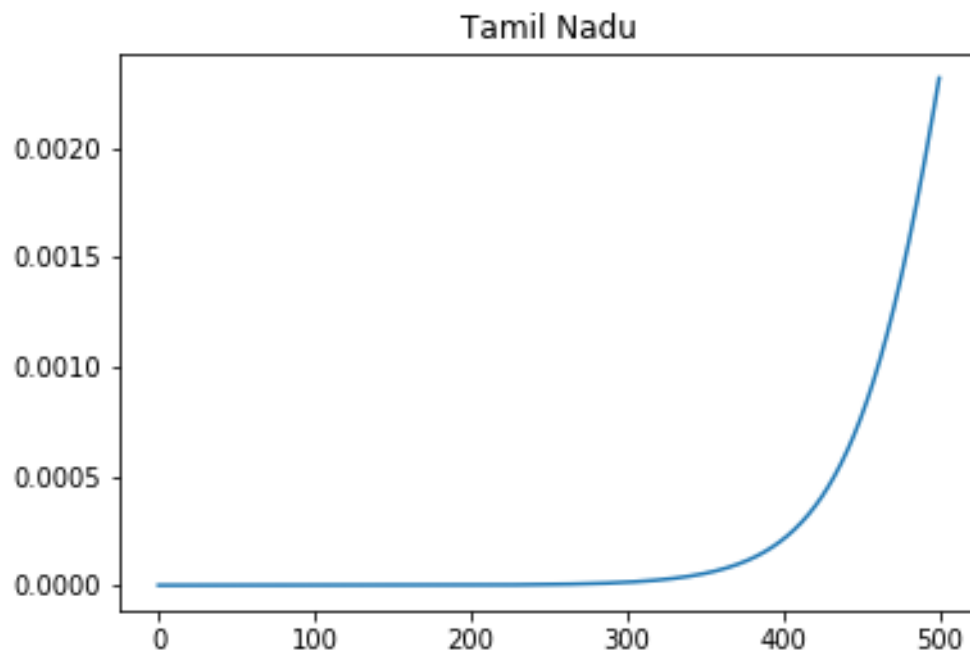


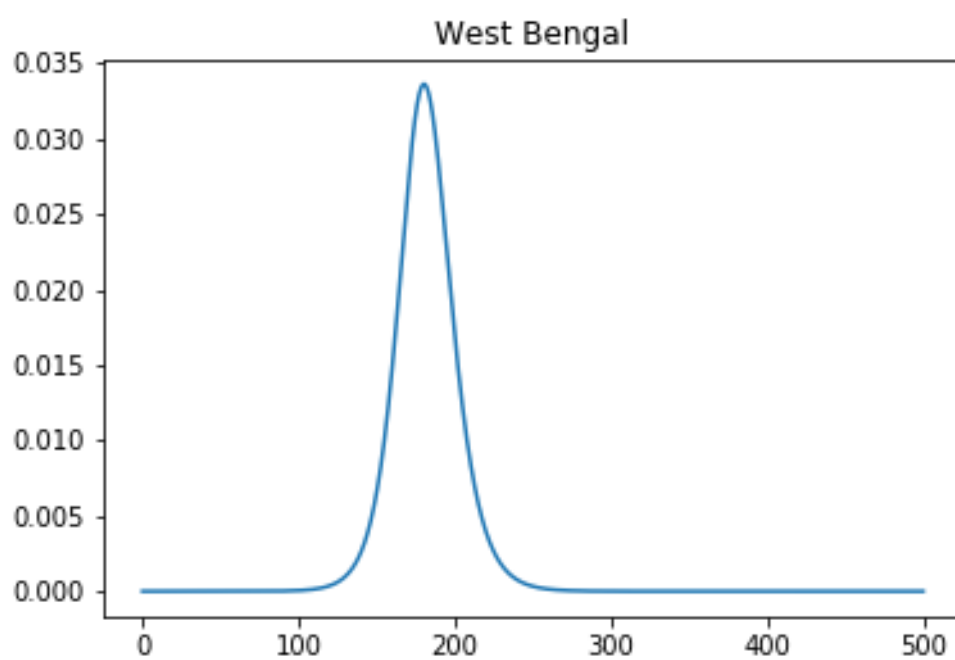
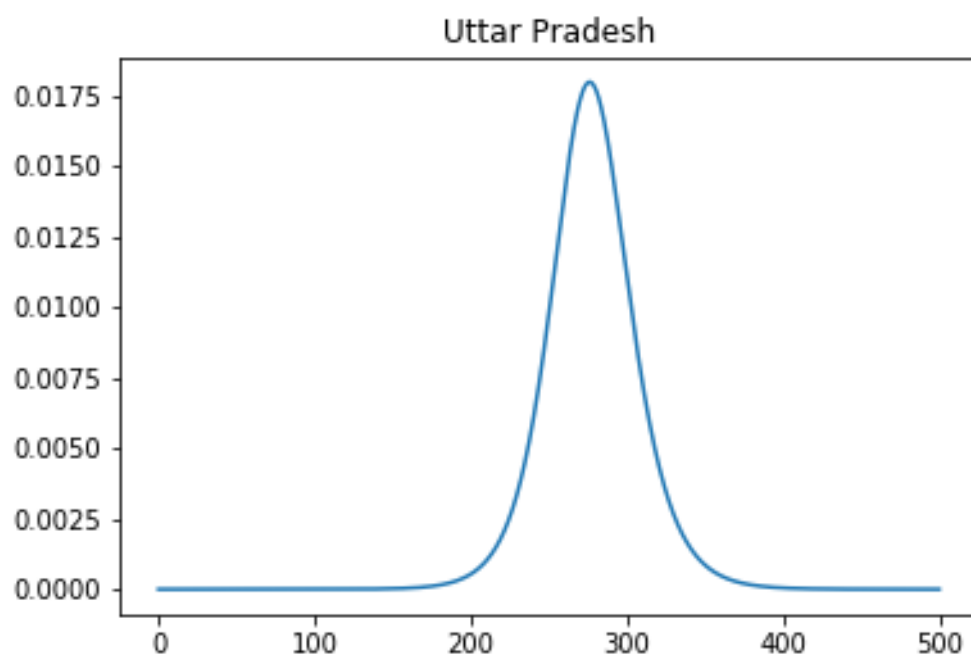












2.1.3 REGRESSION MODEL

Regression is a statistical approach used for estimating or predicting the dependent variable with respect to independent variables. The relationship between variables is used to plot a best fit line or an equation which can be used to draw predictions[14]. There are several types of regression like linear, polynomial, ridge, stepwise etc. In this paper, linear and polynomial regression models are used for predicting COVID-19 cases[15].

Linear regression is a basic model which mostly work on continues data for giving predictions. Equation of linear regression model can be written down in following way :-

$$Y(\text{predicted}) = (\beta_1 * x + \beta_0) + \text{Error value}$$

Here, β_1 is the slope of curve and β_0 is intercept. Error value can be defined as sum of residual squares between predicted and actual output. Our goal is minimize error rate to make the linear regression model more accurate.

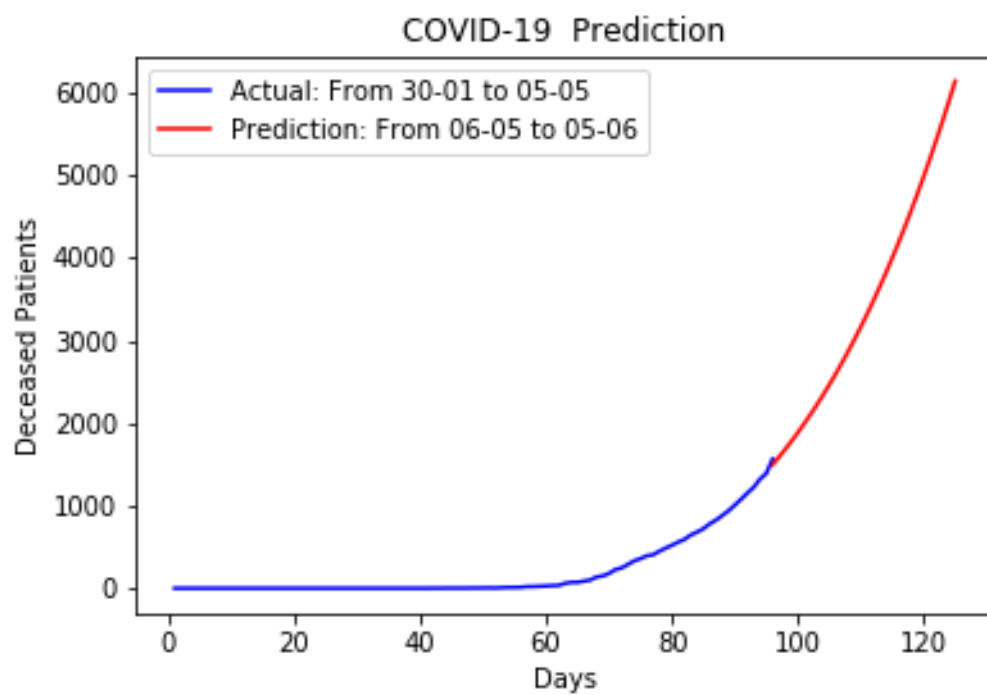
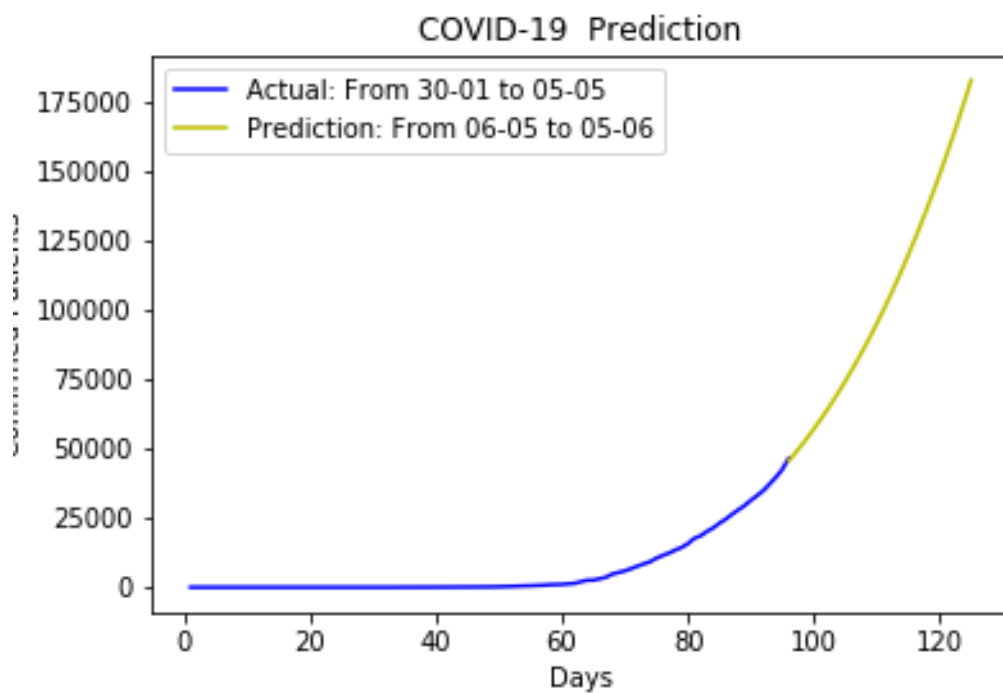
Polynomial regression is a special case of linear regression and it is used when there is co-relation exist between variables but the relationship does not look linear so we fit polynomial equation to data[16]. The general equation of polynomial regression can be written down as follows :-

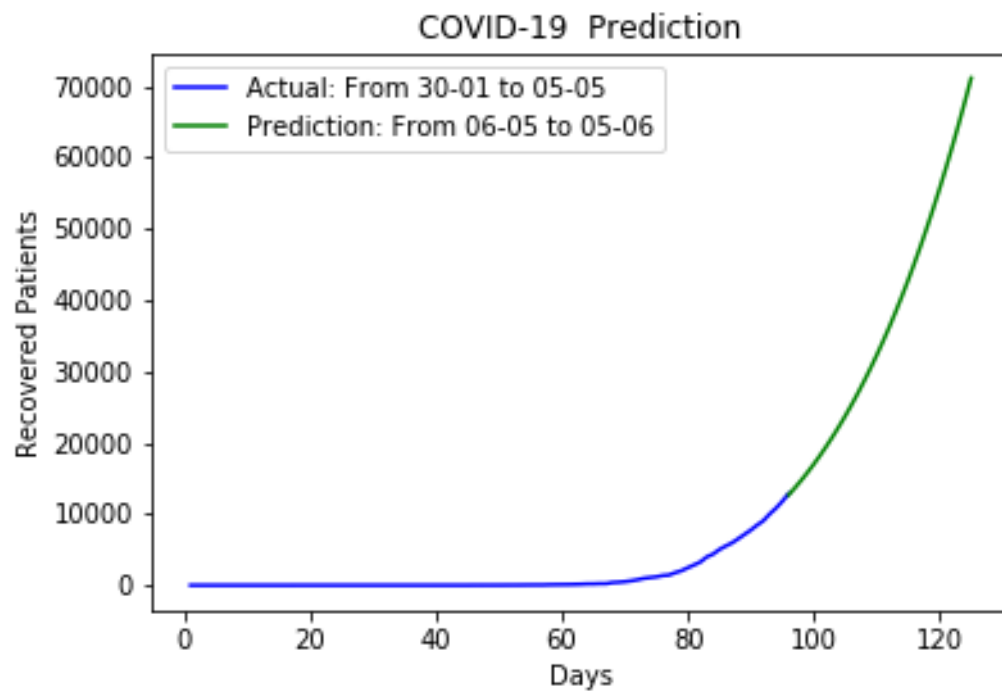
$$Y = \theta_0 + \theta_1 X + \theta_2 X^2 + \dots + \theta_m X^m + \text{residual error}$$

Here, X is independent variable, m is polynomial degree, θ_0 is intercept and $\theta_1, \theta_2, \dots, \theta_m$ are weights assigned to predictors. Polynomial regression of degree 1 is called linear regression. Choosing the polynomial degree is very challenging task. If we choose small value, data will not properly fit model and if a large value is chosen, there will be problem of overfitting. Also, these models are too sensitive to outliers and validation tools are also less for detecting outliers in linear regression but function of abroad range and a curvature of wide range can easily fit into polynomial regression model[17].

2.1.4 REGRESSION RESULTS

- Upcoming 30 days of India's COVID-19 data(confirmed cases, deaths, recovery) is being predicted starting from 6th May.
- Confirmed cases data for some states of India for next 30 days is also predicted.
- Few states can not be plotted due to various limitations like unofficial data/Insufficient data/Not enough cases etc.
- Data of all the cases of India is taken from John Hopkins University Repository.
- Data of all Indian states is taken from [18].



