

A Project Report

on

LATEST COVID-19 ANALYSIS

USING R-PROGRAMMING

(SIR MODEL)

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ABSTRACT

In this project we can analyze and visualize the impact (deaths, recoveries, confirmed cases) caused by the novel corona virus (till present) using R programming. We can analyze the statistics of the pandemic day by day, month by month, region by region. We can visualize these statistics graphically (both linear and log) and we can also visualize the number of covid-19 cases in each and every country in a world map. This is important because we can get a lot of information on the worldwide pandemic covid-19. The main purpose of this project is to know about the recent statistics of the pandemic and the impact caused by the disease globally and regionally. We learnt about many aspects of R programming. We conclude that the analysis of COVID-19 using R programming has given us some significant results about the pandemic.

INTRODUCTION:

Corona viruses disease (COVID-19) is an infectious disease caused by a newly discovered corona virus. Corona virus is a novel microorganism that causes respiratory illness in hosts. This is the major health problem faced by public around the world. That's why it is indicated as a global pandemic. The coronavirus disease (COVID-19) is highly pathogenic viral infection caused by SARS-CoV-2. Currently, Covid-19 has caused global health concern. It is assumed that Covid-19 has zoonotic origin based on the large number of infected people

who are exposed to the wet market in Wuhan City, China. The phylogenetic analysis has revealed that SARS-CoV-2 has significant sequence similarity with severe acute respiratory syndrome-like (SARS-like) bat viruses, thus bats could be primarily possible reservoir. The intermediate host and there subsequent transfer is not known yet, although human to human transfer is widely confirmed. The transmission of COVID-19 infection from one person to another resulted in the isolation of patients who were subsequently given a variety of treatments. We are going to analyze the effects caused by the pandemic in this project using R Studio by installing certain packages.

OUTLINE:

This project is intended to calculate the various statistical parameters and plot the graph for the latest COVID-19 data. This includes getting the latest COVID-19 data from a RStudio package namely “covid19.analytics”. Then we will analyze this data and visualize the results graphically using R programming. Then we will summarize the report. We will also calculate the statistics parameters like regression. We can also visualize the number of cases region-wise in a world map. We will also generate a SIR model which is very informative to get a clear view about the pandemic.

WHY THIS PROJECT?

This project gives a detailed statistical analysis about the COVID-19 global pandemic. We can use the results and inferences of this project in order to predict the forth coming effects of the pandemic. We

can forecast death rates, growth rates and recovery rates and take the measures accordingly. The government's of various countries of the world can interpret these results appropriately and can take decisions about unlocking the existing lockdowns with certain safety measures. It will also be useful to various organizations because they can make their own arrangements for the working of the organization based on the results of the analysis.

NEED AND IMPORTANCE:

The statistical analysis of COVID-19 is essential to understand the impact and effects caused due to the outbreak of this global pandemic. This analysis is needed to assess the losses that has been incurred as a result of this disease. It also shows the past and present trends in the growth and recovery rates of the virus-causing disease, which helps in evaluating the future trends in the COVID cases by considering the various factors involved in the prediction of further cases of the disease. It is very important as we discussed earlier in the previous section. The analysis gives a detailed idea to various governments of the world on unlocking the various lockdowns imposed when the pandemic was at its peak. They can make some arrangements for the conduct of various industries and IT firms and other companies and institutions by imposing some rules and regulations like allowing only 50% of employees/students, maintaining social distance at all times, wearing proper and hygiene masks which has many protection layers, sanitizing at frequent intervals and avoiding unhygienic habits.

PROPOSED WORK:

The proposed work is to get the data, analyze the data and visualize the growth, recovery and death rates of the global pandemic, COVID-19. The analysis of data will be on a daily basis, monthly basis and also region-wise. We will be visualizing the total number of confirmed cases in each region in a world map. We will be plotting the graph for the growth rate, the total confirmed cases for each day in a month for every region. We will be also plotting a bar graph, pie-chart for comparing the total COVID-19 positive cases in various countries globally. We will also summarize the analysis of the data. Hence, by plotting the graph and visualizing the results we can get an inference about the analysis of data. We will generate a SIR model which groups the people into three groups namely Susceptible to disease, Infected to disease and Recovered from disease.

EXPERIMENTAL WORK:

First of all, we have to get the data for analyzing the COVID-19 pandemic.

For this, we have to go to the package section in RStudio and search for the package “covid19.analytics” and install the package which gives us the data about COVID-19 up-to-date.

Then, we should use the command “covid19.data” for getting the specified or the required data. From the environment, we can see the data which we require.

```

> #library
> library(covid19.analytics)
> #data
> ag <- covid19.data(case = 'aggregated')
Data being read from JHU/CCSE repository
~~~~~
Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_daily_reports/10-23-2020.csv
> View(ag)
> tsc <- covid19.data(case = 'ts-confirmed')
Data being read from JHU/CCSE repository
~~~~~
Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_confirmed_global.csv
Data retrieved on 2020-10-24 14:24:07 || Range of dates on data: 2020-01-22--2020-10-23 | Nbr of records: 267
> View(tsc)
> tsa <- covid19.data(case = 'ts-ALL')
Data being read from JHU/CCSE repository
~~~~~
Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_confirmed_global.csv
Data retrieved on 2020-10-24 14:26:02 || Range of dates on data: 2020-01-22--2020-10-23 | Nbr of records: 267
Data being read from JHU/CCSE repository
~~~~~
Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_deaths_global.csv
Data retrieved on 2020-10-24 14:26:03 || Range of dates on data: 2020-01-22--2020-10-23 | Nbr of records: 267
Data being read from JHU/CCSE repository
~~~~~
Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_recovered_global.csv
Data retrieved on 2020-10-24 14:26:03 || Range of dates on data: 2020-01-22--2020-10-23 | Nbr of records: 254
> View(tsc)
> View(tsa)

```

For getting the summary report, we can use the “`report.summary()`” command which summarizes the whole report of the data statistically.

We are summarizing the report of top ten countries affected by this pandemic. We will also represent this report in graphical way.

```

> #summary
> report.summary(Nentries = 10, graphical.output = T)
Data being read from JHU/CCSE repository
~~~~~
Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_confirmed_global.csv
Data retrieved on 2020-10-24 14:28:29 || Range of dates on data: 2020-01-22--2020-10-23 | Nbr of records: 267
>>> checking data integrity...
checking for ... Country Province Lat Long
No critical issues have been found.
>>> checking data consistency...
warning in consistency.check(data, n0, nf, datasetName, details = details, :
  Inconsistency of type.II in ts-confirmed data detected -- 51 records (out of 267) show inconsistencies in the data...
#####
##### TS-CONFIRMED Cases -- Data dated: 2020-10-23 :: 2020-10-24 14:28:29 #####
#####
Number of Countries/Regions reported: 189
Number of Cities/Provinces reported: 82
Unique number of distinct geographical locations combined: 267
Worldwide ts-confirmed Totals: 42148875
Country.Region.Province.State Totals GlobalPerc LastDayChange t-2 t-3 t-7 t-14 t-30
1 US 8491459 20.15 83757 71671 62735 57519 54639 44132
2 India 7761312 18.41 0 54366 55830 61871 74383 86052
3 Brazil 5353656 12.70 30026 24858 24814 24062 26749 66338
4 Russia 1471000 3.49 17077 15704 15444 14703 12673 6489
5 Argentina 1069368 2.54 15718 16325 18326 13510 12414 13467
6 France 1048842 2.49 41816 41575 26304 - - 0 27801
7 Spain 1046132 2.48 19851 20986 16973 0 0 10653
8 Colombia 998942 2.37 8569 8673 7561 7017 8447 6555
9 Mexico 880775 2.09 6604 6612 6845 5447 4308 5408
10 Peru 879876 2.09 0 5758 3242 2677 7474 6149
Global Perc. Average: 0.37 (sd: 1.88)
Global Perc. Average in top 10 : 6.88 (sd: 7.29)
~~~~~
Data being read from JHU/CCSE repository
~~~~~
Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_deaths_global.csv
Data retrieved on 2020-10-24 14:28:30 || Range of dates on data: 2020-01-22--2020-10-23 | Nbr of records: 267
>>> checking data integrity...
checking for ... Country Province Lat Long
No critical issues have been found.
>>> checking data consistency...
warning in consistency.check(data, n0, nf, datasetName, details = details, :
  Inconsistency of type.II in ts-deaths data detected -- 43 records (out of 267) show inconsistencies in the data...
#####
##### TS-DEATHS Cases -- Data dated: 2020-10-23 :: 2020-10-24 14:28:31 #####
#####
Number of Countries/Regions reported: 189
Number of Cities/Provinces reported: 82
Unique number of distinct geographical locations combined: 267
Worldwide ts-deaths Totals: 1143495

```

```

worldwide ts-deaths Totals: 1143495
-----
Country,Region Province.State Totals Perc LastDayChange t-2 t-3 t-7 t-14 t-30
1 US 223975 2.64 943 856 1124 711 618 913
2 Brazil 156212 2.92 574 497 586 461 559 1703
3 India 77306 1.51 0 690 552 1033 903 1141
4 Mexico 86312 10.03 897 0 522 355 145 490
5 United Kingdom 44571 5.36 224 189 191 150 81 40
6 Italy 37059 7.64 91 136 127 47 29 23
7 Spain 34752 3.32 231 155 156 0 84
8 France 34236 3.26 297 162 141 0 0 81
9 Peru 33984 3.86 0 109 55 71 125 302
10 Iran 31985 5.74 335 304 312 253 195 175
-----
```

```

Data being read from JHU/CSSE repository
-----
```

Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_recovered_global.csv
Data retrieved on 2020-10-24 14:28:32 || Range of dates on data: 2020-01-22--2020-10-23 | Nbr of records: 254

```

>>> checking data integrity...
>>> checking for ... Country Province Lat Long
No critical issues have been found.
>>> checking data consistency...
warning in consistency.check(data, n0, nf, datasetName, details = details, :
    Inconsistency of type.Int in ts-recovered data detected -- 78 records (out of 254) show inconsistencies in the data...
#####
##### TS-RECOVERED Cases -- Data dated: 2020-10-23 :: 2020-10-24 14:28:33
#####
Number of Countries/Regions reported: 189
Number of Cities/Provinces reported: 68
Unique number of distinct geographical locations combined: 254
-----
```

```

worldwide ts-recovered Totals: 28484306
-----
Country,Region Province.State Totals LastDayChange t-2 t-3 t-7 t-14 t-30
1 India 6948497 0 73979 79415 72614 89154 81177
2 Brazil 4526393 0 0 0 0 0 56127
3 US 3375427 22371 29702 28206 23034 23894 39927
4 Russia 1113736 11172 11303 10803 8499 6712 6061
5 Colombia 901652 7842 8915 8164 10466 2584 0
6 Argentina 866695 14841 11334 10873 12673 12323 11103
7 Peru 71919 0 8225 7139 5239 4784 0
8 Mexico 740934 3497 3160 3303 3599 2244 4185
9 South Africa 643523 963 854 2138 176 672 1687
10 Chile 471166 1401 2496 626 1615 1757 1711
-----
```

```

Data being read from JHU/CSSE repository
-----
```

Reading data from https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_daily_reports/10-23-2020.csv
>>> checking data integrity...
>>> checking for ... Country Province Lat Long
No critical issues have been found.

```

No critical issues have been found.
Possible <>Aggregated data-type> detected...
>>> checking for ... Active Deaths Recovered Confirmed
No critical issues have been found.
*** 7 entries were removed due to data inconsistencies
>>> checking data consistency...
This function applies to Timeseries data only
#####
##### AGGREGATED Data -- ORDERED BY CONFIRMED Cases -- Data dated: 2020-10-24 :: 2020-10-24 14:28:34
#####
Number of Countries/Regions reported: 189
Number of Cities/Provinces reported: 561
Unique number of distinct geographical locations combined: 3951
-----
```

	Location	Confirmed	Perc.	Confirmed	Deaths	Perc.	Deaths	Recovered	Perc.	Recovered	Perc.	Active
1	Maharashtra, India	1625197	3.86	42831	2.64	1431856	88.10	150510	9.26	83.81	136834	12.63
2	Sao Paulo, Brazil	1083641	2.57	38608	3.56	908199	81.05	174335	16.30	8.54	925006	88.19
3	Argentina	1069368	2.54	28338	2.65	866695	86.85	92946	11.79	90.33	49998	7.02
4	France	1048842	2.49	34236	3.26	89600	86.85	92946	11.79	643523	643523	0.00
5	Andhra Pradesh, India	796919	1.89	6524	0.82	758138	95.13	32257	4.05	1.32	1.32	0.00
6	Karnataka, India	788551	1.87	10770	1.37	684835	80.21	78221	14.05	90.33	49998	7.02
7	South Africa	712412	1.69	18891	2.65	643523	93.57	34198	4.88	8.54	925006	88.19
8	England, United Kingdom	704443	1.67	39488	5.61	0	0.00	664955	94.39	8.54	925006	88.19
9	Tamil Nadu, India	700193	1.66	10825	1.55	655170	90.33	49998	7.02	90.33	49998	7.02
10	Iran	556891	1.32	31985	5.74	446685	80.21	78221	14.05	8.54	925006	88.19

```

#####
##### AGGREGATED Data -- ORDERED BY DEATHS Cases -- Data dated: 2020-10-24 :: 2020-10-24 14:28:34
#####
Number of Countries/Regions reported: 189
Number of Cities/Provinces reported: 561
Unique number of distinct geographical locations combined: 3951
-----
```

	Location	Confirmed	Perc.	Confirmed	Deaths	Perc.	Deaths	Recovered	Perc.	Recovered	Perc.	Active
1	Maharashtra, India	1625197	3.86	42831	2.64	1431856	88.10	150510	9.26	83.81	136834	12.63
2	England, United Kingdom	704443	1.67	39488	5.61	0	0.00	664955	94.39	8.54	925006	88.19
3	Sao Paulo, Brazil	1083641	2.57	38608	3.56	908199	83.81	136834	12.63	8.54	925006	88.19
4	France	1048842	2.49	34236	3.26	89600	80.21	78221	14.05	90.33	49998	7.02
5	Iran	556891	1.32	31985	5.74	446685	80.21	78221	14.05	8.54	925006	88.19
6	Argentina	1069368	2.54	28338	2.65	866695	81.05	174335	16.30	90.33	49998	7.02
7	Rio de Janeiro, Brazil	296797	0.70	20115	6.78	258928	87.24	17754	5.98	90.33	49998	7.02
8	South Africa	712412	1.69	18891	2.65	643523	61.64	37950	26.42	90.33	49998	7.02
9	Lombardia, Italy	143645	0.34	17159	11.95	88536	0.00	383592	96.17	8.54	925006	88.19
10	Lima, Peru	398886	0.95	15294	3.83	0	0.00	383592	96.17	8.54	925006	88.19

```

#####
##### AGGREGATED Data -- ORDERED BY RECOVERED Cases -- Data dated: 2020-10-24 :: 2020-10-24 14:28:34
#####
Number of Countries/Regions reported: 189
Number of Cities/Provinces reported: 561
Unique number of distinct geographical locations combined: 3951
-----
```

	Location	Confirmed	Perc.	Confirmed	Deaths	Perc.	Deaths	Recovered	Perc.	Recovered	Perc.	Active
1	Maharashtra, India	1625197	3.86	42831	2.64	1431856	88.10	150510	9.26	83.81	136834	12.63
2	Sao Paulo, Brazil	1083641	2.57	38608	3.56	908199	83.81	136834	12.63	8.54	925006	88.19
3	Argentina	1069368	2.54	28338	2.65	866695	81.05	174335	16.30	90.33	49998	7.02
4	Andhra Pradesh, India	796919	1.89	6524	0.82	758138	95.13	32257	4.05	8.54	925006	88.19

```

4 Andhra Pradesh, India 796919 1.89 6524 0.82 758138 95.13 32257 4.05
5 Karnataka, India 788551 1.87 10770 1.37 684835 86.85 92946 11.79
6 Tamil Nadu, India 700193 1.66 10825 1.55 655170 93.57 34198 4.88
7 South Africa 712412 1.69 18891 2.65 643523 90.33 49998 7.02
8 Iran 556891 1.32 31985 5.74 446685 80.21 78221 14.05
9 Uttar Pradesh, India 463858 1.10 6790 1.46 427937 92.26 29131 6.28
10 Iraq 445949 1.06 10513 2.36 375188 84.13 60248 13.51
#####
##### AGGREGATED Data -- ORDERED BY ACTIVE Cases -- Data dated: 2020-10-24 :: 2020-10-24 14:28:34
#####
Number of Countries/Regions reported: 189
Number of Cities/Provinces reported: 561
Unique number of distinct geographical locations combined: 3951
-----
Location Confirmed Perc.Confirmed Deaths Perc.Deaths Recovered Perc.Recovered Active Perc.Active
1 France 1048842 2.49 34236 3.26 89600 8.54 925006 88.19
2 England, United Kingdom 704443 1.67 39488 5.61 0 0.00 664955 94.39
3 Lima, Peru 398886 0.95 15294 3.83 0 0.00 383592 96.17
4 Los Angeles, California, US 296821 0.70 6974 2.35 0 0.00 289847 97.65
5 Belgium 287700 0.68 10658 3.70 22517 7.83 254525 88.47
6 Madrid, Spain 292754 0.69 10211 3.49 40736 13.91 241807 82.60
7 Miami-Dade, Florida, US 181017 0.43 3597 1.99 0 0.00 177420 98.01
8 Argentina 1069368 2.54 28338 2.65 866695 81.05 174335 16.30
9 Cook, Illinois, US 171437 0.41 5392 3.15 0 0.00 166045 96.85
10 catalonia, Spain 192035 0.46 5960 3.10 26203 13.64 159872 83.25
-----
Confirmed Deaths Recovered Active
Totals 42148391 1143214 24311707 NA
Average 10667.78 289.35 6153.3 NA
Standard Deviation 58295.48 1770.37 46169.59 NA
-----
* Statistical estimators computed considering 3951 independent reported entries
>>> checking data integrity...
checking for ... Country Province Lat Long
No critical issues have been found.
Possible <<Aggregated data-type>> detected...
checking for ... Active Deaths Recovered Confirmed
No critical issues have been found.

*****
***** OVERALL SUMMARY*****
*****
**** Time Series worldwide TOTS *****
ts-confirmed ts-deaths ts-recovered
42148875 1143495 28484306
2.71% 67.58%
**** Time Series worldwide AVGS *****
ts-confirmed ts-deaths ts-recovered
157860.96 4282.75 112142.94
2.71% 71.04%
**** Time Series worldwide SDS *****
ts-confirmed ts-deaths ts-recovered
791191.2 19723.62 573309.4
2.49% 72.46%

```

```

*****
***** OVERALL SUMMARY*****
*****
**** Time Series Worldwide TOTS *****
ts-confirmed ts-deaths ts-recovered
42148875 1143495 28484306
2.71% 67.58%
**** Time Series worldwide AVGS *****
ts-confirmed ts-deaths ts-recovered
157860.96 4282.75 112142.94
2.71% 71.04%
**** Time Series Worldwide SDS *****
ts-confirmed ts-deaths ts-recovered
791191.2 19723.62 573309.4
2.49% 72.46%
-----
* Statistical estimators computed considering 267/267/254 independent reported entries per case-type
*****
```

For getting the total number of cases per location, we are going to use the command “`tots.per.location()`”. In this case the location is United States(US). In the running models we have linear regression model.