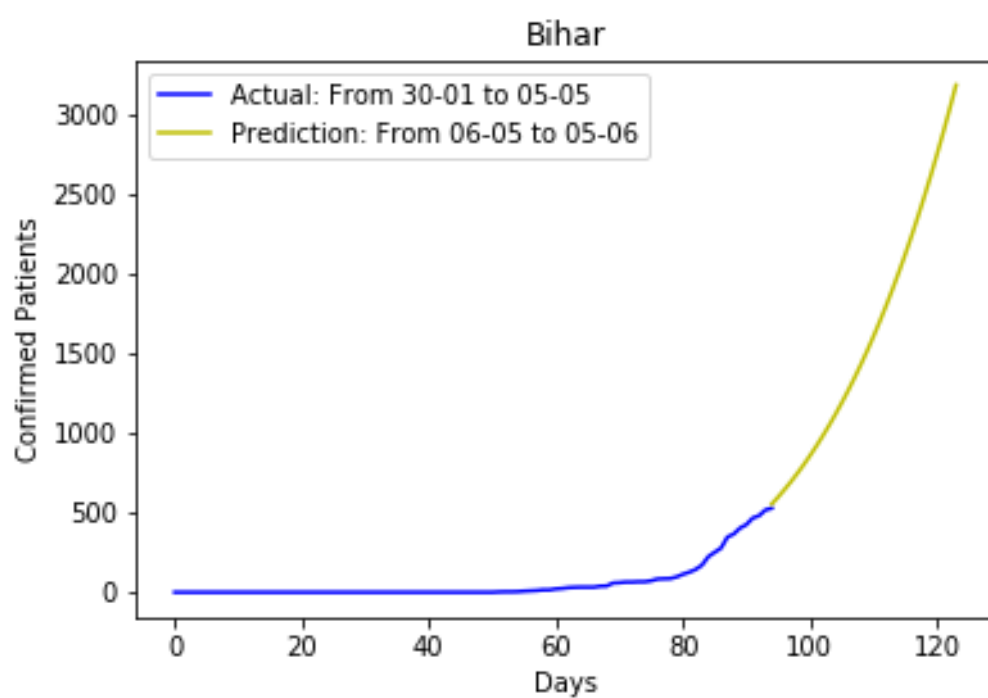
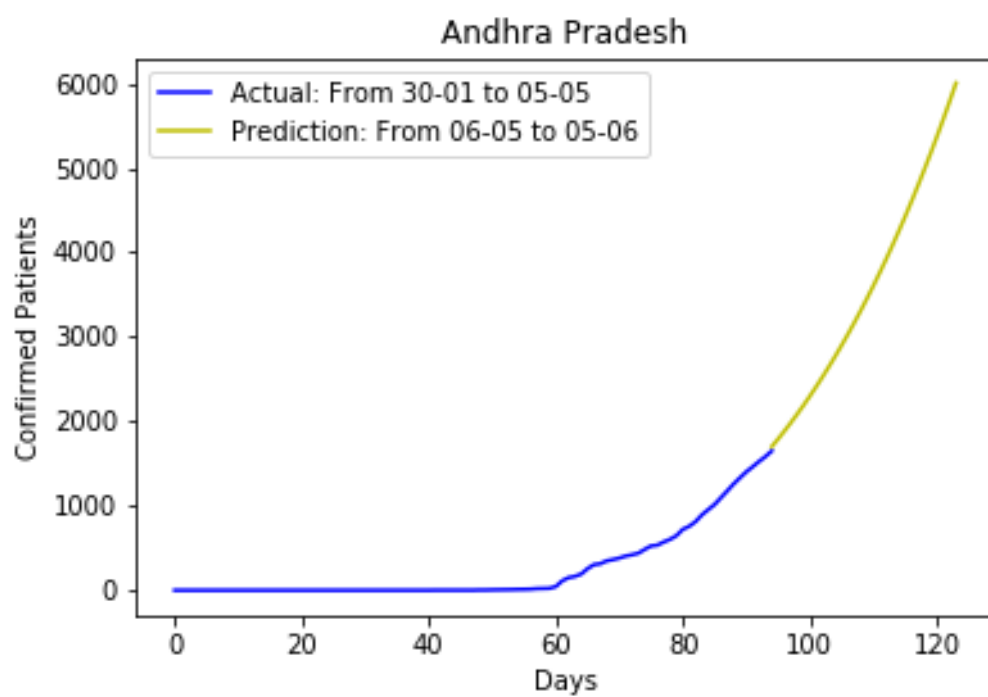


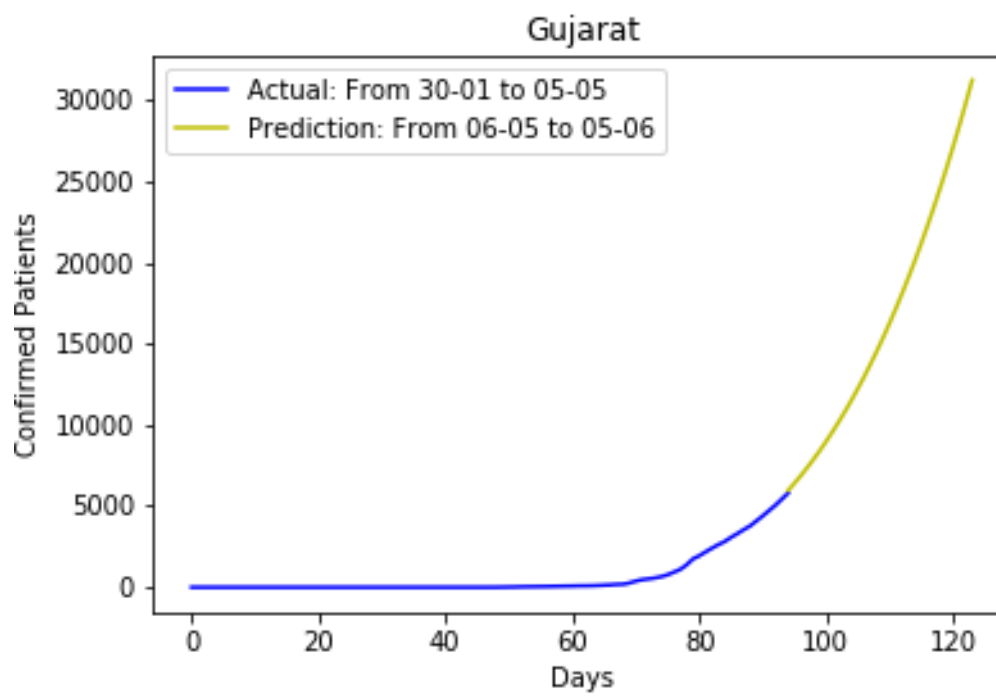
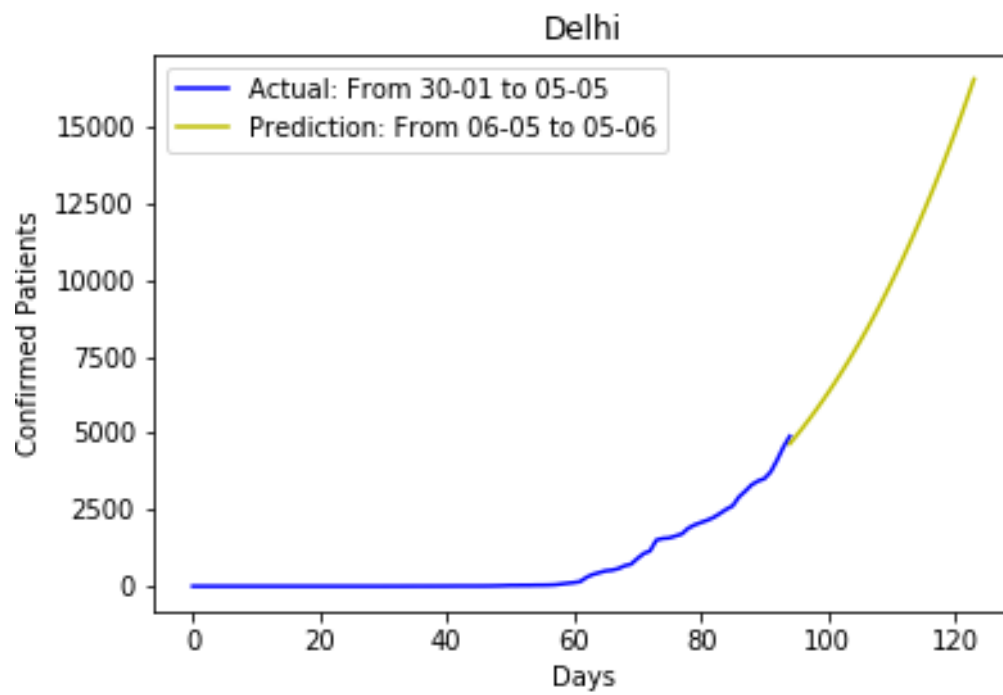
Date	Confirmed	Death	Recovery
1	45510	1498	12668
2	48218	1589	13665
3	51041	1683	14717
4	53882	1782	15825
5	57044	1885	16991
6	60230	1992	18217
7	63543	2103	19505
8	66987	2219	20858
9	70566	2339	22276
10	74281	2465	23763
11	78137	2595	25320
12	82137	2729	26949
13	86284	2869	28652
14	90583	3014	30432
15	95036	3165	32290

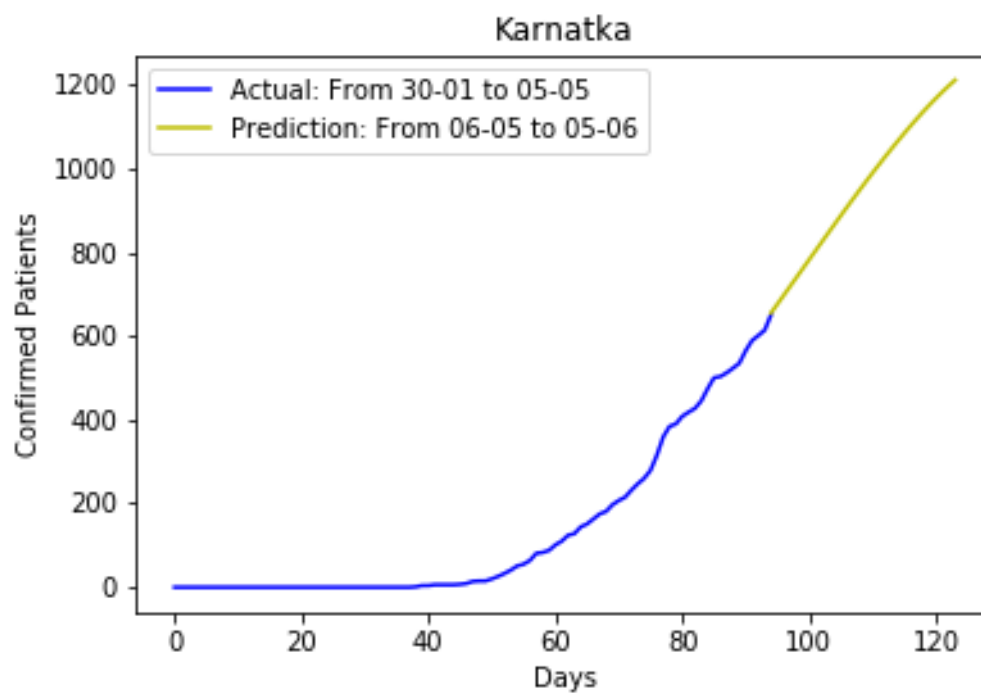
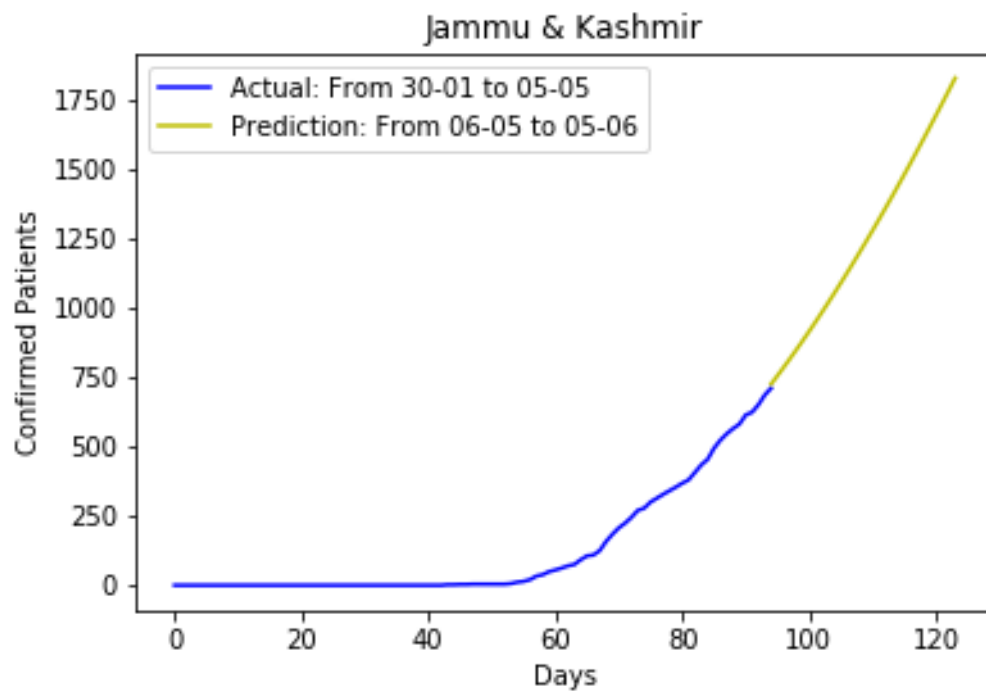
16	99647	3321	34230
17	104420	3482	36252
18	109358	3649	38360
19	114466	3822	40556
20	119746	4001	42841
21	125203	4186	45219
22	130840	4377	47692
23	133662	4574	50262
24	142671	4778	52932
25	148873	4989	55703
26	155271	5206	58580
27	161868	5430	61653
28	168670	5661	64656
29	175680	5899	67861
30	182903	6145	71182

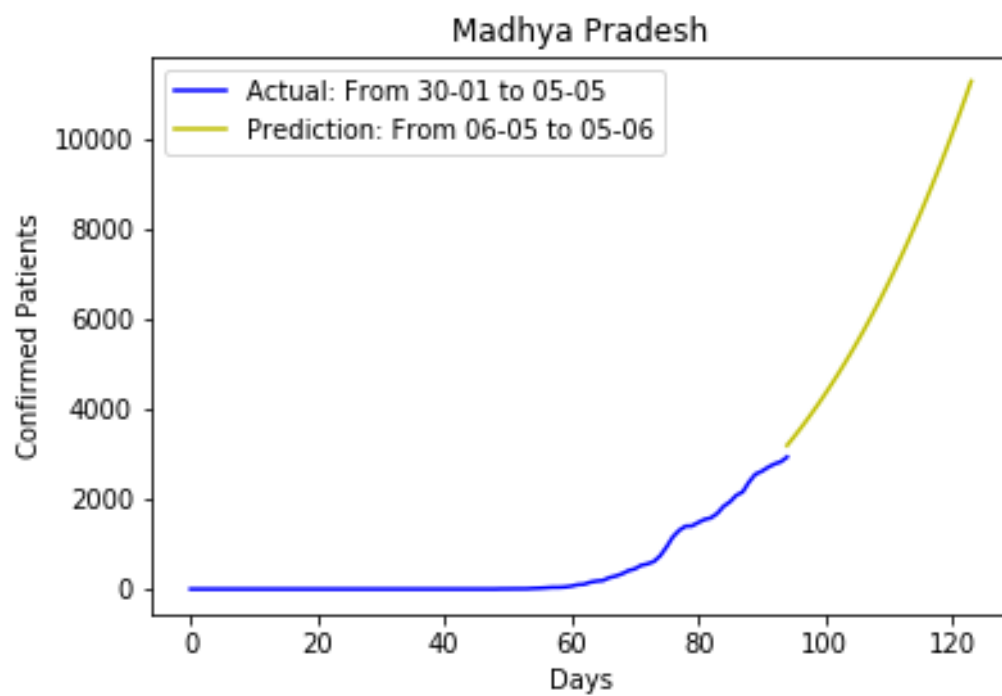
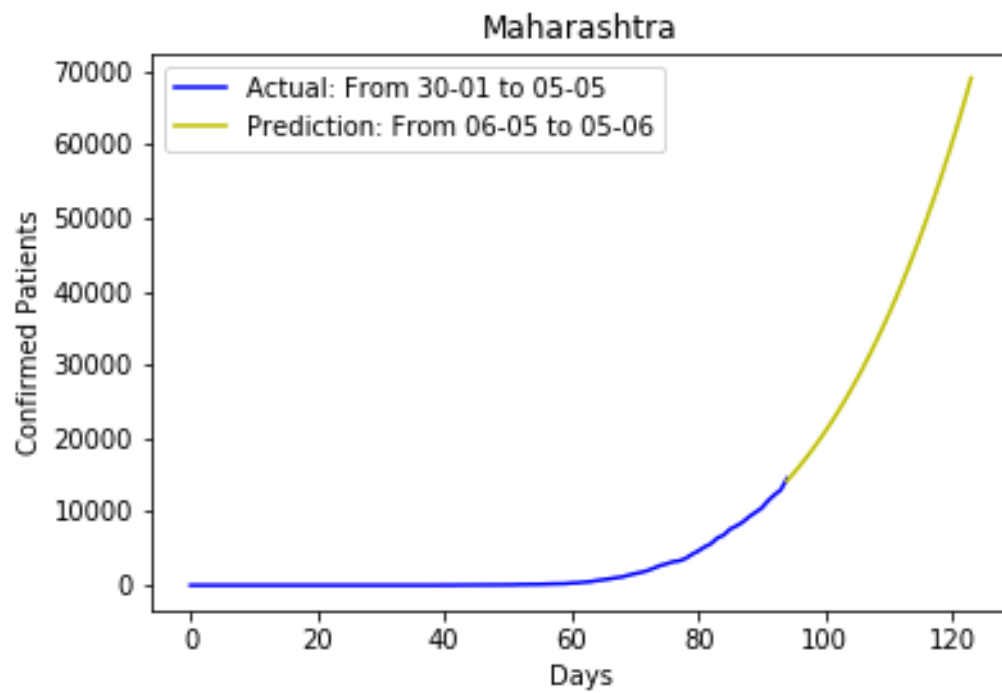
.Forecasting next 30 days India's COVID-19 data

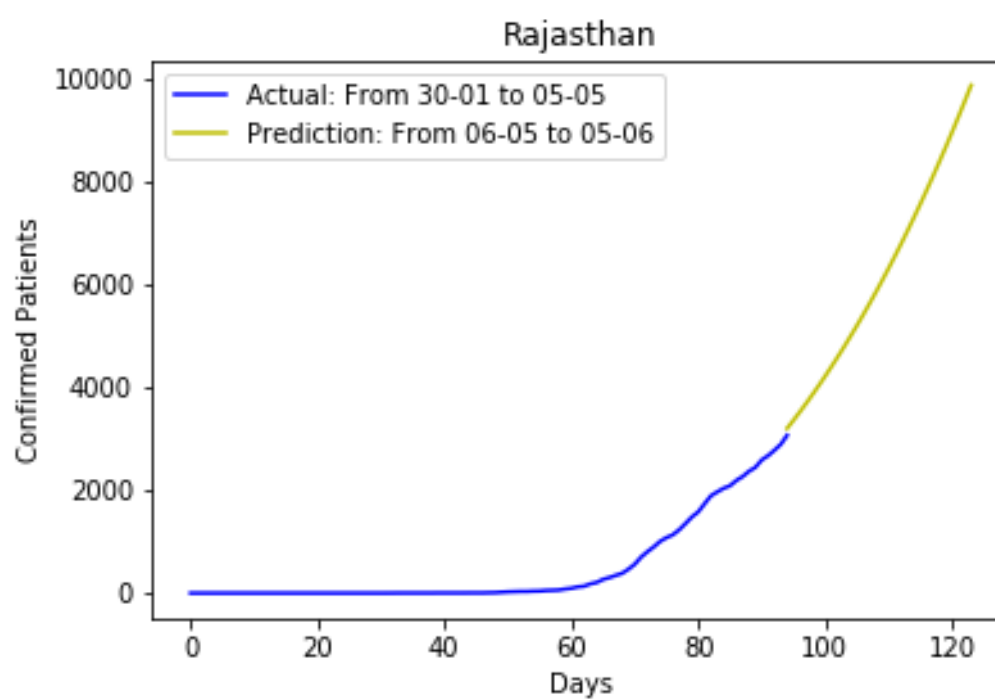
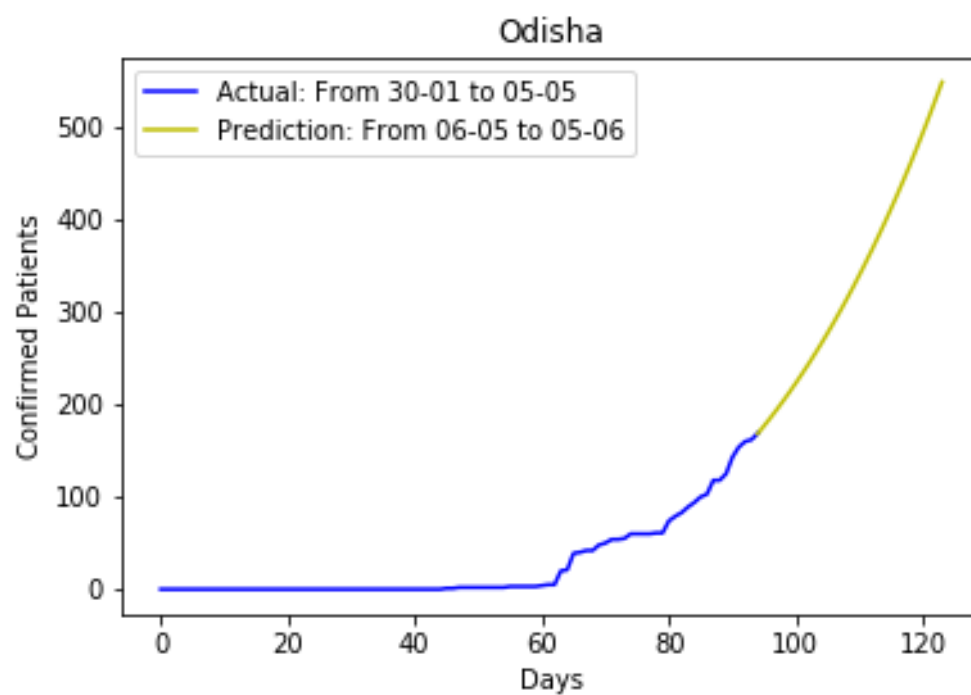
- According to the predictions, COVID-19 cases will only rise in India in upcoming days
- Currently India is in Stage II of the virus spread, there might be high chances that it will reach Stage III after 30 days which is community transmission.
- Although external factors like curfew, hard lockdown, social distancing and self isolation etc can help India from not reaching Stage III.
- One more thing has to be kept in mind that India is developing country so its medical facilities are limited as compare to developed countries like USA, Italy, Spain etc which are still struggling hard despite having one of the best medical facilities. So situation can become out of control in India if cases keep rising at this rate.

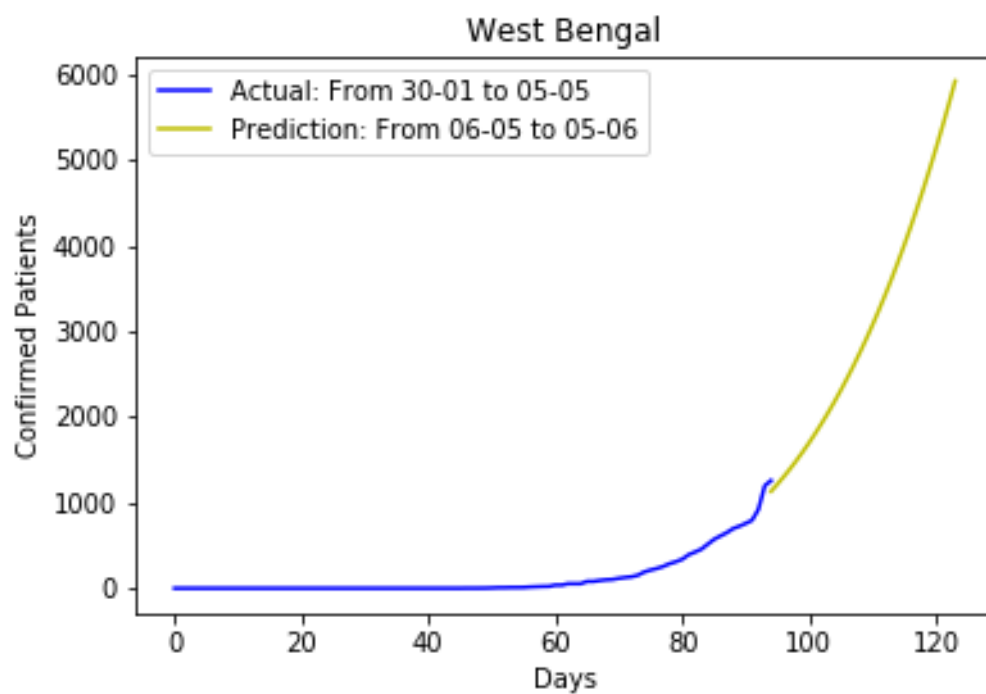
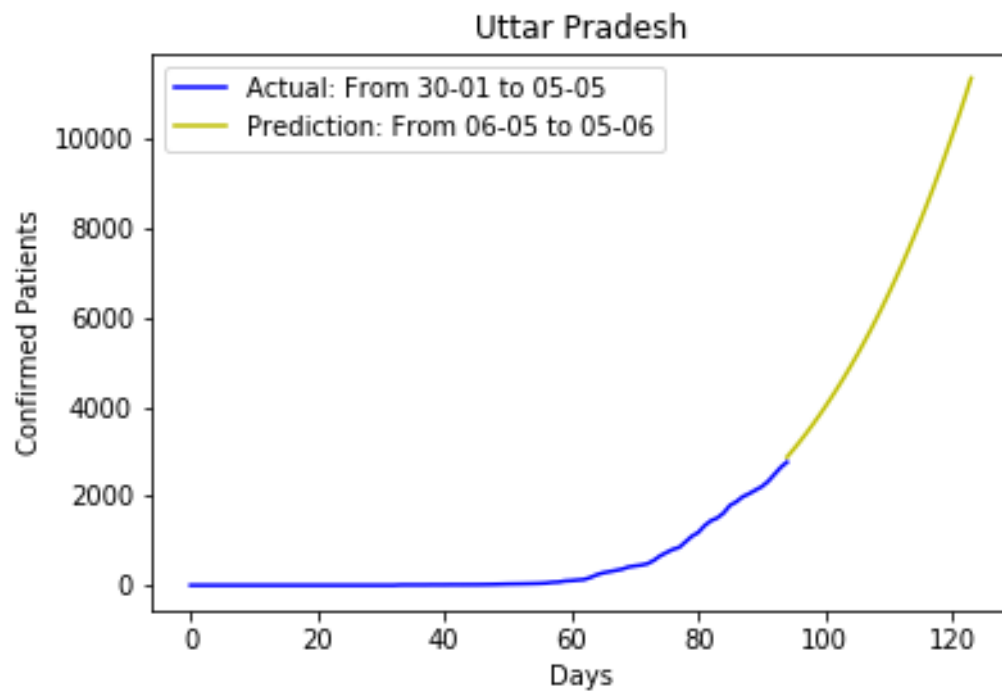








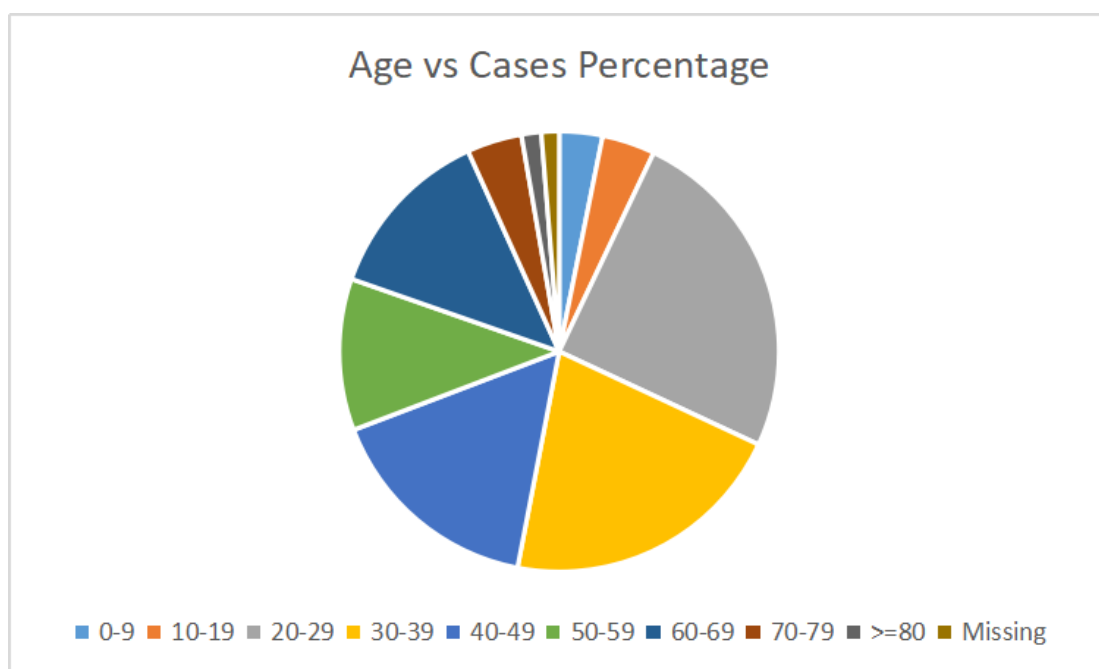


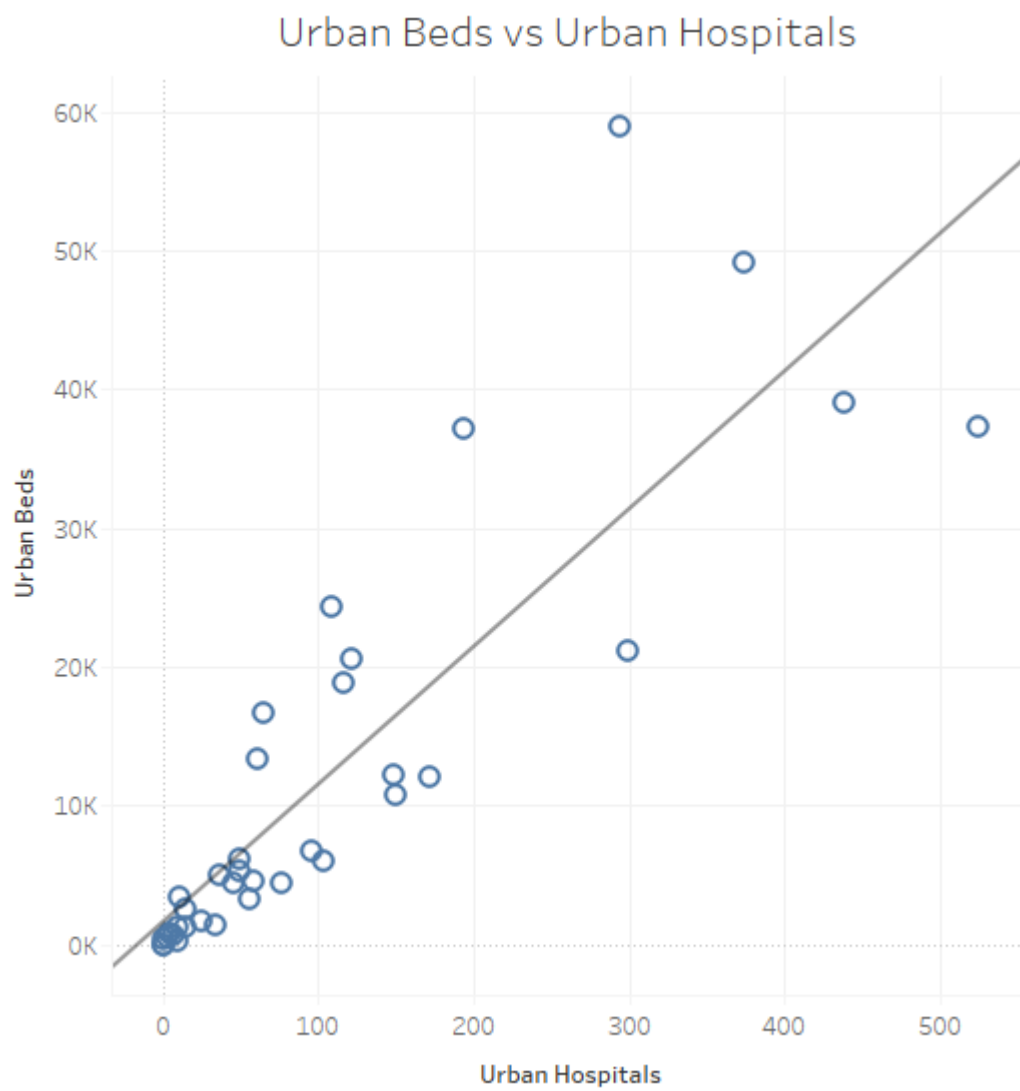


2.2 HOSPITALS AND BEDS

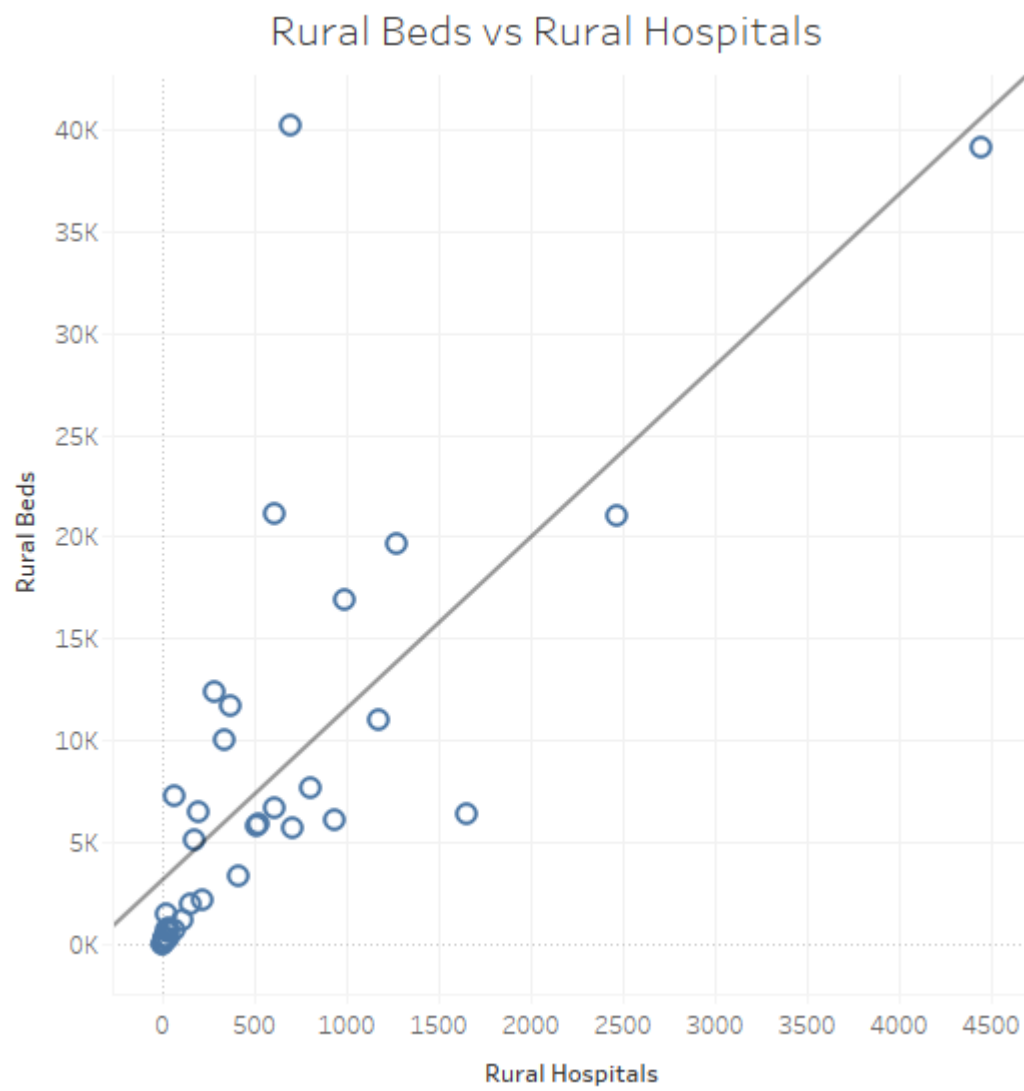
Data of all the hospitals of India and number of beds they have has been taken from [18]. By plotting the scatter plot between hospitals and number of beds of different states, analysis has been done. Scatter plots are used to find the relationship between two variables[19].