We will get two plots in this case.

```
> #Totals per location
> tots.per.location(tsc,geo.loc = 'us')
[1] "US"
US -- 8491459
===== running models...
Linear Regression (lm):
Call:
lm(formula = y.var ~ x.var)

Residuals:
    Min      1Q  Median      3Q     Max 
-1021943 -557777 -64562   521146 1660306 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) -1693144     84368  -20.07 <2e-16 ***
x.var        32839       528    62.19 <2e-16 ***  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 698900 on 274 degrees of freedom
Multiple R-squared:  0.9338, Adjusted R-squared:  0.9336 
F-statistic: 3868 on 1 and 274 DF, p-value: < 2.2e-16

-----
Linear Regression (lm):
Call:
lm(formula = y.var ~ x.var)

Residuals:
    Min      1Q  Median      3Q     Max 
-5.0061 -2.1365  0.2946  2.3322  3.6269 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 5.601574   0.314169  17.83 <2e-16 ***
x.var       0.048859   0.001966  24.85 <2e-16 ***  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.603 on 274 degrees of freedom
Multiple R-squared:  0.6926, Adjusted R-squared:  0.6915 
F-statistic: 617.5 on 1 and 274 DF, p-value: < 2.2e-16

-----
GLM using Family [1] "poisson" :
Call:
glm(formula = y.var ~ x.var, family = family)

Deviance Residuals:
    Min      1Q  Median      3Q     Max 
-968.20 -704.58   87.79  277.67  574.28
```

```

Deviance Residuals:
    Min      1Q  Median      3Q     Max 
-968.20 -704.58   87.79  277.67  574.28 

Coefficients:
            Estimate Std. Error z value Pr(>|z|)    
(Intercept) 1.233e+01  1.341e-04  91962 <2e-16 ***
x.var       1.415e-02  6.113e-07  23155 <2e-16 ***  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for poisson family taken to be 1)

Null deviance: 808111116  on 275  degrees of freedom
Residual deviance: 78183475  on 274  degrees of freedom
AIC: 78187396

Number of Fisher Scoring iterations: 5

-----
GLM using Family Family: Gamma Link function: log : 

Call:
glm(formula = y.var ~ x.var, family = family)

Deviance Residuals:
    Min      1Q  Median      3Q     Max 
-4.3310 -1.1217 -0.1776  0.5178  1.1686 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 1.033e+01  1.046e-01  98.74 <2e-16 ***
x.var       2.589e-02  6.546e-04  39.55 <2e-16 ***  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for Gamma family taken to be 0.7506805)

Null deviance: 1388.54  on 275  degrees of freedom
Residual deviance: 862.95  on 274  degrees of freedom
AIC: 8044.3

Number of Fisher Scoring iterations: 25

```

For getting the growth rate of the pandemic, we are going to use the command “growth.rate()” and specify the location. The location we are going to use is US.

```

> #Growth rate
> growth.rate(tsc,geo.loc = 'us')
[1] "us"
Processing... us
Loading required package: pheatmap
Loading required package: gplots

Attaching package: 'gplots'

The following object is masked from 'package:stats':

  lowess

$changes
geo.loc 2020-01-23 2020-01-24 2020-01-25 2020-01-26 2020-01-27 2020-01-28 2020-01-29 2020-01-30 2020-01-31 2020-02-01 2020-02-02 2020-02-03 2020-02-04
1   US      0       1       0       3       0       0       0       1       0       2       0       0       0       3       0
1 2020-02-05 2020-02-06 2020-02-07 2020-02-08 2020-02-09 2020-02-10 2020-02-11 2020-02-12 2020-02-13 2020-02-14 2020-02-15 2020-02-16 2020-02-17 2020-02-18
1   0       1       0       2       0       0       0       1       0       1       0       0       0       3       0
1 2020-02-19 2020-02-20 2020-02-21 2020-02-22 2020-02-23 2020-02-24 2020-02-25 2020-02-26 2020-02-27 2020-02-28 2020-02-29 2020-03-01 2020-03-02 2020-03-03
1   0       0       2       1       0       0       0       0       0       1       0       0       1       2       0
1 2020-03-04 2020-03-05 2020-03-06 2020-03-07 2020-03-08 2020-03-09 2020-03-10 2020-03-11 2020-03-12 2020-03-13 2020-03-14 2020-03-15 2020-03-16 2020-03-17
1   33      77      53      166     116      75      188      365      439      633      759      234      1467      1832
1 2020-03-18 2020-03-19 2020-03-20 2020-03-21 2020-03-22 2020-03-23 2020-03-24 2020-03-25 2020-03-26 2020-03-27 2020-03-28 2020-03-29 2020-03-30 2020-03-31
1   2654     4494    6367     5996    8802    11219    10577    12034    17894    18631    19607    18929    22013    26363
1 2020-04-01 2020-04-02 2020-04-03 2020-04-04 2020-04-05 2020-04-06 2020-04-07 2020-04-08 2020-04-09 2020-04-10 2020-04-11 2020-04-12 2020-04-13 2020-04-14
1   25819    30392   32000   33001   28184   31399   30185   32016   34648   33536   29357   26959   25791   28591
1 2020-04-15 2020-04-16 2020-04-17 2020-04-18 2020-04-19 2020-04-20 2020-04-21 2020-04-22 2020-04-23 2020-04-24 2020-04-25 2020-04-26 2020-04-27 2020-04-28
1   30008    31522   32806   27851   25681   28422   26038   29297   33431   33566   31801   27099   23174   24674
1 2020-04-29 2020-04-30 2020-05-01 2020-05-02 2020-05-03 2020-05-04 2020-05-05 2020-05-06 2020-05-07 2020-05-08 2020-05-09 2020-05-10 2020-05-11 2020-05-12
1   27845    29505   34220   28002   24502   23402   24563   25147   27790   26882   24968   18856   19447   22758
1 2020-05-13 2020-05-14 2020-05-15 2020-05-16 2020-05-17 2020-05-18 2020-05-19 2020-05-20 2020-05-21 2020-05-22 2020-05-23 2020-05-24 2020-05-25 2020-05-26
1   20966    27308   25298   24013   18114   22012   21044   23505   25665   23438   21917   20114   18317   19524
1 2020-05-27 2020-05-28 2020-05-29 2020-05-30 2020-05-31 2020-06-01 2020-06-02 2020-06-03 2020-06-04 2020-06-05 2020-06-06 2020-06-07 2020-06-08 2020-06-09
1   18590    22948   24351   23843   19172   17364   21373   19977   21719   25167   21836   17787   17528   18369
1 2020-06-10 2020-06-11 2020-06-12 2020-06-13 2020-06-14 2020-06-15 2020-06-16 2020-06-17 2020-06-18 2020-06-19 2020-06-20 2020-06-21 2020-06-22 2020-06-23
1   20824    23197   24865   25260   19372   19924   23795   25904   28185   31310   32254   26106   30482   35765
1 2020-06-24 2020-06-25 2020-06-26 2020-06-27 2020-06-28 2020-06-29 2020-06-30 2020-07-01 2020-07-02 2020-07-03 2020-07-04 2020-07-05 2020-07-06 2020-07-07
1   34465    40536   45314   42349   39351   40685   46163   51320   55110   52548   45740   49777   44650   60156
1 2020-07-08 2020-07-09 2020-07-10 2020-07-11 2020-07-12 2020-07-13 2020-07-14 2020-07-15 2020-07-16 2020-07-17 2020-07-18 2020-07-19 2020-07-20 2020-07-21
1   59173    63271   67719   60151   58879   59470   66957   67623   77362   72010   62748   61255   61942   64431
1 2020-07-22 2020-07-23 2020-07-24 2020-07-25 2020-07-26 2020-07-27 2020-07-28 2020-07-29 2020-07-30 2020-07-31 2020-08-01 2020-08-02 2020-08-03 2020-08-04
1   71305    69073   73107   66454   54802   56580   65793   71302   67779   67153   57903   47329   44830   57460
1 2020-08-05 2020-08-06 2020-08-07 2020-08-08 2020-08-09 2020-08-10 2020-08-11 2020-08-12 2020-08-13 2020-08-14 2020-08-15 2020-08-16 2020-08-17 2020-08-18
1   53652    59640   58332   55690   46123   49760   46903   57004   51977   64601   47425   41413   35939   45354
1 2020-08-19 2020-08-20 2020-08-21 2020-08-22 2020-08-23 2020-08-24 2020-08-25 2020-08-26 2020-08-27 2020-08-28 2020-08-29 2020-08-30 2020-08-31 2020-09-01
1   47330    44081   48219   44410   34249   37854   38229   45091   45871   46196   46020   35354   34512   42529
1 2020-09-02 2020-09-03 2020-09-04 2020-09-05 2020-09-06 2020-09-07 2020-09-08 2020-09-09 2020-09-10 2020-09-11 2020-09-12 2020-09-13 2020-09-14 2020-09-15
1   40603    43918   50107   44051   31131   24056   26736   33552   36360   47522   41123   34624   33946   39191
1 2020-09-16 2020-09-17 2020-09-18 2020-09-19 2020-09-20 2020-09-21 2020-09-22 2020-09-23 2020-09-24 2020-09-25 2020-09-26 2020-09-27 2020-09-28 2020-09-29
1   38551    44730   48716   44050   36214   52464   38965   38433   44132   50585   44872   36422   33312   42100
1 2020-09-30 2020-10-01 2020-10-02 2020-10-03 2020-10-04 2020-10-05 2020-10-06 2020-10-07 2020-10-08 2020-10-09 2020-10-10 2020-10-11 2020-10-12 2020-10-13
1   41405    44749   54506   50044   35504   39557   41939   50341   56191   57420   54639   44614   41653   52406
1 2020-10-14 2020-10-15 2020-10-16 2020-10-17 2020-10-18 2020-10-19 2020-10-20 2020-10-21 2020-10-22 2020-10-23
1   59494    63610   69156   57519   48210   58387   60315   62735   71671   83757