2.3 HOSPITAL ANALYSIS RESULTS

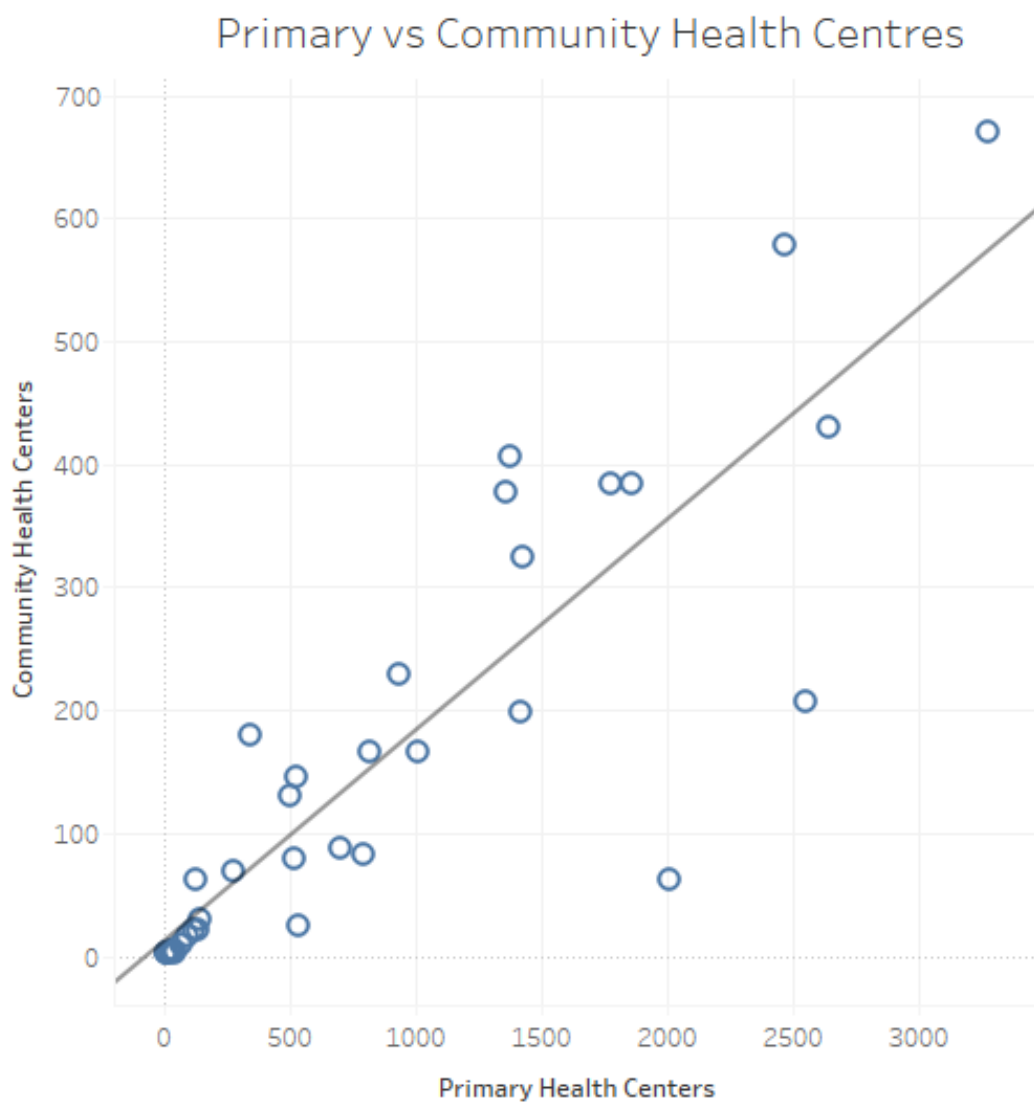




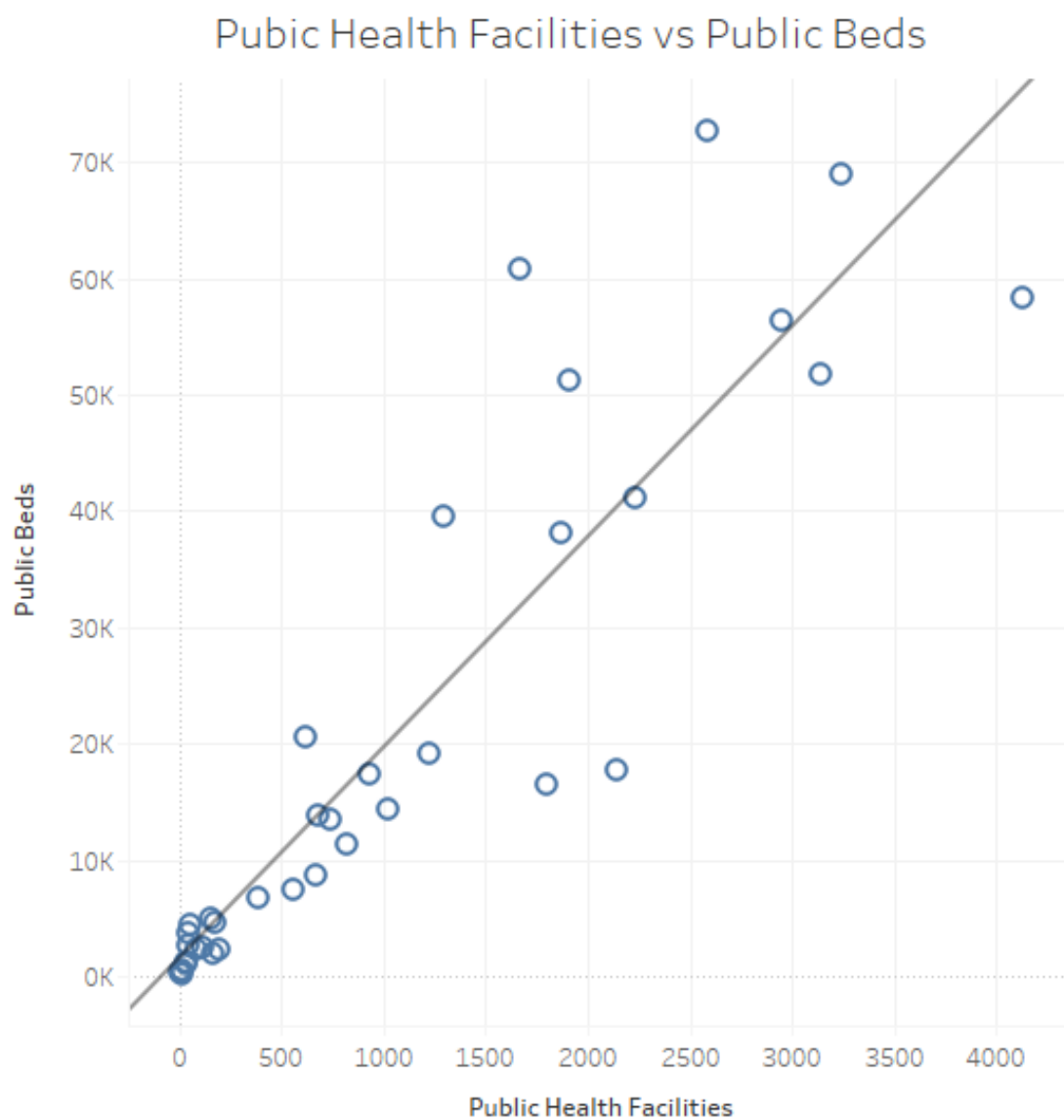
Sum of Urban Hospitals vs. sum of Urban Beds. Details are shown for State/UT.



Sum of Rural Hospitals vs. sum of Rural Beds. Details are shown for State/UT.



Sum of Primary Health Centers vs. sum of Community Health Centers. Details are shown for State/UT.



Sum of Public Health Facilities vs. sum of Public Beds. Details are shown for State/UT.

- There can be linear relationship seen between the number of urban hospitals and beds they have so government has made a solid arrangements in the health care department which is appreciable.
- It can be observed that number of hospitals are more in rural areas as compare to urban after seeing that rural hospitals vs beds graph.
- The reason behind it might be more number of old people living in rural areas as COVID-19 affects old age people a lot due to their low immunity.
- The relationship between community health centers and primary health centers is also quiet linear in style so a government is trying to maintain a balance between them which is a good decision.
- Again, linear relationship can be seen between public health facilities and public beds so there is a balance in every relationship and this balance should be maintained in future too to better India's health facilities.

2.4 CONTROL MEASURES

In this paper, a table listing of all the control measures taken by government regarding COVID-19 like travel ban, social distancing, restrictions etc. All the data is taken from various articles and other papers. This will help in understanding whether control measures imposed by government did bring success to some extent or not. Also, it will help in suggesting the authorities what other control measures can be included to control the spread of disease.

Date	Control Measure
13-03 until April 15 th [22]	Suspension of all visas except diplomatic, official, UN, employment and project
13-03 days[22]	Incoming travelers (including Indians) have visited China, Italy, Iran, Republic of Korea, France, Spain and Germany after 15 th February, 2020 quarantine 14
10-03 COVID-19 health certificate[22]	Incoming travelers having visited Italy or Korea to produce negative
15-03 Assistance to COVID-19 victims and families of deceased[23]	
18-03 March[24]	Introduction of quarantine policies for travelers expanded to those coming or transiting from UAE, Qatar, Oman, Kuwait starting 18 March until 31
18-03 from 18 March[24]	ban of entry for passengers from EU countries, EFTA countries, Turkey, UK
16-03 March 31 and postponement of several local elections[25]	closure of selected public institutions such as museums (incl. Taj Mahal) until
15-03 Nepal, Myanmar and Bhutan until 15 April[26]	temporary closure of specified Indian land border crossings with Bangladesh,
05-03 health screens at border crossings[27]	
Until March 31, 2020[28]	
25-01 entry[29]	screening for travelers from 2019-nCoV affected countries at points of

establish In country/ community surveillance through the Integrated Disease
25-01 Surveillance Programme network(IDSP)[29]

Social distancing advisory until 31 March 2020, including (1) closure of all education establishments, gyms, museums, cultural and social centers, swimming pools and theaters, offices, non-essential social and cultural gatherings, non-essential travel, and (2) physical distance ensured at restaurants, religious mass gatherings, transportation, and greetings. [30]

All hospitals must provide treatment free of cost to any medical personnel who pick up infection while treating patients[31]

all pneumonia patients must also be notified to NCDC or IDSP so that they can be tested for COVID 19. [31]

All unauthorized/ authorized shops (excluding pharmacies) and eateries in the vicinity of hospitals should be compulsorily shut.[31]

Indian citizens are advised to refrain from travel to China. People travelling to China henceforth will be quarantined on return. Indian citizens are advised to refrain from non-essential travel to Singapore, Republic of Korea, Iran, and
26-02 Italy.[32]

People coming from Republic of Korea, Iran and Italy or those having history of travel to these countries may be quarantined for 14 days on arrival to
26-02 India.[32]

Existing visas (including eVisa already issued) of those traveling from China to
26-02 India are no longer valid for any foreign national travelling from China.[32]

Indian citizens are advised to refrain from travel to COVID-19 affected Countries (China, Republic of Korea, Islamic Republic of Iran, Italy and Japan). For those planning a visit to India from these countries, Existing visas (including eVisa already issued) are no longer valid for any foreign national
02-03 travelling from these countries.[33]

All regular (sticker) Visas/e-Visa (including VoA for Japan and South Korea) granted to nationals of Italy, Iran, South Korea, Japan and issued on or before 03.03.2020 and who have not yet entered India, stand suspended with immediate effect. Such foreign nationals may not enter India from any Air, Land or Seaport ICPs. Regular (sticker) visas/e-Visas granted to all foreign nationals who have travelled to Peoples Republic of China, Iran, Italy, South Korea and Japan on or after 01.02.2020, and who have not yet entered India stand suspended with immediate effect. Such foreign nationals may not enter
03-03 India from any Air, Land or Seaport ICPs.[34]

Passengers (foreign and Indian) other than those restricted, arriving directly or indirectly from China, South Korea, Japan, Iran, Italy, Hong Kong, Macau, Vietnam, Malaysia, Indonesia, Nepal, Thailand, Singapore and Taiwan must
03-03 undergo medical screening at port of entry[34].

05-03 Advisory against mass gatherings[35].

Indian citizens are advised to refrain from travel to China, Iran, Republic of Korea, Italy & Japan and advised to avoid non-essential travel to other COVID-19 affected countries. All regular (sticker) Visas/e-Visa (including VoA for Japan and South Korea) granted to nationals of Italy, Iran, South Korea, Japan and issued on or before 03.03.2020 and who have not yet entered India, stand suspended with immediate effect. Regular (sticker) visa / e-Visa granted to nationals of Peoples Republic of China, issued on or before 05.02.2020 were suspended earlier. It shall remain in force. Regular (sticker) visas/e-Visas granted to all foreign nationals who have travelled to Peoples Republic of China, Iran, Italy, South Korea and Japan on or after 01.02.2020, 06-03 and who have not yet entered India stand suspended with immediate effect.[36]

All international Passengers entering into India are required to furnish duly filled self-declaration form (including personal particulars i.e. phone no. and address in India) to Health Officials and Immigration officials and undergo Universal Health Screening at the designated health counters at all Points of 06-03 Entry.[37]

all passengers having travel history to China, Hong Kong, Republic of Korea, Japan, Italy, Thailand, Singapore, Iran, Malaysia, France, Spain and Germany are advised to undergo self-imposed quarantine for a period of 14 days from the 10-03 date of their arrival[38].

All regular Visas (including e Visas) which have been granted to nationals of France, Germany and Spain on or before 11.03.2020 and where these foreigners 10-03 have not yet entered India stands suspended[38].

Indian citizens are advised to avoid non- essential travel abroad. They are further strongly advised to refrain from travelling to China, Italy, Iran, Republic 10-03 of Korea, Japan, France, Spain and Germany[38].

Incoming travelers, including Indian nationals, are advised to avoid non-essential travel and are informed that they can be quarantined for a minimum of 14 days on their arrival in India. Indian nationals are further strongly advised to refrain from travelling to China, Italy, Iran, Republic of 11-03 Korea, France, Spain and Germany[39].

International traffic through land borders will be restricted to designated check 11-03 posts with robust screening facilities[39].

All passenger movements through all Immigration Land Check Posts located at Indo-Bangladesh Border, Indo-Nepal Border, Indo-Bhutan Border, and Indo-Myanmar Border will be suspended with effect from 00:00 hours March 13-03 15, 2020 until further orders, except through designated posts[40]

Intensified health inspections at all these entry points. Subject to quarantine if 13-03 symptomatic[40].

Additional border restrictions, modifying the announcement from 13 March 2020. Suspending all types of passenger movements through all Immigration Land Check Posts. In effect 00:00 hours on March 15, except at the India-Pakistan border where it will go into effect from 00:00 hours on March 15-03 16[41]

14-03 Invoking use of emergency protocol & funds[42].

“Travel of passengers from Afghanistan, Philippines, Malaysia to India is prohibited with immediate effect. No flight shall take off from these countries to India after 1500 hours Indian Standard Time (IST)... till 31st March 2020 17-03 and will be reviewed subsequently.”[43]

No international flights to take off for India from foreign airports after 0001 hrs GMT of March 22, 2020 until 0001 hrs GMT March 29, 2020. 20 hours maximum travel time. So no incoming international passengers allowed on 22-03 Indian soil (foreigner or Indian) after 2001 hrs GMT of March 22, 2020[44].

All asymptomatic individuals who have undertaken international travel in the last 14 days should stay in home quarantine for 14 days, be tested only if symptomatic, and all family members living with a confirmed case should be 20-03 quarantined[45].

Testing all symptomatic contacts of laboratory confirmed cases, symptomatic health care workers, and all hospitalized patients with Severe Acute Respiratory 20-03 Illness[45].

Complete lockdown of entire nation for 21 days. Agriculture-Farming and 24-03 allied activities exempted from Lockdown (announced 3/28)[46]

Deploy fiscal resources for additional medical facilities, central instruct state 24-03 government[46]

Govt asks distilleries / sugar mills to maximize manufacture of hand 26-03 sanitizers[46]

Relief Package towards responsive Governance in Challenging Times Which 26-03 Will Provide Relief to Vulnerable Sections[46]

Govt gives benefits to farmers on crop loan repayments due to Covid-19 30-03 lockdown[46]

02-04 adopt community-approach in the battle against the pandemic[46]

03-04 Advise religious leaders to not hold any congregations/ functions[46]

extended the period of completion of election including postponing the date of poll and counting concerning elections to the Council of States, since the electoral process necessarily involves movement and gathering of polling officials, agents of political parties, support officials and members of respective 03-04 Legislative Assemblies on the poll day, which may put public safety at risk and

create public health hazard[46].

04-04 More lockdown relaxations for Agriculture-Farming sector[46]

CBDT issues orders u/s 119 of IT Act,1961 to mitigate hardships to taxpayers
04-04 arising out of compliance of TDS/TCS provisions[46]

04-04 Manual on Home Made Masks to prevent COVID-19[46]

COVID-19 Emergency Response and Health System Preparedness Package
09-04 Posted On: 09 Apr 2020[46]

MoS Agriculture, Shri Kailash Choudhary inaugurates Pusa Decontamination
16-04 & Sanitizing Tunnel[46]

17-04 Armed Forces Medical Services deployed[46]

Amends the extant FDI policy for curbing opportunistic takeovers/acquisitions
18-04 of Indian companies due to the current COVID-19 pandemic[46]

launches 'COVID India Seva', an interactive platform for citizen engagement
21-04 on COVID-19 Po[46]

In-house Care-givers of Senior Citizens, Prepaid mobile recharge utilities, Food
processing units in urban areas exempt from Lockdown Restrictions to fight
21-04 COVID-19 Post[46]

Advisory against spraying of disinfectant on people for COVID-19
22-04 management[47]

COVID-19 GIS Dashboard: This is a location-based information system used to
geotag - people who are home quarantined (purple colour dots on map), last
location of COVID-19 positive persons (Red Drop Marks), Area Cordoning
(Black lines), Lane closure, etc.. Once a patient is found to be COVID-19
positive, his/her last location of stay is marked on the dashboard. Similarly, all
home quarantined persons are marked on the map. This information is used to
generate a heat map which helps classify areas from low risk to high risk. This
dashboard is also used to identify epicentres of COVID-19 cases which helps
the Health Department to identify locations for immediate spraying of
24-04 disinfectants[46].

MHA allows opening of certain categories of shops. In rural areas, all shops,
except those in shopping malls are allowed to open. In urban areas, all
standalone shops, neighborhood shops & shops in residential complexes are
allowed to open. Shops in markets/market complexes and shopping malls are
not allowed to open. It is clarified that sale by e-commerce companies will
25-04 continue to be permitted for essential goods only[46].

States promotes the concept of 'Direct marketing' to facilitate farmers/ group of
farmers/FPOs/ Cooperatives in selling their produce to bulk buyers/big
26-04 retailers/processors etc[46].

Government launches online data pool of critical human resource for combating
19-04 and containing Covid-19[48]

Gov is focusing on easing policy and implementation bottleneck to supply
27-04 chains of essential items[46]

Guidelines issues for home isolation of very mild / pre-symptomatic
28-04 patients[46]

28-04 \$1.5 billion loan to support government's response to COVID-19 pandemic[46]

Rs. 50 lakh compensation for Port employees/workers, in case of loss of life
28-04 from COVID-19[46]

29-04 HCARD, a robot, to assist frontline COVID-19 healthcare warriors[46]

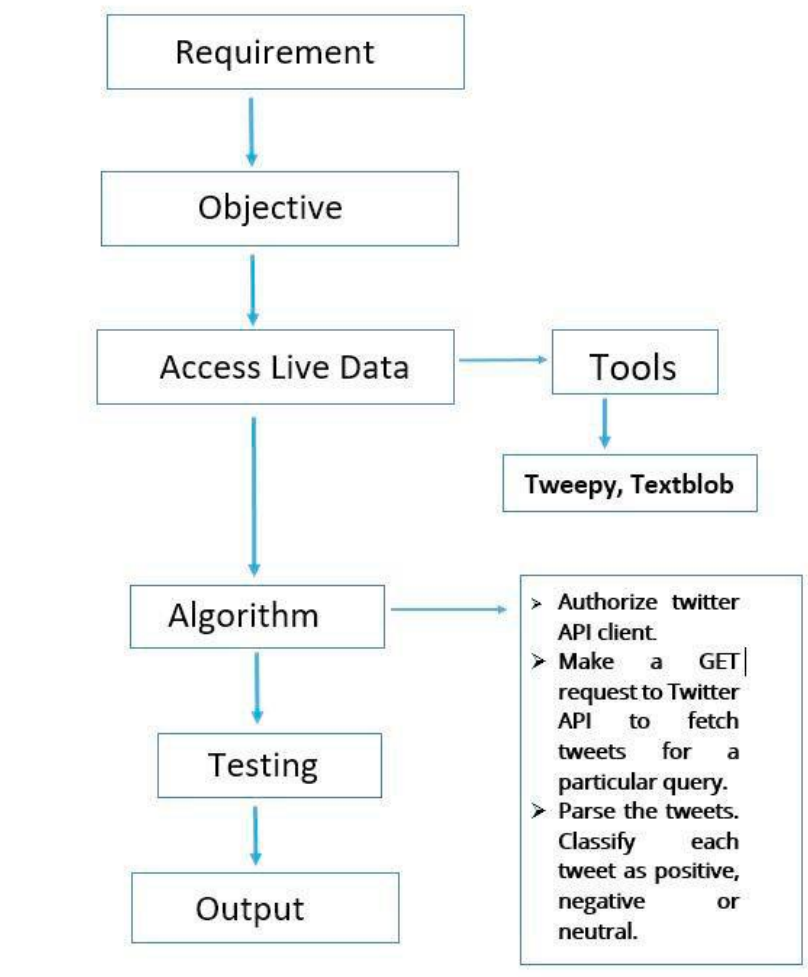
a dash board about COVID-19 situation in KDMC area is now available in
public domain. The page has been linked with the website of municipal
corporation, and other social media handles of city government (such as
Facebook, Twitter, Instagram), and is open for viewing by public. Dashboard
can be accessed at <https://kdmc-coronavirus-response-skdccl.hub.arcgis.com/>
29-04 [49]

Table of Control Measures

- Stating the fact that India is still at Stage II of disease transmission even after 3 months since detecting first case, it can be said that these control measures were pretty successful.
- Traveling ban at early stage was a good decision because as India share borders with China so people often go to China for holidays or business purpose and Chinese people also often come India so imposing ban on travel and suspending visas might have helped India to rise at a slower pace in confirmed cases.
- Quarantine policies kept updating with new countries inclusion also helped is getting less number of foreign nationals positive cases. Same goes with suspension of visa policies.
- 21-days of complete lockdown also slower the pace of rising cases upto an extent.'
- Giving benefits to farmers on repayment of loan during lockdown helped farmers' situation else they would be huge debt and would not be able to pay their loan payments.
- Direct Marketing concept can improve India's economy during this pandemic.
- Extra things the government can do is to make more testing labs and do more testings of people with even mild cold. This would help detecting patients at early stage and their recovery chances will also increase.
- Government can adopt some AI technique like BlueDot to detect temprature of people from a distance.
- Strict laws should be made and imposed against people who violate social distancing rules or hide their travel history.

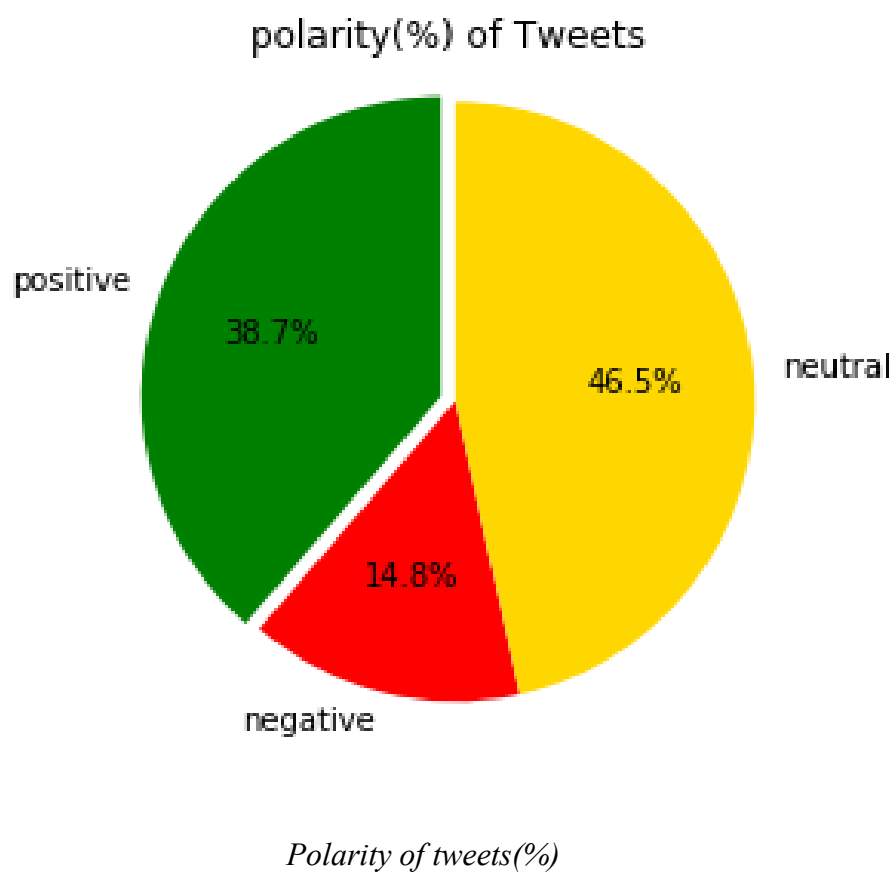
2.5 SENTIMENT ANALYSIS

To detect the polarity of a text or sentence or paragraph, and tell whether it is positive or negative or neutral, a process called sentiment analysis is used. It helps in understanding emotions of people towards a particular topic or area of interest. The process includes gathering of data, cleaning of data, sentiment generation, stock independent variables and atlast do prediction. For this paper, for sentiment analysis, tweets related to COVID-19 are analysed. Data is extracted from the twitter using the Twitter API. Data of tweets done on the date 12th march using #CoronavirusIndia has been taken. This date was decided because first lockdown was about to end close to this date. Total 15000 tweets were extracted and polarity of tweets was analysed then.



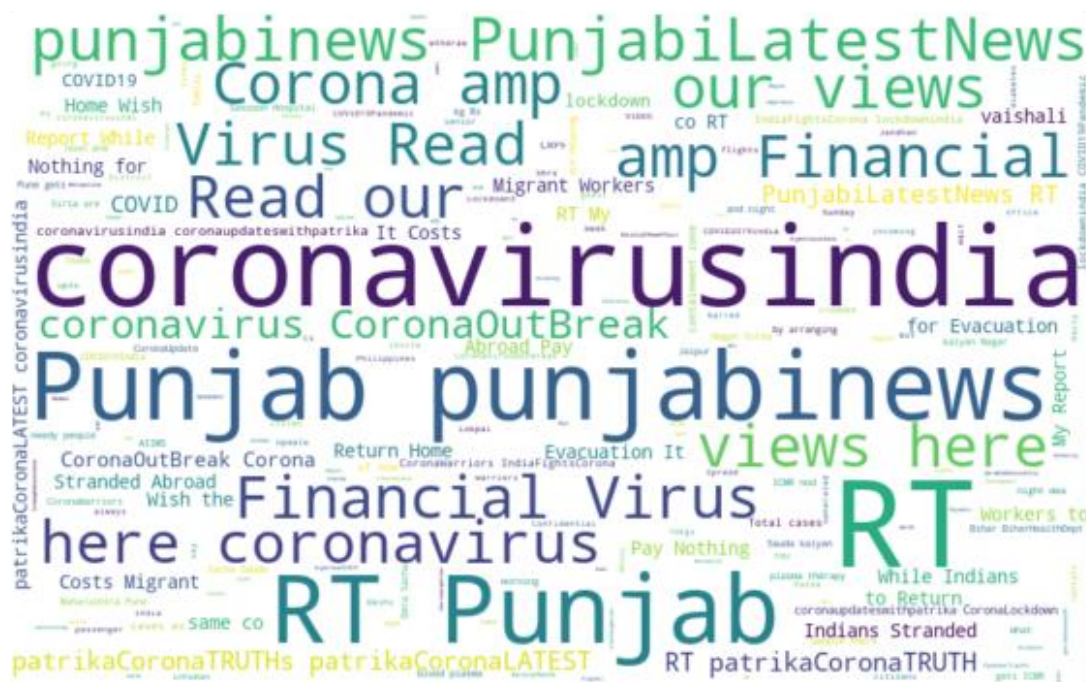
Twitter Sentiment Analysis Flow Chart[55]