```

```

$Growth.Rate
geo.loc 2020-01-24 2020-01-25 2020-01-26 2020-01-27 2020-01-28 2020-01-29 2020-01-30 2020-01-31 2020-02-01 2020-02-02 2020-02-03 2020-02-04 2020-02-05
1   US      NA      0      NA
1 2020-02-06 2020-02-07 2020-02-08 2020-02-09 2020-02-10 2020-02-11 2020-02-12 2020-02-13 2020-02-14 2020-02-15 2020-02-16 2020-02-17 2020-02-18 2020-02-19
1   NA      0      NAN     NAN     NAN     NAN     0      NA      0      NAN     NAN     NAN     NAN     NAN     NAN
1 2020-02-20 2020-02-21 2020-02-22 2020-02-23 2020-02-24 2020-02-25 2020-02-26 2020-02-27 2020-02-28 2020-02-29 2020-03-01 2020-03-02 2020-03-03 2020-03-04
1   Nan     NA      0      NAN     NAN     NAN     Nan     Nan     Nan     NA      0      0.875   3.285714   0.826087   1.736842
1   2.333333  0.6883117  3.132075  0.6987952  0.6465517  2.506667  1.941489  1.20274  1.441913  1.199052  0.3083004  6.269231  1.248807  1.44869
1 2020-03-19 2020-03-20 2020-03-21 2020-03-22 2020-03-23 2020-03-24 2020-03-25 2020-03-26 2020-03-27 2020-03-28 2020-03-29 2020-03-30 2020-03-31 2020-04-01
1   1.693293  1.416778  0.9417308  1.467979  1.274597  0.9427756  1.137752  1.486954  1.04187  1.052386  0.9654205  1.162925  1.197611  0.979365
1 2020-04-02 2020-04-03 2020-04-04 2020-04-05 2020-04-06 2020-04-07 2020-04-08 2020-04-09 2020-04-10 2020-04-11 2020-04-12 2020-04-13 2020-04-14 2020-04-15
1   1.177118  1.052909  1.031281  0.8540347  1.070998  1.040219  1.01965  1.082209  0.9679058  0.8753876  0.9183159  0.956675  1.108565  1.049561
1 2020-04-16 2020-04-17 2020-04-18 2020-04-19 2020-04-20 2020-04-21 2020-04-22 2020-04-23 2020-04-24 2020-04-25 2020-04-26 2020-04-27 2020-04-28 2020-04-29
1   1.050453  1.040733  0.8489606  0.9220854  1.106733  0.9161213  1.125163  1.141107  1.004038  0.947417  0.852143  0.8551607  1.064728  1.128516
1 2020-04-20 2020-05-01 2020-05-02 2020-05-03 2020-05-04 2020-05-05 2020-05-06 2020-05-07 2020-05-08 2020-05-09 2020-05-10 2020-05-11 2020-05-12 2020-05-13
1   1.059616  1.159803  0.8182934  0.8750089  0.9551057  1.049611  1.023776  1.105102  0.9673264  0.9287999  0.7552067  1.031343  1.170258  0.9212585
1 2020-05-14 2020-05-15 2020-05-16 2020-05-17 2020-05-18 2020-05-19 2020-05-20 2020-05-21 2020-05-22 2020-05-23 2020-05-24 2020-05-25 2020-05-26 2020-05-27
1   1.30249  0.9263952  0.9492055  0.7543414  1.215193  0.956024  1.116945  1.091895  0.9132281  0.904386  0.9489079  0.9106592  1.065895  0.9521614
1 2020-05-28 2020-05-29 2020-05-30 2020-05-31 2020-06-01 2020-06-02 2020-06-03 2020-06-04 2020-06-05 2020-06-06 2020-06-07 2020-06-08 2020-06-09 2020-06-10
1   1.234427  1.061138  0.9791384  0.8040934  0.9056958  1.23088  0.9246839  1.0872  1.158755  0.8676441  0.8145723  0.9854388  1.04798  1.133649
1 2020-06-11 2020-06-12 2020-06-13 2020-06-14 2020-06-15 2020-06-16 2020-06-17 2020-06-18 2020-06-19 2020-06-20 2020-06-21 2020-06-22 2020-06-23 2020-06-24
1   1.113955  1.071906  1.015886  0.7669042  1.028495  1.194288  1.088632  1.08056  1.110875  1.03105  0.809388  1.167624  1.173315  0.9636516
1 2020-06-25 2020-06-26 2020-06-27 2020-06-28 2020-06-29 2020-06-30 2020-07-01 2020-07-02 2020-07-03 2020-07-04 2020-07-05 2020-07-06 2020-07-07 2020-07-08
1   1.17615  1.17871  0.9345677  0.9292073  1.0339  1.134644  1.111713  1.07385  0.9535112  0.8704423  1.092632  0.893411  1.347279  0.9836592
1 2020-07-09 2020-07-10 2020-07-11 2020-07-12 2020-07-13 2020-07-14 2020-07-15 2020-07-16 2020-07-17 2020-07-18 2020-07-19 2020-07-20 2020-07-21 2020-07-22
1   1.069255  1.070301  0.8882441  0.9788532  1.010038  1.125895  1.009947  1.144019  0.9308187  0.871379  0.9762064  1.011215  1.040183  1.106688
1 2020-07-23 2020-07-24 2020-07-25 2020-07-26 2020-07-27 2020-07-28 2020-07-29 2020-07-30 2020-07-31 2020-08-01 2020-08-02 2020-08-03 2020-08-04 2020-08-05
1   0.9686978  1.058402  0.908964  0.8246607  1.032444  1.162831  1.083732  0.9505904  0.9907641  0.8632549  0.8173842  0.9471994  1.281731  0.937278
1 2020-08-06 2020-08-07 2020-08-08 2020-08-09 2020-08-10 2020-08-11 2020-08-12 2020-08-13 2020-08-14 2020-08-15 2020-08-16 2020-08-17 2020-08-18 2020-08-19
1   1.11608  0.9780684  0.9347075  0.8282097  1.078854  0.9423844  1.215359  0.9118132  1.242877  0.7341218  0.8732314  0.8678193  1.261972  1.043568
1 2020-08-20 2020-08-21 2020-08-22 2020-08-23 2020-08-24 2020-08-25 2020-08-26 2020-08-27 2020-08-28 2020-08-29 2020-08-30 2020-08-31 2020-09-01 2020-09-02
1   0.9313543  1.093873  0.9210062  0.7752533  1.09948  1.00908  1.179497  1.017298  1.007085  0.9961901  0.7682312  0.9761837  1.232996  0.9547133
1 2020-09-03 2020-09-04 2020-09-05 2020-09-06 2020-09-07 2020-09-08 2020-09-09 2020-09-10 2020-09-11 2020-09-12 2020-09-13 2020-09-14 2020-09-15 2020-09-16
1   1.081644  1.140922  0.8791386  0.7067036  0.7727346  1.14407  1.254937  1.081691  1.306986  0.8653466  0.8419619  0.9804182  1.15451  0.9836697
1 2020-09-17 2020-09-18 2020-09-19 2020-09-20 2020-09-21 2020-09-22 2020-09-23 2020-09-24 2020-09-25 2020-09-26 2020-09-27 2020-09-28 2020-09-29 2020-09-30
1   1.160283  1.089112  0.9042204  0.8221132  1.448721  0.7426998  0.9863467  1.148284  1.14622  0.8870614  0.8181686  0.914612  1.263809  0.9834917
1 2020-10-01 2020-10-02 2020-10-03 2020-10-04 2020-10-05 2020-10-06 2020-10-07 2020-10-08 2020-10-09 2020-10-10 2020-10-11 2020-10-12 2020-10-13 2020-10-14
1   1.080763  1.218038  0.9181305  0.7094537  1.114156  1.060217  1.200339  1.16207  1.021872  0.9515674  0.816523  0.9336307  1.258157  1.135252
1 2020-10-15 2020-10-16 2020-10-17 2020-10-18 2020-10-19 2020-10-20 2020-10-21 2020-10-22 2020-10-23 2020-10-24 2020-10-25 2020-10-26 2020-10-27 2020-10-28 2020-10-29
1   1.069183  1.087188  0.8317283  0.8381578  1.211097  1.033021  1.040123  1.14244  1.168632 NA

```

For getting an interactive plot of overall COVID cases across the globe
we are going to use the command “totals.plot()”

```
> #Totals plot
> totals.plt(tsa)
Loading required package: plotly
Loading required package: ggplot2

Attaching package: 'plotly'

The following object is masked from 'package:ggplot2':
  last_plot

The following object is masked from 'package:stats':
  filter

The following object is masked from 'package:graphics':
  layout
```

```
> totals.plt(tsa,c('India'))
[1] "INDIA"
A line object has been specified, but lines is not in the mode
Adding lines to the mode...
> |
```

For visualizing the total number of cases, in each and every region of the world we can use the command “live.map()” which generates a world map which displays the number of COVID cases in each country.

```
Adding lines to the mode...
> #World Map
> live.map(tsc)
```