2.6 SENTIMENT ANALYSIS RESULTS





Wordcloud of positive tweets



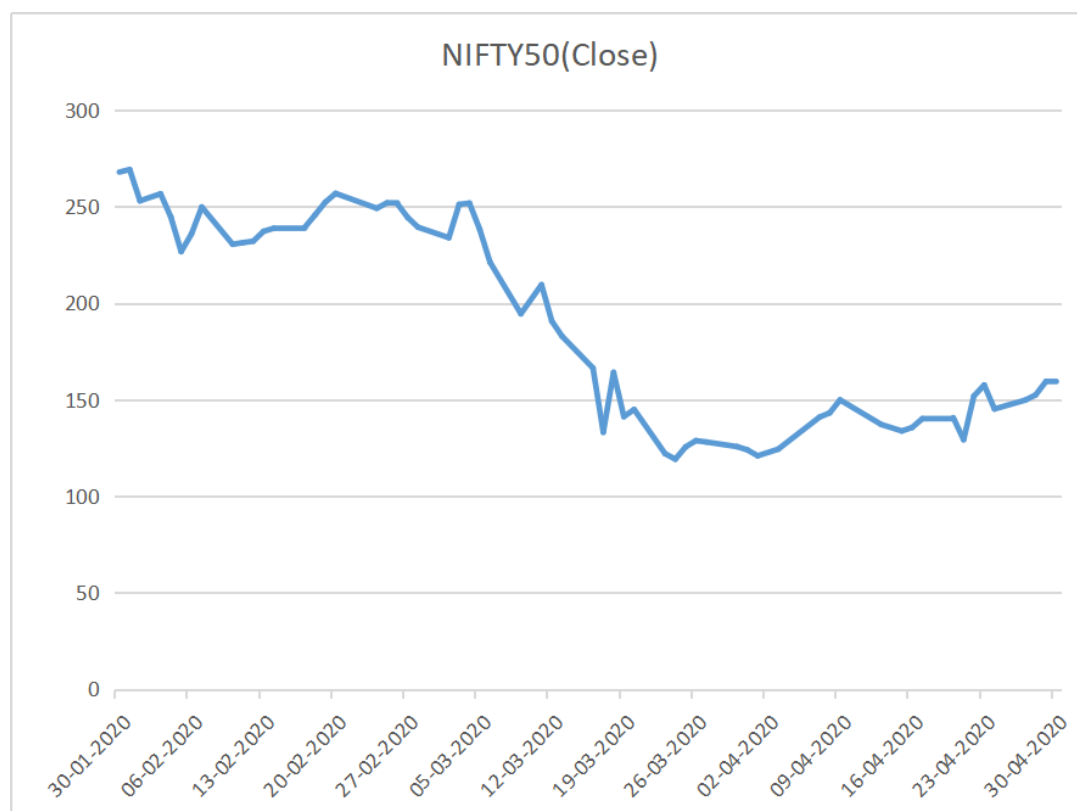
Wordcloud of neutral tweets

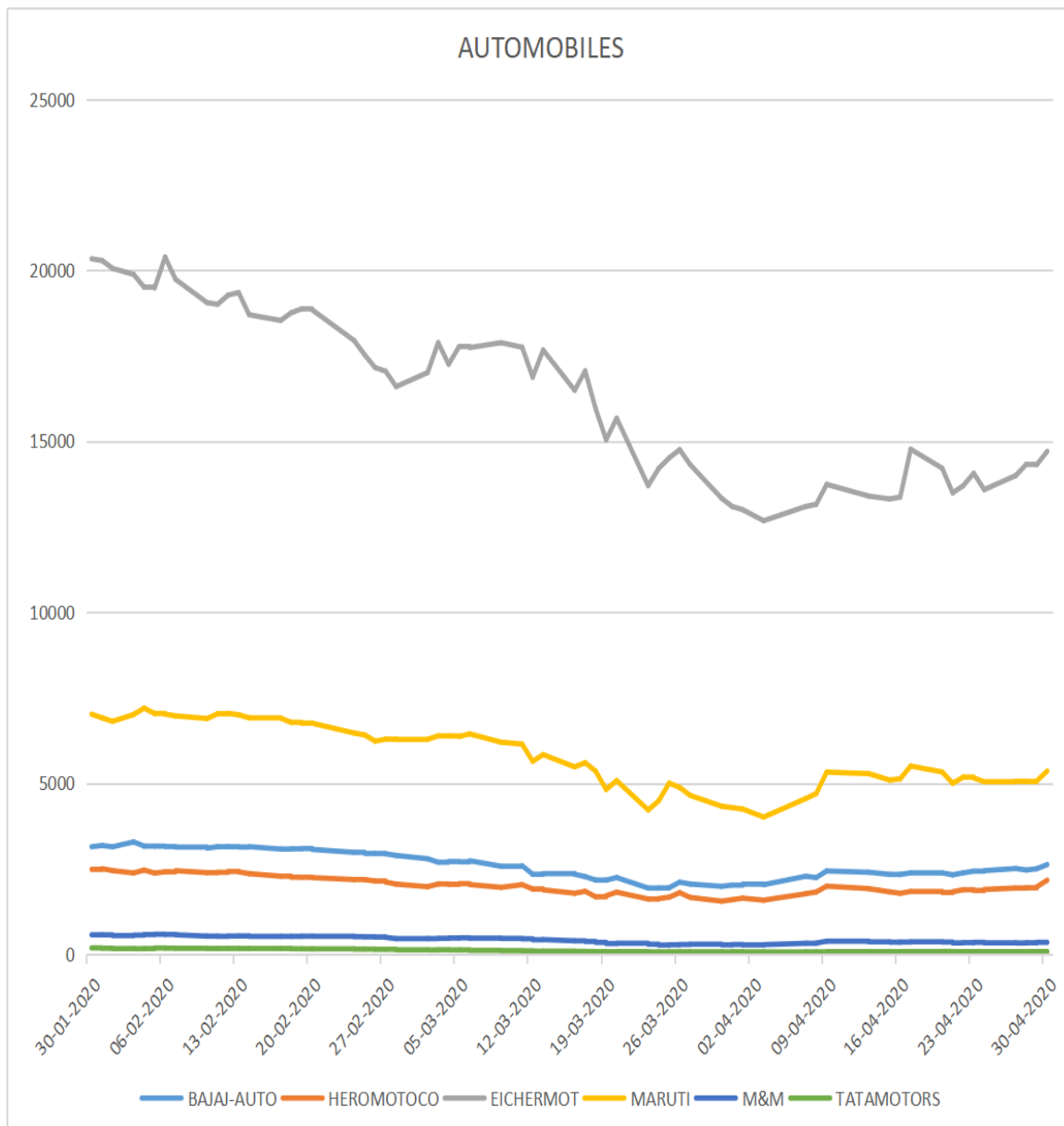
- Positive words might be related to appreciation tweets done for police workers and doctors and celebrities who were donating huge amounts of money in PMCare fund to fight coronavirus in India.
- Also, some states saw a rise in recovery rate which might be appreciated in positive tweets.
- Neutral tweets are mostly related to Punjab.
- The reason behind it could be that Punjab was one of the first states to extend the curfew and lockdown so some people who were migrants or daily wagers or people who support them might have tweeted against it and there would be some people who supported the decision. Also hand of a policeman was cut down by a person in Patiala, Punjab which might have drawn lots of negative tweets.
- There are total 14.8% of negative tweets.
- The reason behind it could be the incidents happened during those days like gathering of migrants or gathering on religious places or attacks on doctors etc.
- People must have thought that rise in cases in India is a result of these gatherings that is why they must have tweeted negative tweets.

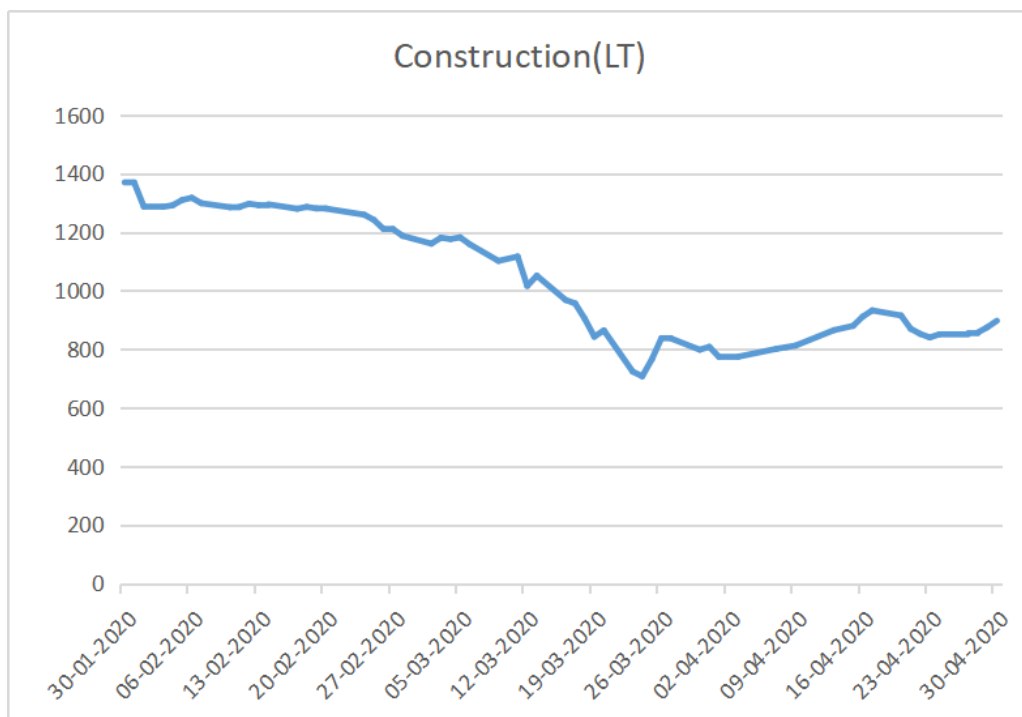
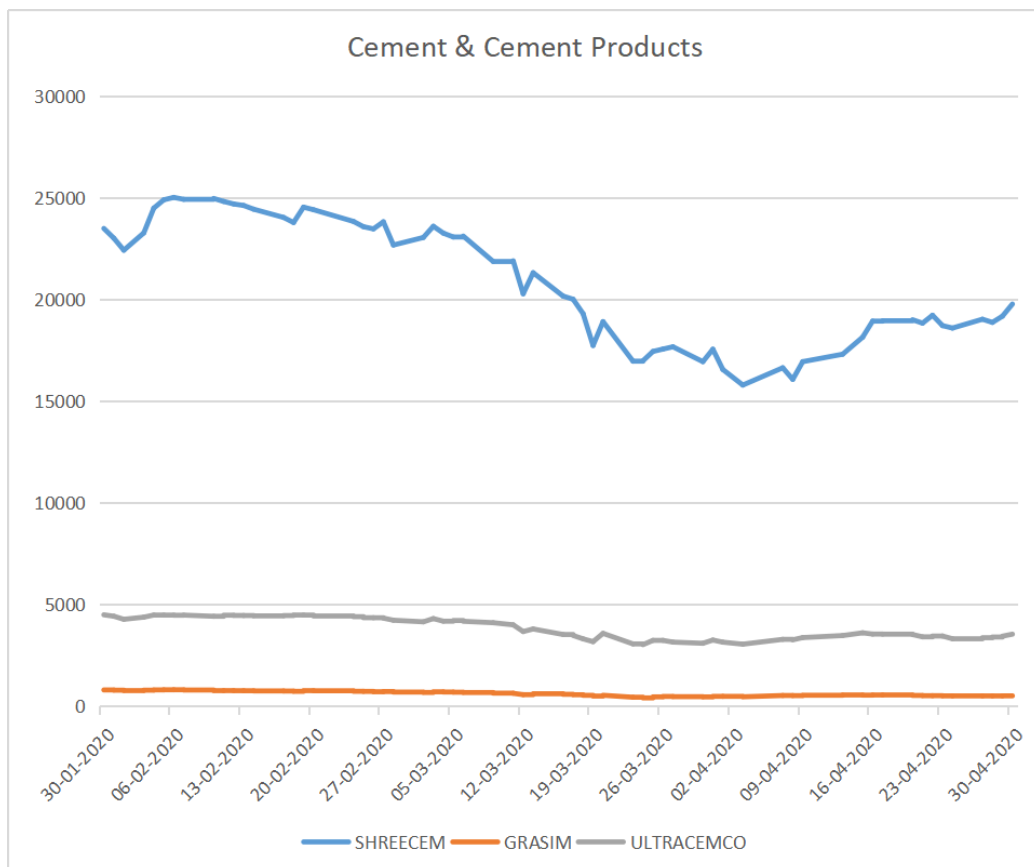
2.7 ECONOMICAL EFFECTS

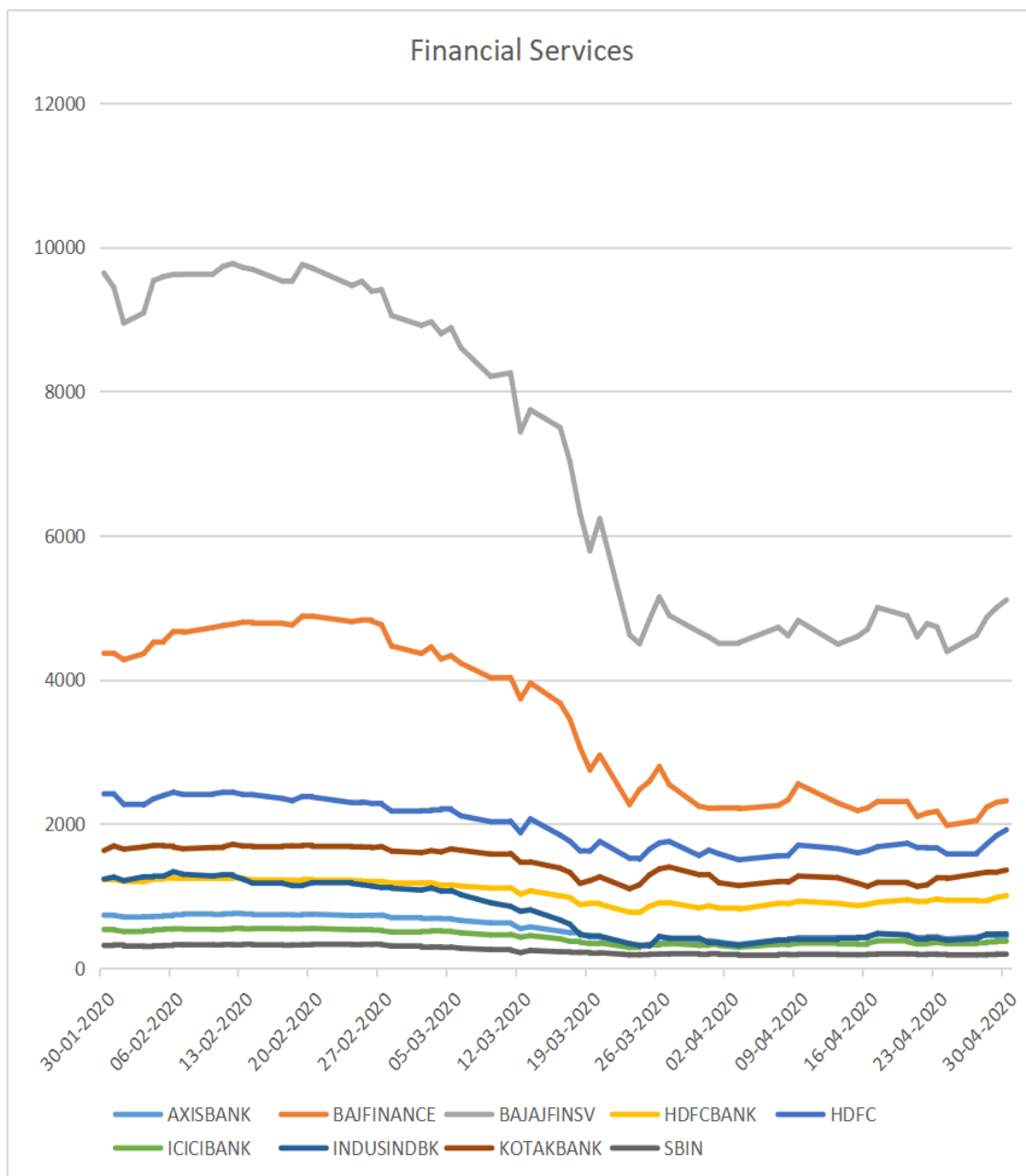
COVID-19 has shattered the world market and put it on the verge of recession and similar to 2008 crisis and India has also faced its wrath. India's GDP is already down even before COVID-19 and the pandemic will only make it worse. To see what effects have the outbreak done on Indian economy NIFTY50 data is analysed. NIFTY50 contains stock values of 50 large cap Indian companies belonging to different Industries. It offers investment managers exposure to the Indian market in one portfolio. Data is taken from [50]. Only the data starting from 30th January is analysed because first case of COVID-19 was reported on this date. Also only closing price is included to analyse stocks and all of the stocks are divided into 14 Industries[51].