For generating a SIR model we are going to use the command “generating.SIR.model” which splits up the common people into three categories namely Susceptible to disease, Infected to disease and Recovered from disease and compares the three categories of people which is very useful for predicting the impact of the pandemic in the future.

```
> #SIR Model
> generate.SIR.model(tsc,'India',tot.population = 1380004385)
#####
This is an experimental feature, being currently under active development!
Please check the development version of the package for the latest updates on it
#####
[1] "INDIA"
Processing... INDIA
[1] 0 0 0 0 0 0 0 0 1 1 1 1 2 3 3 3 3 3 3
[20] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
[39] 3 3 5 5 28 30 31 34 39 43 56 62 73 82 102 113 119 142 156
[58] 194 244 330 396 499 536 657 727 887 987 1024 1251 1397 1998 2543 2567 3082 3588 4778
[77] 5311 5916 6725 7598 8446 9205 10453 11487 12322 13430 14352 15722 17615 18539 20080 21370 23077 24530 26283
[96] 27890 29451 31324 33062 34863 37257 39699 42505 46437 49400 52987 56351 59695 62808 67161 70768 74292 78055 81997
[115] 85784 90648 95698 100328 106475 112028 118226 124794 131423 138536 144950 150793 158086 165386 173491 181827 190609 198370 207191
[134] 216824 26713 236184 246622 257486 265928 276146 286605 297535 308993 320922 332424 343091 354065 366946 380532 395048 410451 425282
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[172] 849522 878254 906752 936181 968857 1003832 1039084 1077781 1118206 1155338 1193078 1238798 1288108 1337024 1385635 1435616 1480073 1531669 1581963
[191] 1634746 1695988 1750723 1803695 1855745 1908254 1964536 2027074 2088611 2153010 2215074 2268675 2329638 2396637 2461190 2525922 2589952 2647663 2702681
[210] 2767253 2836925 2905825 2975701 3044940 3106348 3167323 3224547 3310234 3387500 3463972 3542733 3621245 3691166 3769523 3853406 3936747 4023179 4113811
[229] 4204613 4280422 4370128 4465863 4562414 4659984 4754356 4846427 4930236 5020359 5118253 5214677 5308014 5400619 5487580 5562663 5646010 5732518 5818570
[248] 5903932 592332 6074702 6145291 6225763 6312584 6394068 6473544 6549373 6623815 6685082 6757131 6835655 6906151 6979423 7053806 7120538 7175880 7239389
[267] 7307097 7370468 7432680 7494551 7550273 7597063 7651107 7706946 7761312 7761312
[1] 42
[1] 5 28 30 31 34 39 43 56 62 73 82 102 113 119 142 156 194 244 330 396 499 536 657 727 887 987
----- Parameters used to create model -----
Region: INDIA
Time interval to consider: t0=42 - t1= ; tfinal=90
t0: 2020-03-04 -- t1:
Number of days considered for initial guess: 26
Fatality rate: 0.02
Population of the region: 1380004385
-----
Loading required package: desolve
[1] "CONVERGENCE: REL_REDUCTION_OF_F <= FACTR*EPSMCH"
  beta   gamma
0.6081878 0.3918122
R0 = 1.55224341892099
Max nbr of infected: 100045491.6 ( 7.25 %)
Max nbr of casualties, assuming 2% fatality rate: 2000909.83
Max reached at day : 86 ==> 2020-05-29
-----
Infected
[1] 5 28 30 31 34 39 43 56 62 73 82 102 113 119 142 156 194 244 330 396 499 536 657 727 887 987
```

	\$model	time	S	I	R
1	1	1380004380	5.000000e+00	0.000000e+00	
2	2	1380004377	6.207844e+00	2.187158e+00	
3	3	1380004372	7.707465e+00	4.902667e+00	
4	4	1380004367	9.569348e+00	8.274155e+00	
5	5	1380004361	1.188100e+01	1.246009e+01	
6	6	1380004353	1.475108e+01	1.765722e+01	
7	7	1380004343	1.831449e+01	2.410983e+01	
8	8	1380004330	2.273870e+01	3.212116e+01	
9	9	1380004315	2.823166e+01	4.206779e+01	
10	10	1380004296	3.505155e+01	5.441722e+01	
11	11	1380004272	4.351891e+01	6.974989e+01	
12	12	1380004242	5.403172e+01	8.878645e+01	
13	13	1380004205	6.708410e+01	1.124216e+02	
14	14	1380004160	8.328953e+01	1.417664e+02	
15	15	1380004103	1.034097e+02	1.781999e+02	
16	16	1380004033	1.283902e+02	2.234346e+02	
17	17	1380003946	1.594053e+02	2.795965e+02	
18	18	1380003838	1.979126e+02	3.493255e+02	
19	19	1380003703	2.457221e+02	4.358988e+02	
20	20	1380003537	3.050808e+02	5.433854e+02	
21	21	1380003329	3.787786e+02	6.768375e+02	
22	22	1380003072	4.702795e+02	8.425273e+02	
23	23	1380002753	5.838841e+02	1.048243e+03	
24	24	1380002356	7.249318e+02	1.303652e+03	
25	25	1380001864	9.000518e+02	1.620760e+03	
26	26	1380001253	1.117475e+03	2.014471e+03	
27	27	1380000494	1.387420e+03	2.503290e+03	
28	28	1379999552	1.722574e+03	3.110191e+03	
29	29	1379998383	2.138690e+03	3.863700e+03	
30	30	1379996930	2.655323e+03	4.799229e+03	
31	31	1379995127	3.296754e+03	5.960750e+03	
32	32	1379992889	4.093129e+03	7.402852e+03	
33	33	1379990110	5.081872e+03	9.193312e+03	
34	34	1379986659	6.309450e+03	1.141628e+04	
35	35	1379982375	7.833549e+03	1.417622e+04	
36	36	1379977056	9.725786e+03	1.760285e+04	
37	37	1379970453	1.207507e+04	2.185719e+04	
38	38	1379962254	1.499178e+04	2.713916e+04	
39	39	1379952075	1.861294e+04	3.369698e+04	
40	40	1379939438	2.310866e+04	4.183877e+04	
41	41	1379923748	2.869007e+04	5.194707e+04	
42	42	1379904269	3.561929e+04	6.449678e+04	
43	43	1379880086	4.422163e+04	8.007741e+04	
44	44	1379850063	5.490084e+04	9.942077e+04	
45	45	1379812792	6.815800e+04	1.234352e+05	
46	46	1379766522	8.461487e+04	1.532483e+05	
47	47	1379709083	1.050429e+05	1.902594e+05	
48	48	1379637781	1.303991e+05	2.362052e+05	
49	49	1379549274	1.618702e+05	2.932407e+05	
50	50	1379439417	2.009280e+05	3.640400e+05	
51	51	1379303068	2.493966e+05	4.519201e+05	
52	52	1379133853	3.095363e+05	5.609954e+05	
53	53	1378923871	3.841461e+05	6.963674e+05	
54	54	1378663334	4.766904e+05	8.643605e+05	
55	55	1378340120	5.914536e+05	1.072811e+06	

```
55 55 1378340120 5.914536e+05 1.072811e+06
56 56 1377939229 7.337295e+05 1.331426e+06
57 57 1377442114 9.100508e+05 1.652220e+06
58 58 1376825863 1.128468e+06 2.050054e+06
59 59 1376062207 1.398882e+06 2.543296e+06
60 60 1375116321 1.733445e+06 3.154619e+06
61 61 1373945388 2.147025e+06 3.911972e+06
62 62 1372496883 2.657752e+06 4.849751e+06
63 63 1370706562 3.287630e+06 6.010192e+06
64 64 1368496144 4.063217e+06 7.445025e+06
65 65 1365770665 5.016332e+06 9.217388e+06
66 66 1362415592 6.184757e+06 1.140404e+07
67 67 1358293765 7.612826e+06 1.409779e+07
68 68 1353242406 9.351776e+06 1.741020e+07
69 69 1347070503 1.145965e+07 2.147423e+07
70 70 1339557111 1.400048e+07 2.644679e+07
71 71 1330451309 1.704230e+07 3.251077e+07
72 72 1319474806 2.065363e+07 3.987595e+07
73 73 1306328439 2.489778e+07 4.877816e+07
74 74 1290703908 2.982474e+07 5.947574e+07
75 75 1272301969 3.546017e+07 7.224224e+07
76 76 1250857745 4.179224e+07 8.735440e+07
77 77 1226172640 4.875714e+07 1.050746e+08
78 78 1198150518 5.622602e+07 1.256278e+08
79 79 1166833558 6.399642e+07 1.491744e+08
80 80 1132431088 7.179263e+07 1.757807e+08
81 81 1095333727 7.927820e+07 2.053925e+08
82 82 1056106283 8.608214e+07 2.378160e+08
83 83 1015456520 9.183663e+07 2.727112e+08
84 84 974182428 9.622007e+07 3.096019e+08
85 85 933106246 9.899691e+07 3.479012e+08
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88 88 818313071 9.708253e+07 4.646088e+08
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FINDINGS / RESULTS:

These are the results that is the graphs plotted for the above commands and it also includes the world map visualization of worldwide COVID-19 cases.

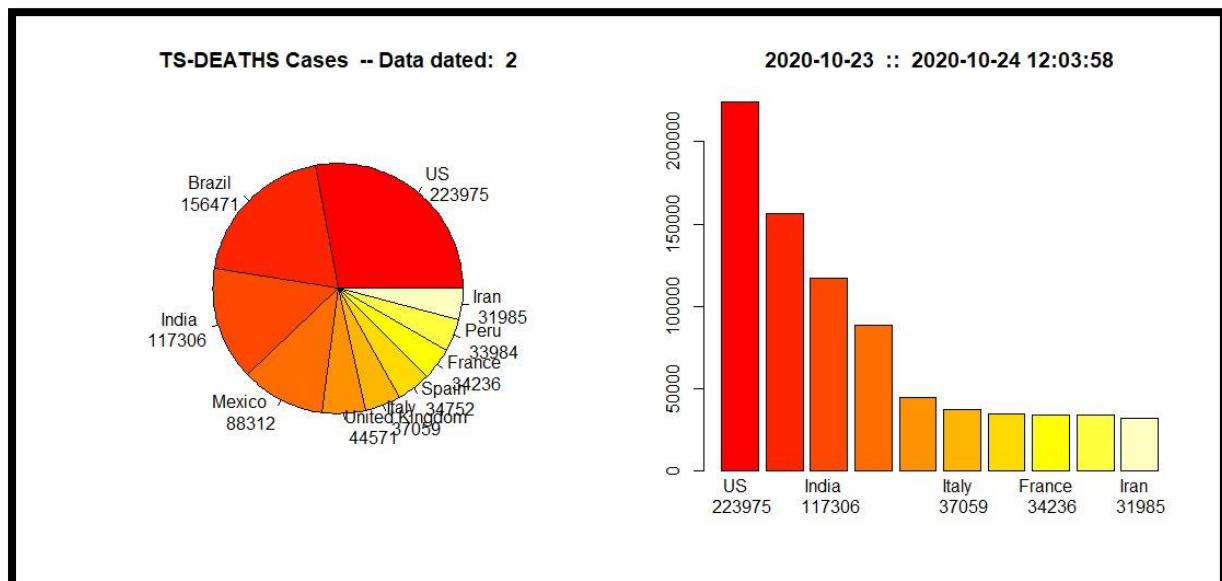
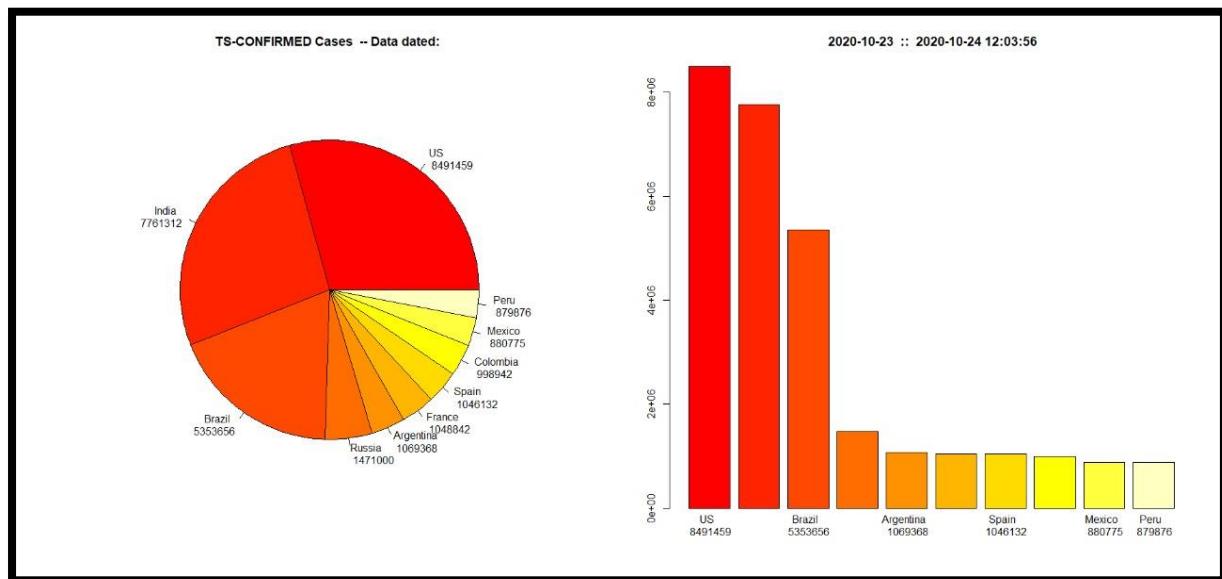
DATA SAMPLE

FIPS	Admin2	Province_State	Country_Region	Last_Update	Lat	Long_	Confirmed	Deaths	Recovered	Active	Combined_Key	Incidence_Rate	Case.Fatality_Ratio
1	NA		Afghanistan	2020-10-24 04:24:46	33.959110	67.709553	40687	1507	34010	5170	Afghanistan	1.045177e+03	3.70368576
2	NA		Albania	2020-10-24 04:24:46	41.153300	20.168300	18556	469	10466	7621	Albania	6.47951e+02	2.52746437
3	NA		Algeria	2020-10-24 04:24:46	28.033900	1.659600	55630	1897	38788	14945	Algeria	1.268613e+02	3.41003056
4	NA		Andorra	2020-10-24 04:24:46	42.506300	1.521800	4038	69	2729	1240	Andorra	5.226170e+03	1.70876672
5	NA		Angola	2020-10-24 04:24:46	-11.202700	17.873900	6829	265	3384	5180	Angola	2.686341e+01	3.00147242
6	NA		Antigua and Barbuda	2020-10-24 04:24:46	17.060600	-61.796400	122	3	107	12	Antigua and Barbuda	1.245013e+02	2.45901639
7	NA		Argentina	2020-10-24 04:24:46	-38.416100	-63.616700	1069368	28338	866695	174335	Argentina	2.366079e+03	2.64997643
8	NA		Armenia	2020-10-24 04:24:46	40.069100	-45.038200	73310	1145	50276	21889	Armenia	2.473966e+03	1.56186059