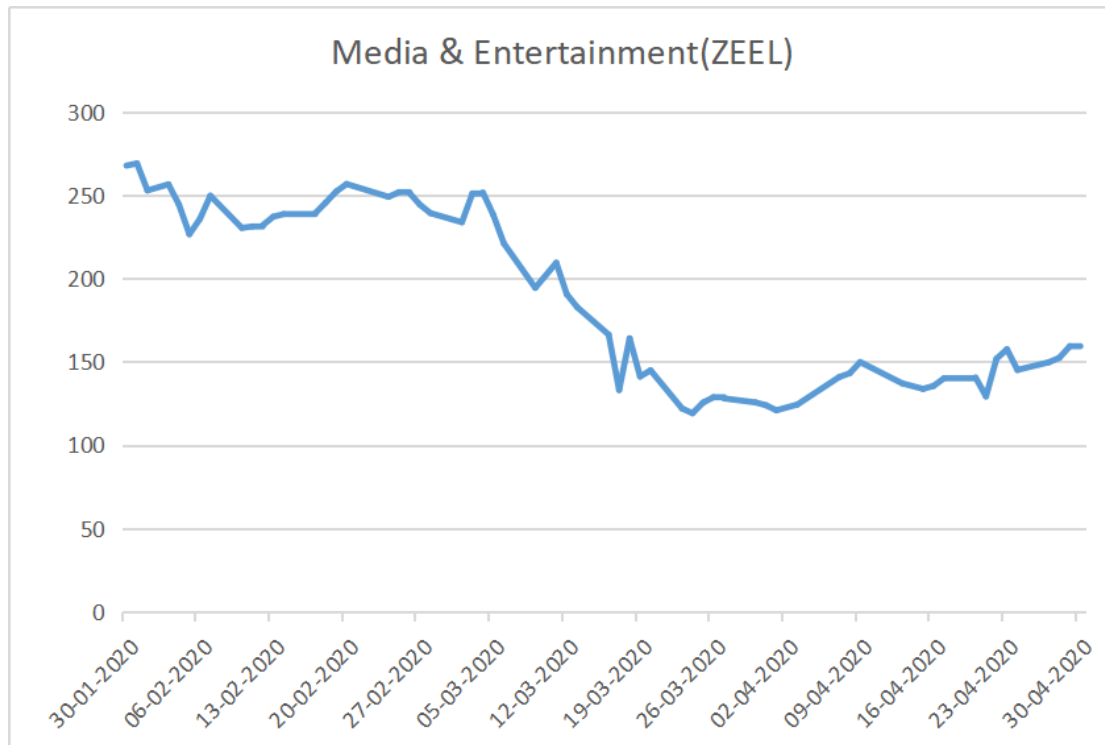
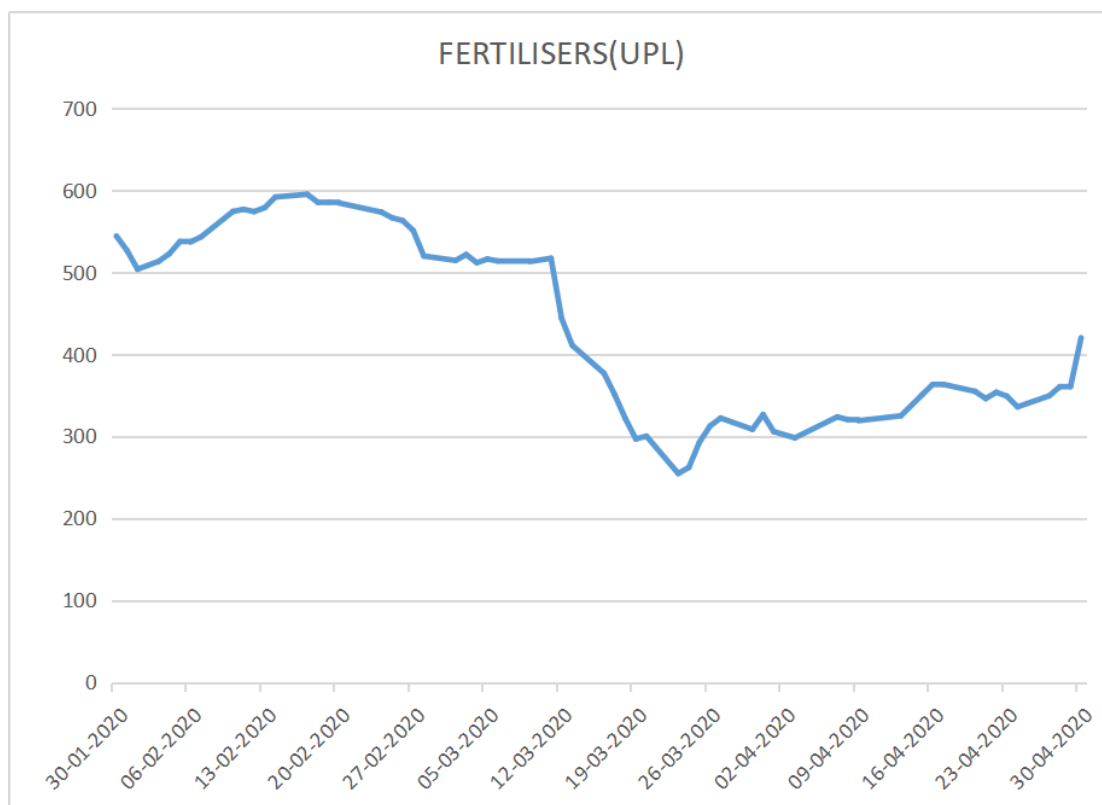
2.8 ECONOMY ANALYSIS RESULTS

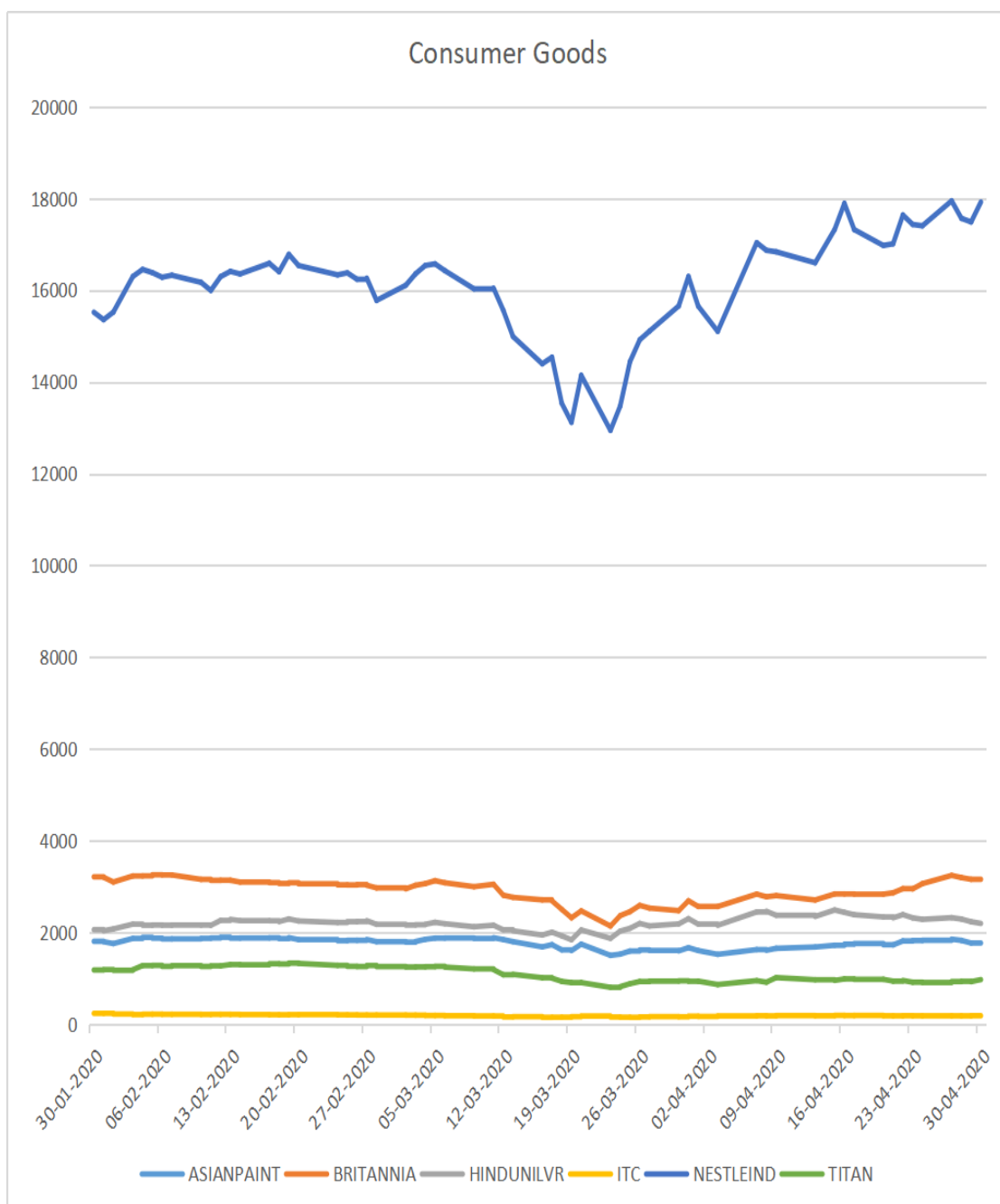


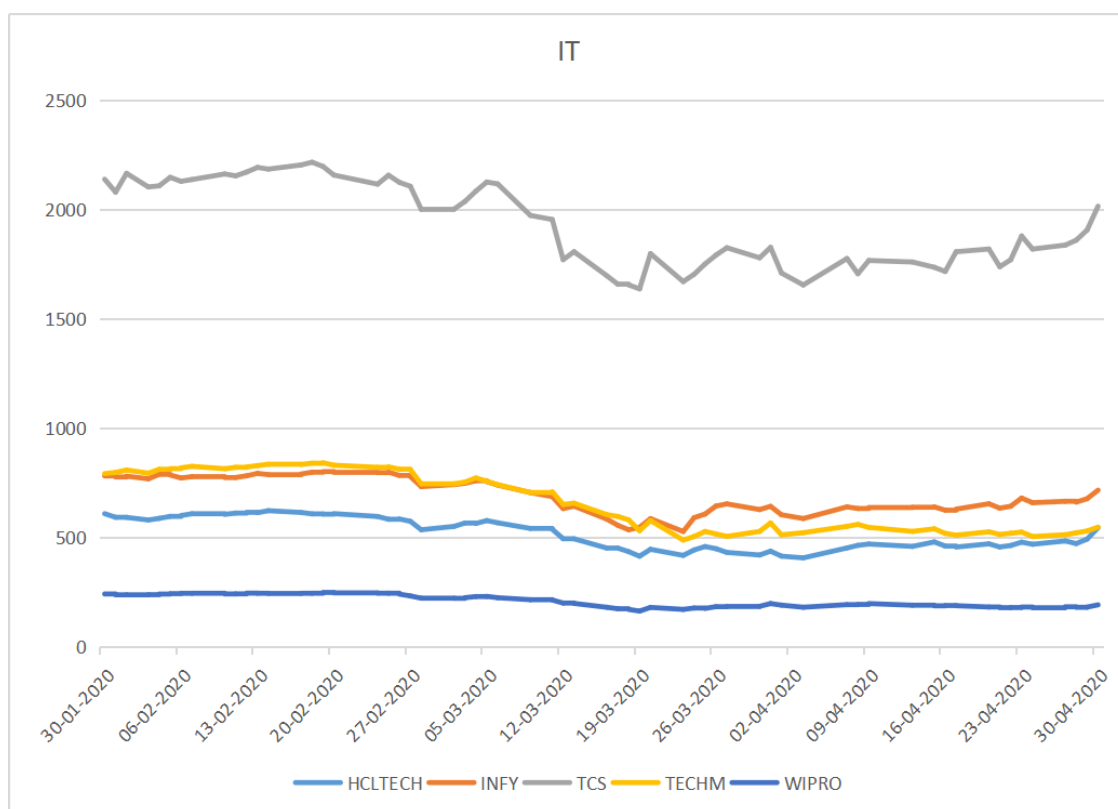
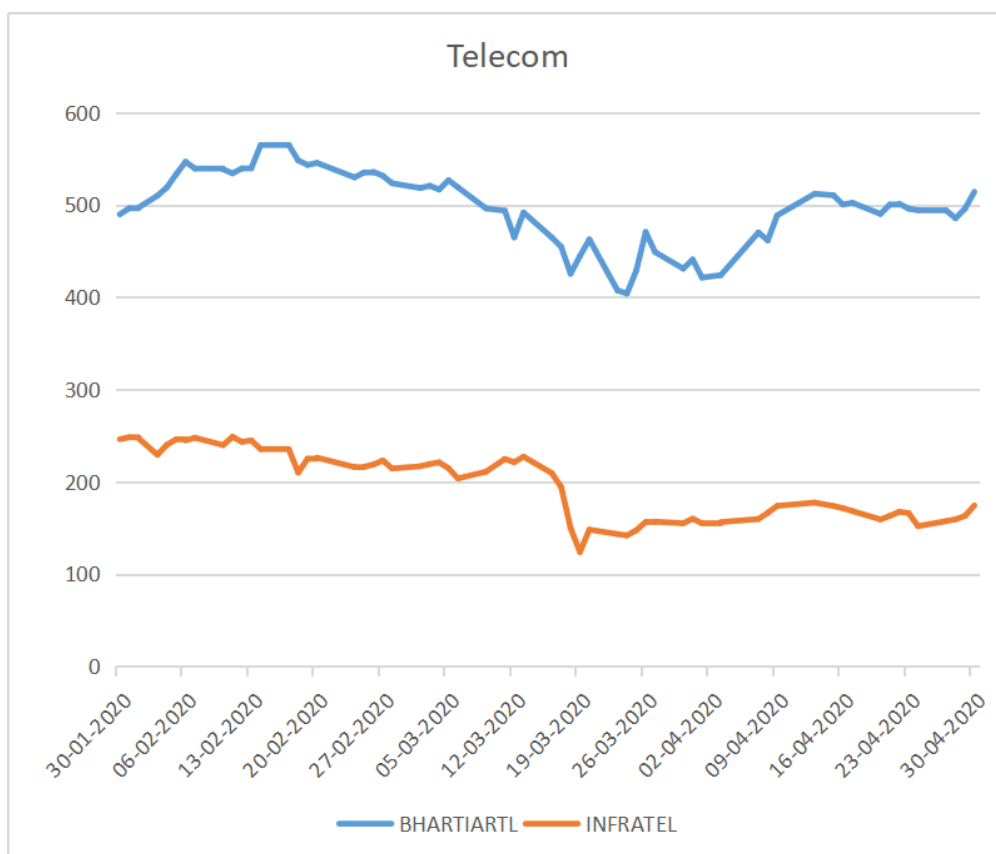