9	NA	Australian Capital Territory	Australia	2020-10-24 04:24:46	-35.473500	149.012400	114	3	110	1	Australian Capital Territory, Australia	2.662929e+01	2.63157895
10	NA	New South Wales	Australia	2020-10-24 04:24:46	-33.866800	151.209300	4375	53	3145	1177	New South Wales, Australia	5.389250e+01	1.21142857
11	NA	Northern Territory	Australia	2020-10-24 04:24:46	-12.463400	130.845600	33	0	33	0	Northern Territory, Australia	1.343648e+01	0.00000000
12	NA	Queensland	Australia	2020-10-24 04:24:46	-27.469800	153.025100	1167	6	1157	4	Queensland, Australia	2.819302e+01	0.51413862
13	NA	South Australia	Australia	2020-10-24 04:24:46	-34.928500	138.600700	487	4	473	10	South Australia, Australia	2.772559e+01	0.82135524
14	NA	Tasmania	Australia	2020-10-24 04:24:46	-42.882100	147.327200	230	13	217	0	Tasmania, Australia	4.295011e+01	5.63217391
15	NA	Victoria	Australia	2020-10-24 04:24:46	-37.813600	144.963100	20336	817	19346	173	Victoria, Australia	3.079316e+02	4.0750590
16	NA	Western Australia	Australia	2020-10-24 04:24:46	-31.959500	115.869500	753	9	692	52	Western Australia, Australia	2.662465e+01	1.19521912
17	NA		Austria	2020-10-24 04:24:46	47.516200	14.550100	74415	954	55195	18266	Austria	8.262458e+02	1.28199960
18	NA		Azerbaijan	2020-10-24 04:24:46	40.143100	47.576900	46221	656	40831	6734	Azerbaijan	4.755910e+02	1.36040314
19	NA		Bahamas	2020-10-24 04:24:46	25.023685	-76.035889	6268	130	3795	2343	Bahamas	1.589905e+03	2.07402660
20	NA		Bahrain	2020-10-24 04:24:46	26.027500	50.550000	79574	311	76143	3120	Bahrain	4.676469e+03	0.39083118
21	NA		Bangladesh	2020-10-24 04:24:46	23.685000	90.356300	396413	3761	312065	78587	Bangladesh	2.407034e+02	1.45328321
22	NA		Barbados	2020-10-24 04:24:46	13.193900	-58.545200	226	7	207	12	Barbados	7.664586e+01	3.08975451
23	NA		Belarus	2020-10-24 04:24:46	53.709800	27.953400	91167	945	82136	8086	Belarus	9.647959e+02	1.03855928
24	NA		Belgium	2020-10-24 04:24:46	50.833300	4.469938	287700	10658	22517	254525	Belgium	2.482395e+03	3.70455335
25	NA		Belize	2020-10-24 04:24:46	17.189800	-86.497800	3050	46	1572	1132	Belize	7.670621e+02	1.50819672
26	NA		Benin	2020-10-24 04:24:46	9.307700	2.315800	2557	41	2330	186	Benin	2.109179e+01	1.6344155
27	NA		Bhutan	2020-10-24 04:24:46	27.514200	90.438500	336	0	306	30	Bhutan	4.354520e+01	0.00000000
28	NA		Bolivia	2020-10-24 04:24:46	-16.289200	-63.568700	140612	8608	107633	24371	Bolivia	1.204589e+03	6.12181057
29	NA		Bosnia and Herzegovina	2020-10-24 04:24:46	43.915900	17.679100	38493	1065	26260	11168	Bosnia and Herzegovina	1.173276e+03	2.76673681
30	NA		Botswana	2020-10-24 04:24:46	-22.328500	24.684900	5923	21	927	4975	Botswana	2.519604e+02	0.35455006

	FIPS	Admin2	Province_State	Country_Region	Last_Update	Lat	Long_	Confirmed	Deaths	Recovered	Active	Combined_Key	Incidence_Rate	Case_Fatality_Ratio
234	NA		Iceland	Iceland	2020-10-24 04:24:46	64.963100	-19.020800	4308	11	3167	1110	Iceland	1.26241e+03	0.25533890
235	NA		Andaman and Nicobar Islands	India	2020-10-24 04:24:46	11.251999	92.961878	4184	57	3937	190	Andaman and Nicobar Islands, India	1.003271e+03	1.36233270
236	NA		Andhra Pradesh	India	2020-10-24 04:24:46	15.912900	79.740000	796919	6524	758138	32257	Andhra Pradesh, India	1.470421e+03	0.81665294
237	NA		Arunachal Pradesh	India	2020-10-24 04:24:46	27.766456	96.364277	14077	32	11407	2638	Arunachal Pradesh, India	8.963637e+02	0.22732116
238	NA		Assam	India	2020-10-24 04:24:46	26.357149	92.803041	203262	698	177662	24724	Assam, India	5.705040e+02	0.44076701
239	NA		Bihar	India	2020-10-24 04:24:46	25.479658	85.064048	209447	1026	197208	11213	Bihar, India	1.67262e+02	0.45986140
240	NA		Chandigarh	India	2020-10-24 04:24:46	30.733389	76.768278	13845	212	12924	712	Chandigarh, India	1.195387e+03	1.53080699
241	NA		Chhattisgarh	India	2020-10-24 04:24:46	21.647075	82.035338	17013	1680	143212	25238	Chhattisgarh, India	5.779612e+02	0.98748016
242	NA		Dadra and Nagar Haveli and Daman and Diu	India	2020-10-24 04:24:46	20.197427	70.060901	3213	2	3164	47	Dadra and Nagar Haveli and Daman and Diu, India	5.216247e+02	0.06242712
243	NA		Delhi	India	2020-10-24 04:24:46	28.646519	77.108690	344318	6163	312910	2527	Delhi, India	1.641986e+03	1.78951154
244	NA		Goa	India	2020-10-24 04:24:46	15.359662	74.057396	41586	564	38031	2991	Goa, India	2.621655e+03	1.35622565
245	NA		Gujarat	India	2020-10-24 04:24:46	22.494884	71.900293	163989	3667	146171	14121	Gujarat, India	2.566977e+02	2.23653474
246	NA		Haryana	India	2020-10-24 04:24:46	29.200040	76.332823	154495	1688	147298	10009	Haryana	5.776335e+02	1.09259199
247	NA		Himachal Pradesh	India	2020-10-24 04:24:46	31.927213	77.233061	19644	284	16937	2623	Himachal Pradesh, India	2.662392e+02	1.48116207
248	NA		Jammu and Kashmir	India	2020-10-24 04:24:46	33.779430	76.612638	90166	1412	80602	7952	Jammu and Kashmir, India	6.626773e+02	1.56600409
249	NA		Jharkhand	India	2020-10-24 04:24:46	23.554536	85.575671	98610	859	91629	6122	Jharkhand, India	2.555046e+02	0.87110841
250	NA		Karnataka	India	2020-10-24 04:24:46	14.705180	76.166436	788551	10770	684835	9246	Karnataka, India	1.1671740e+03	1.36579625
251	NA		Kerala	India	2020-10-24 04:24:46	04.409816	76.405297	369328	1255	274875	93939	Kerala, India	1.034534e+03	0.33581095
252	NA		Ladakh	India	2020-10-24 04:24:46	34.152600	77.577100	5812	68	4902	842	Ladakh, India	2.116933e+03	1.16999312