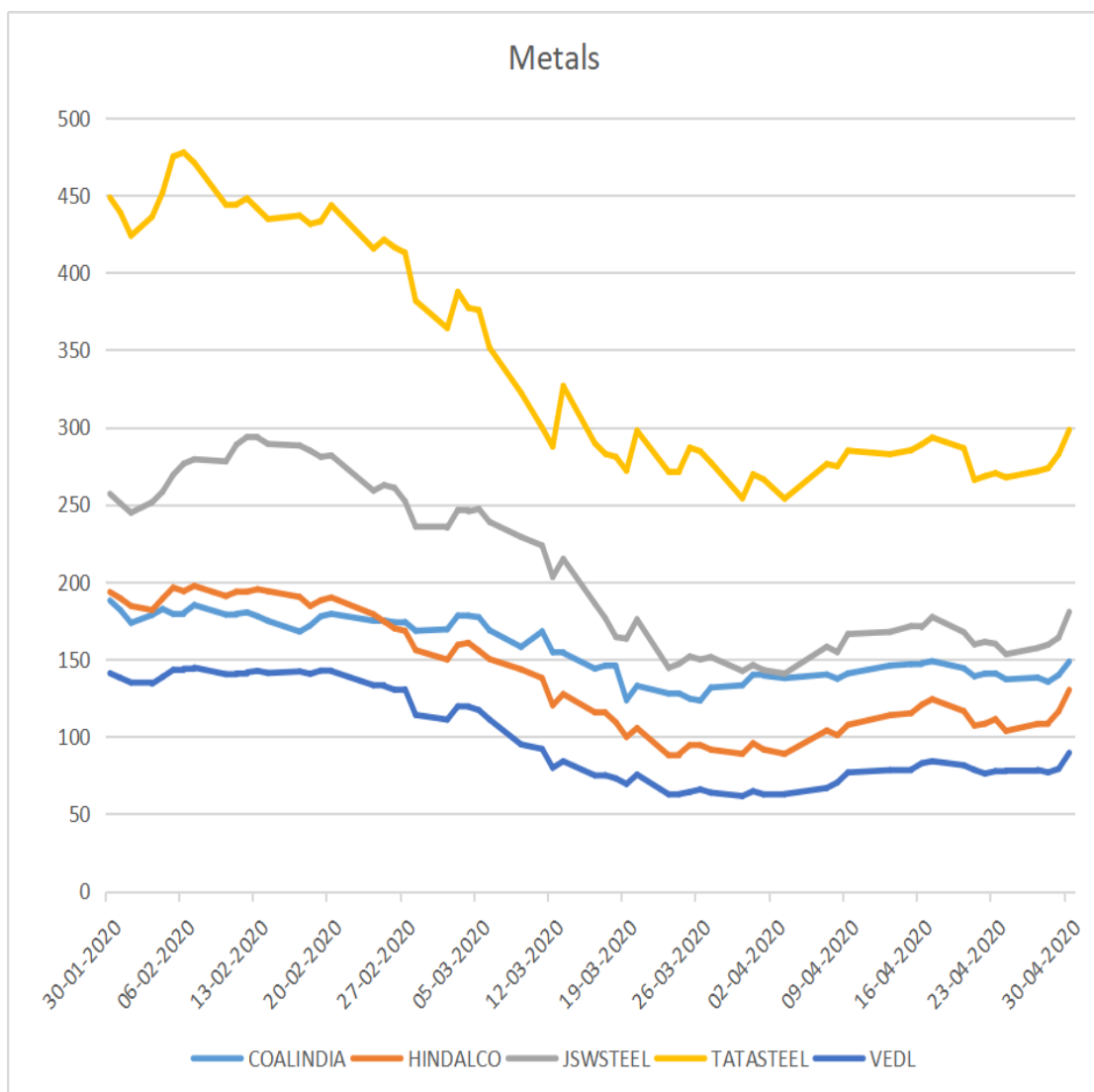


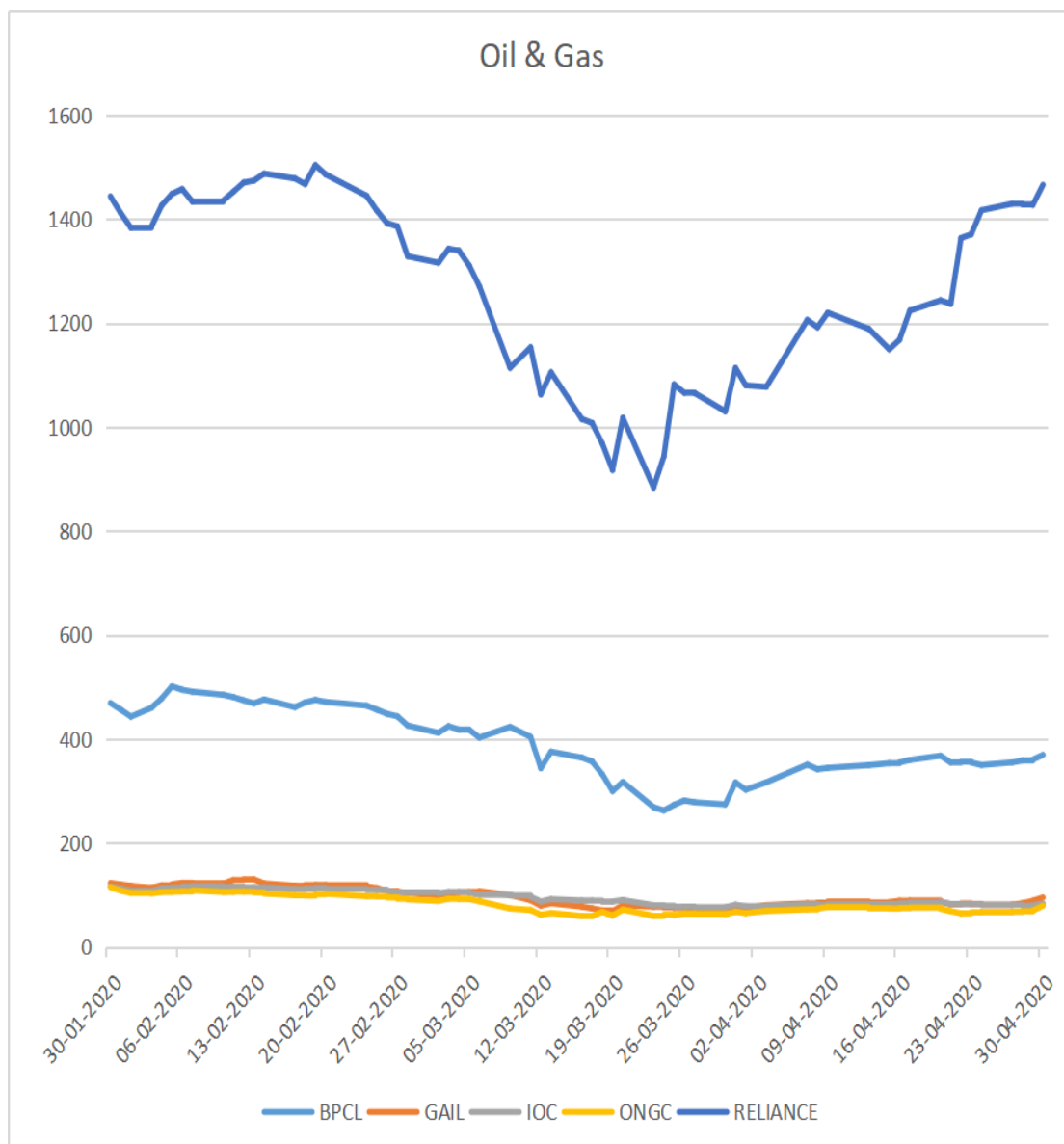


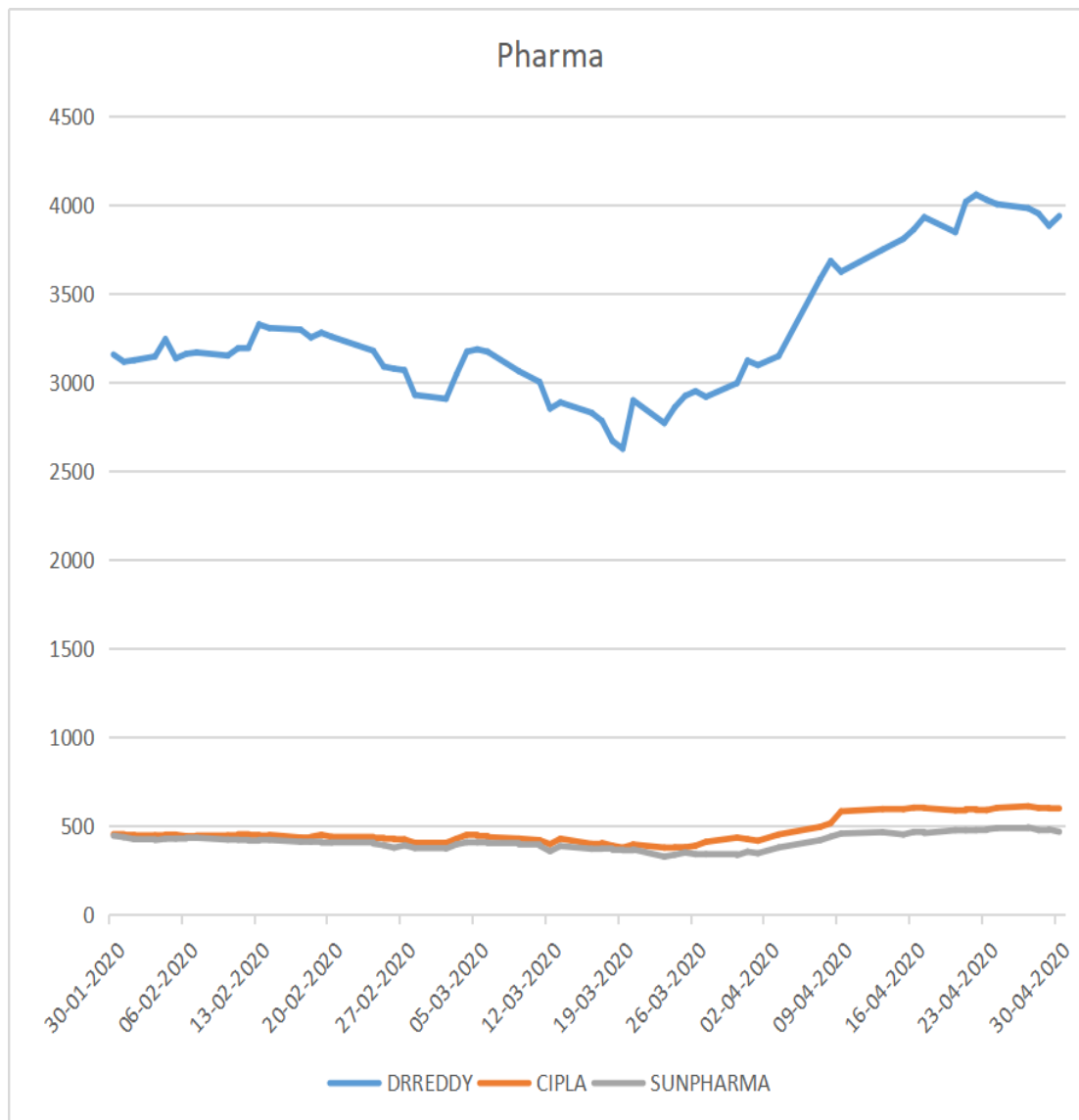


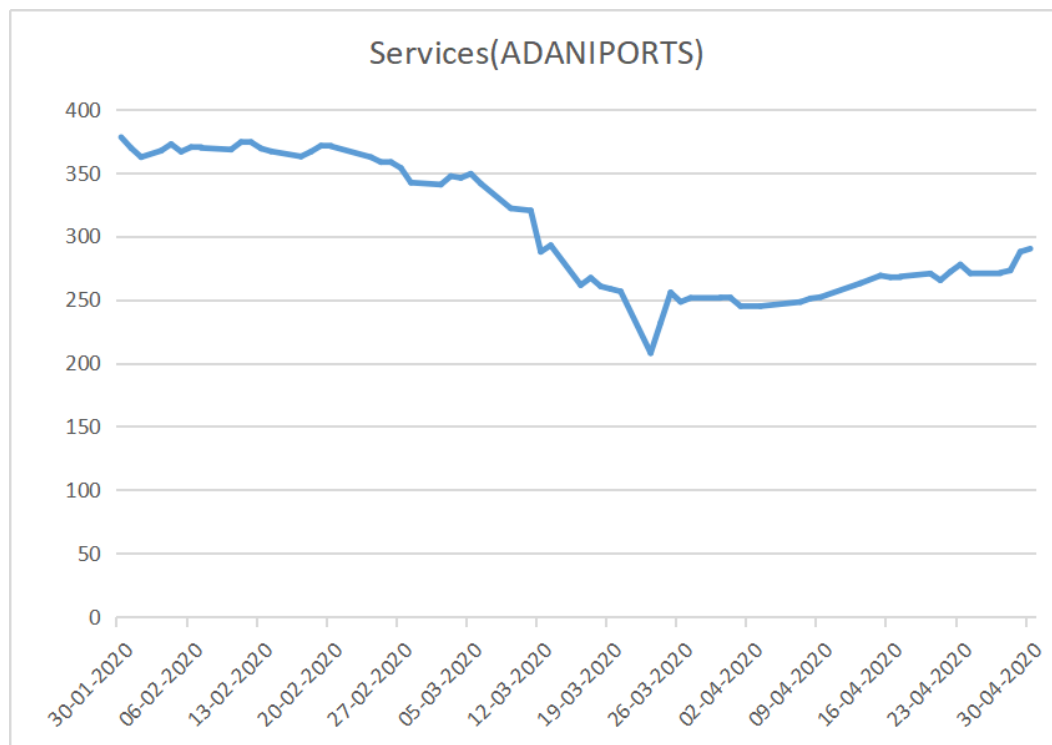
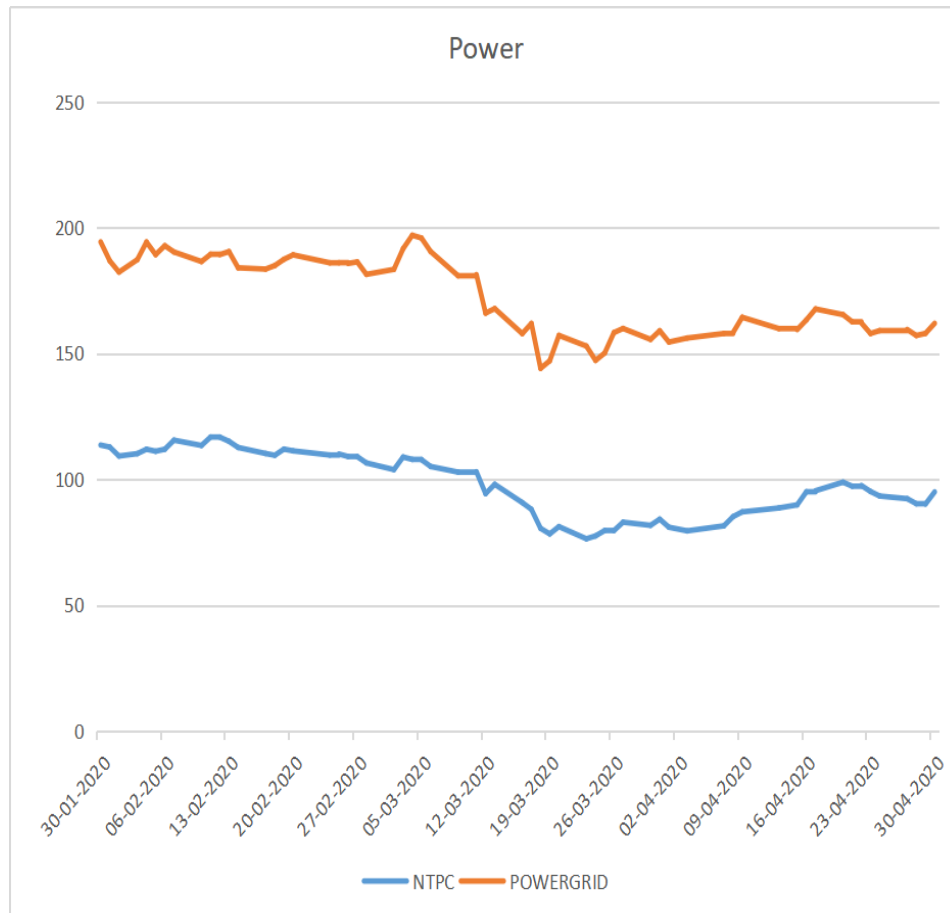












- As seen from the Nifty50 graph, the overall closing price reached its lowest on 19th March and since then a high growth is nowhere to be seen but still it is growing and fluctuating on a steady pace.
- It can be observed that almost all of the companies' closing price starts decreasing just when lockdown was started and starts increasing around the time of lockdown 2.0 where some relaxations were given.
- In automobiles industry, Eicher motors saw a huge dip of 7000 reaching around 13000 from 20000 at end of march, now it is close to 15000 while Maruti also saw a dip in its price and other companies manage to reach to their original closing price which was on 30th January.
- In cement industry, Shree cement saw a great downfall but now has upward trend while ultra tech cement is still going down
- Same trend goes for construction,. power, services and fertilizers industry, starts going up since lockdown 1.0 ended.
- The IT industry companies except TCS almost remain unaffected as kept a nearly constant price mainly because their employees can work from home so they would not suffer much bigger losses as compare to other industries.
- Pharma industry is the most profitable industry during the COVID-19 outbreak which is quite obvious because more patients need more medicine.
- In consumer goods, Nestle India is most profitable company witnessing a sustainable growth in its prices while other companies maintained a constant trend.
- In oil and gas, all the companies are now coming back to the price which was on 30th January including Reliance which saw a huge dip during lockdown.
- The remaining industries financial services, metals and surprisingly media and entertainment all are seeing downward trend in their closing prices.

3. DISCUSSION

Current trend shows that it seems like India is on the verge of exponential growth or community transmission(Stage III) of COVID-19 if proper measure will not be taken by government in future but government's control measures so far have provided success to some extent in controlling disease spread and it is hoped that government will take more measures and strict actions and also improve health facilities like conducting more tests in future to achieve the desired basic reproduction number so that India will not become a COVID-19 hotspot like USA, Italy or Spain because if government fails to do so, economy crash will become bigger threat in India than coronavirus.

In all the sections of this research, various challenges were faced related to data. As data available on John Hopkins University Repository was only related to whole India cases, it was hard to find COVID-19 data related to each state of India as no official source was available. There was no authorized place to get other data like hospital and beds and stock market. There were lots of sources with unreliable and missing data but fortunately there were some unauthorized but reliable sources which provided proper data without any missing value or insufficiency which helped in completing the study successfully. Only the graphs of confirmed cases could be plotted for Indian states in regression model due to very less number of deaths or recoveries and in SEIR model, only infectious curve was plotted for states. Even for states, the threshold was to have atleast 100 confirmed cases to become able to be plotted. Both regression and SEIR models use different variables to predict data over time that is why SEIR curve did not grow exponentially with time. Only NIFTY50 data was analysed to see economical effects because most of industries and big companies got covered in this single dataset. The date 12th April,2020 was chosen for sentiment analysis because of incidents happened during that date, be it lockdown extension, giving relaxations or attacks on doctors and policemen.

4. CONCLUSION

In this research paper, we tried to describe COVID-19 disease effects on almost every aspect of country India by using SEIR and Regression model to forecast data of disease spread in India and most of its states, analysis of various types of hospitals and their occupancy, analysis of control measures introduced by government till now and discussing what other measures government can take, doing sentiment analysis of Indian people and discuss reasoning behind each polarity and at last analysis of different stock prices categorized by industry to see the economical effects of COVID-19 outbreak on India. A range of R_0 values were taken for India to plot SEIR graphs and on the other hand, R_0 values of states were already available and Regression model predicted the next 30 days COVID-19 cases for India and its states. In addition to all of this, total days to infect whole India and its states using R_0 were also calculated.

Data of almost all the sections was taken from 30th January, 2020 to 4th May, 2020. Findings showed that COVID-19 cases trend is going upwards and stocks prices trends of almost every industry is going downwards and only Pharmacy industry is in profit during this outbreak. So it is being suggested that government should introduce some measures to control economy and disease spread at same time which is a very challenging task though so far government has done a pretty well job in terms of taking control measures like imposing visa and travel bans at early stages and giving relaxations to farmers on loan repayment. Suggestion is also that government should focus more on hospital facilities and testings. Although there is good relationship between hospitals and beds they have but if India keep seeing upward trend then there might be shortage of them because India has large population. Apart from that, sentiment analysis done on the data of 12th April shows that people are mostly neutral or positive about fighting with the disease while only few of them are negative. So, government actions are supported by most of the people but few more strict measures should have to taken in order to control the spread and GDP.

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