253	NA		Lakshadweep	India	2020-10-24 04:24:46	13.699997	72.183333	0	0	0	0	Lakshadweep, India	0.000000e+00	N/A
254	NA		Madhya Pradesh	India	2020-10-24 04:24:46	23.541513	78.269933	164341	2842	149353	12146	Madhya Pradesh, India	1.925293e+02	1.72293119
255	NA		Maharashtra	India	2020-10-24 04:24:46	19.449759	76.108221	1625197	42631	1401856	150510	Maharashtra, India	1.319751e+03	2.63534345
256	NA		Manipur	India	2020-10-24 04:24:46	24.738975	93.625241	16621	127	12389	4101	Manipur, India	5.37627e+02	0.76409362
257	NA		Meghalaya	India	2020-10-24 04:24:46	25.536934	91.278682	8720	78	6981	1661	Meghalaya, India	2.590066e+02	0.89449541
258	NA		Mizoram	India	2020-10-24 04:24:46	23.209381	92.883220	2359	0	2175	184	Mizoram, India	1.903580e+02	0.00000000
259	NA		Nagaland	India	2020-10-24 04:24:46	26.067020	94.470302	8296	28	6469	1799	Nagaland, India	3.687611e+02	0.33751205
260	NA		Odisha	India	2020-10-24 04:24:46	20.305428	64.810509	276094	1196	257041	17857	Odisha, India	5.955907e+02	0.43176580
261	NA		Puducherry	India	2020-10-24 04:24:46	11.882658	76.064980	33832	582	29211	4039	Puducherry, India	2.393420e+03	1.72026484
262	NA		Punjab	India	2020-10-24 04:24:46	30.641655	75.407890	129693	4072	121155	4666	Punjab, India	4.302823e+02	1.39772227
263	NA		Rajasthan	India	2020-10-24 04:24:46	26.583433	73.847973	180755	1803	160614	18341	Rajasthan, India	2.330643e+02	0.99582308

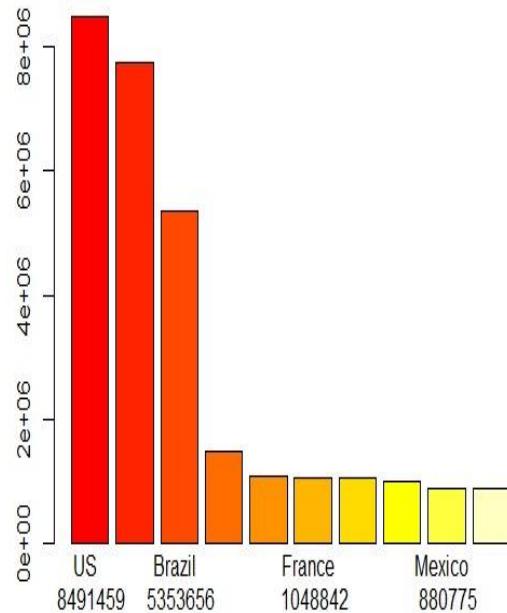
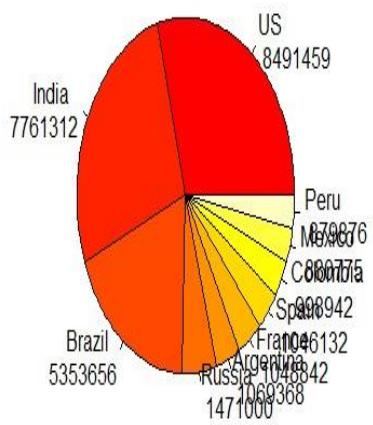
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33	Xizang	Lhasa	29.6482300	91.11999900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
54		Central African Republic	6.611100	20.959400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
55		Chad	15.454200	18.733200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
56		Chile	-35.675100	-71.540000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
57	Anhui	China	31.827930	117.238400	1	9	19	39	60	70	106	152	200	237	287	340	408	480	530	591	665	733	779	830	880	
58	Billing	China	40.182400	116.414200	14	22	36	41	68	60	91	111	114	139	168	191	212	226	233	274	317	351	326	337	342	
59	Chongqing	China	30.057230	107.874000	6	9	27	57	75	110	132	147	162	211	247	300	337	366	389	411	426	408	488	505	518	
60	Fujian	China	26.079800	119.987400	1	5	10	16	35	58	60	64	101	120	144	159	179	194	205	215	224	238	250	261	267	
61	Gansu	China	35.751800	104.268100	0	2	2	4	7	14	19	24	28	29	40	51	55	57	62	62	67	79	83	85	88	
62	Guangdong	China	23.347100	113.944400	26	32	53	76	111	151	207	277	354	436	535	632	725	813	895	970	1034	1095	1131	1158	1177	
63	Guangxi	China	23.826930	106.785100	3	9	23	23	36	46	51	58	78	87	100	111	127	139	150	166	172	183	195	210	215	
64	Guizhou	China	26.015420	108.574800	1	3	3	4	5	7	9	9	12	29	29	38	46	58	64	71	81	89	99	109	127	
65	Hainan	China	19.199500	104.743000	4	5	8	19	22	33	40	43	46	52	62	64	72	80	99	106	117	124	131	138	144	
66	Hebei	China	38.549000	116.139500	1	1	2	6	13	18	33	48	65	65	62	66	104	113	126	135	157	172	195	206	218	
67	Heilongjiang	China	47.662000	127.761500	0	2	4	9	15	21	33	38	44	59	60	95	121	155	190	227	277	295	307	331	360	
68	Henan	China	37.899730	114.904200	5	9	9	32	63	128	168	206	278	352	422	493	566	675	764	851	914	981	1033	1073	1105	
69	Hong Kong	China	22.300000	114.020000	0	2	2	5	6	6	6	10	10	12	13	15	15	17	21	24	25	26	29	38	49	
70	Hubei	China	30.957600	112.277000	444	444	549	761	1058	1243	1354	1354	4903	5506	5133	11177	15322	16978	19665	22112	24935	27100	29831	31728	33566	33566
71	Hunan	China	27.610420	111.758800	4	9	24	43	69	100	143	221	277	332	369	463	521	593	661	711	772	803	838	878	912	946
72	Inner Mongolia	China	44.095500	113.946200	0	0	1	7	7	11	15	16	19	20	23	27	34	35	42	46	50	52	54	58	60	
73	Jiangsu	China	32.971100	119.459500	1	5	9	16	33	47	70	99	129	168	202	238	271	308	341	373	408	439	468	492	515	
74	Jiangxi	China	27.614020	115.721200	3	7	18	18	38	72	109	109	162	240	288	333	391	476	548	600	661	698	740	771	854	
75	SJL	China	43.666100	136.152600	0	1	3	4	4	6	8	9	14	14	17	23	31	42	54	59	65	69	78	80	81	
76	Uanning	China	41.295600	122.605000	2	3	4	17	21	27	34	39	41	48	64	70	74	81	89	94	99	105	127	128	116	
77	Meitu	China	22.166700	115.955000	1	2	2	5	6	7	7	7	7	7	8	8	10	10	10	10	10	10	10	10		
78	Ningxia	China	37.269200	106.165000	1	1	2	3	4	7	11	12	17	21	26	28	31	34	34	40	43	45	49	53	58	
79	Qinghai	China	35.745200	95.959500	0	0	0	1	1	6	6	6	6	8	9	11	13	15	17	18	18	18	18	18		
80	Shaanxi	China	35.191700	108.070100	0	3	5	15	22	35	46	56	63	67	71	101	116	128	142	165	173	184	195	226		
81	Shandong	China	36.543700	116.149500	2	6	15	27	46	75	95	130	155	184	206	230	259	275	307	347	386	416	444	486	497	

SUMMARIZING THE REPORT





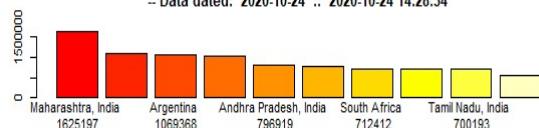
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AGGREGATED Data -- ORDERED BY CONFIRMED Cases -



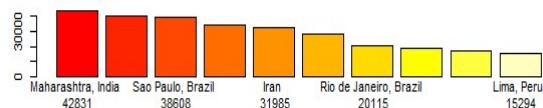
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AGGREGATED Data -- ORDERED BY DEATHS Cases --



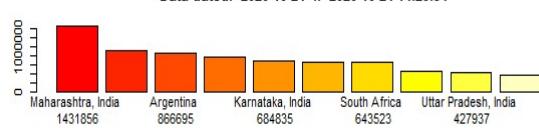
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AGGREGATED Data -- ORDERED BY RECOVERED Cases -



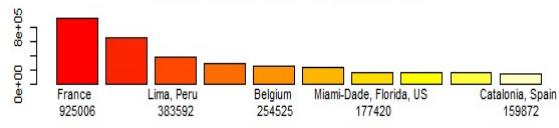
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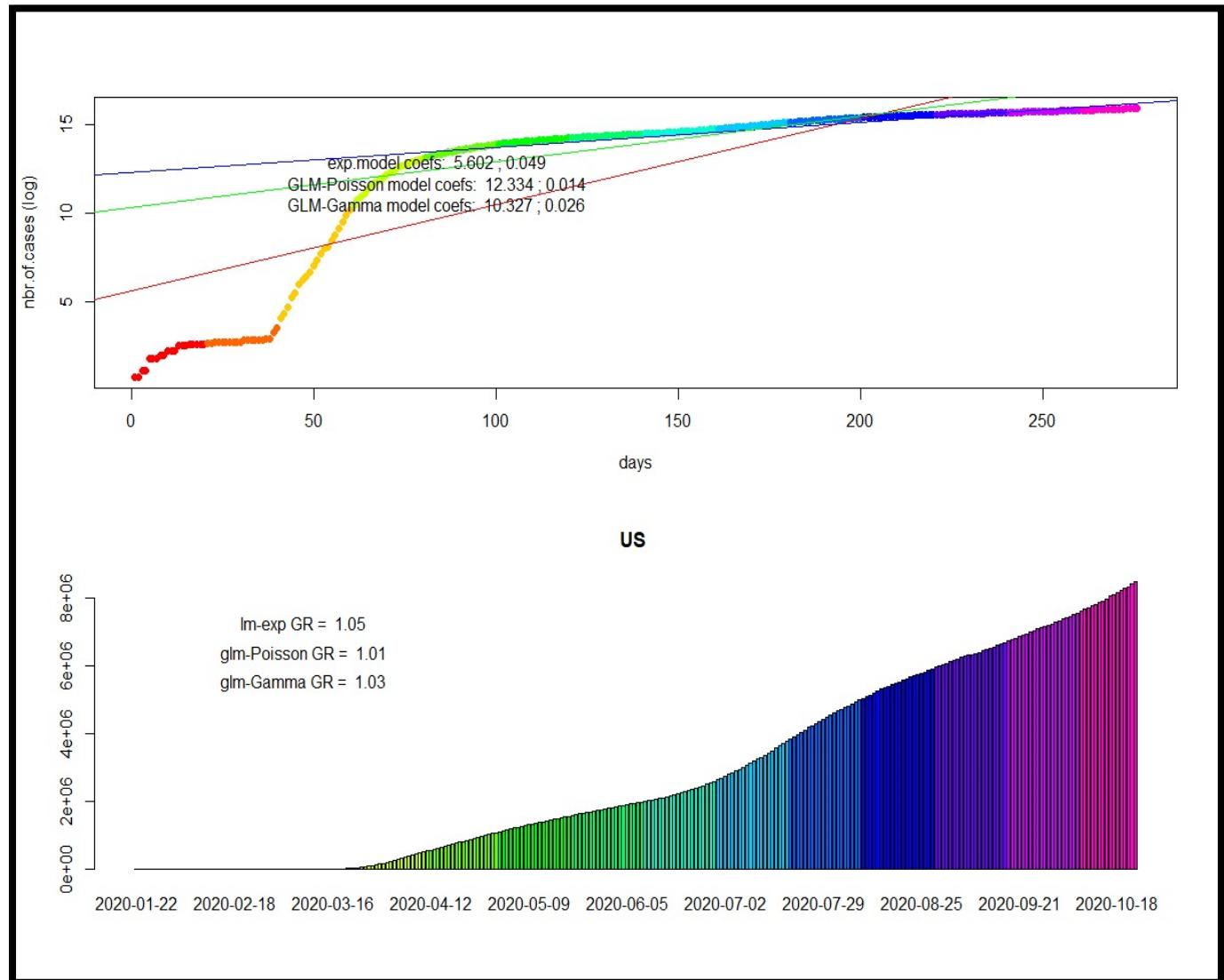
AGGREGATED Data -- ORDERED BY ACTIVE Cases --



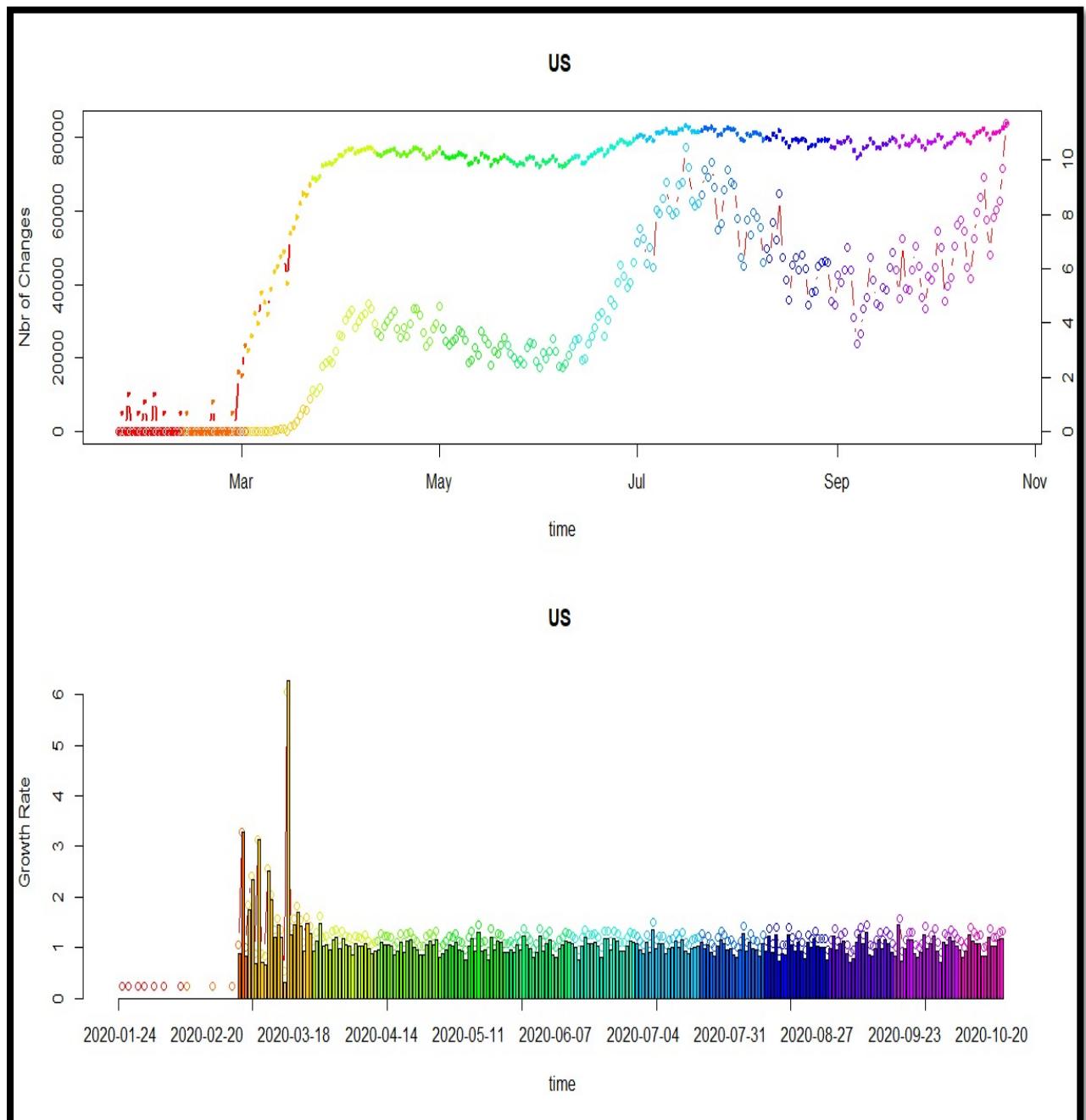
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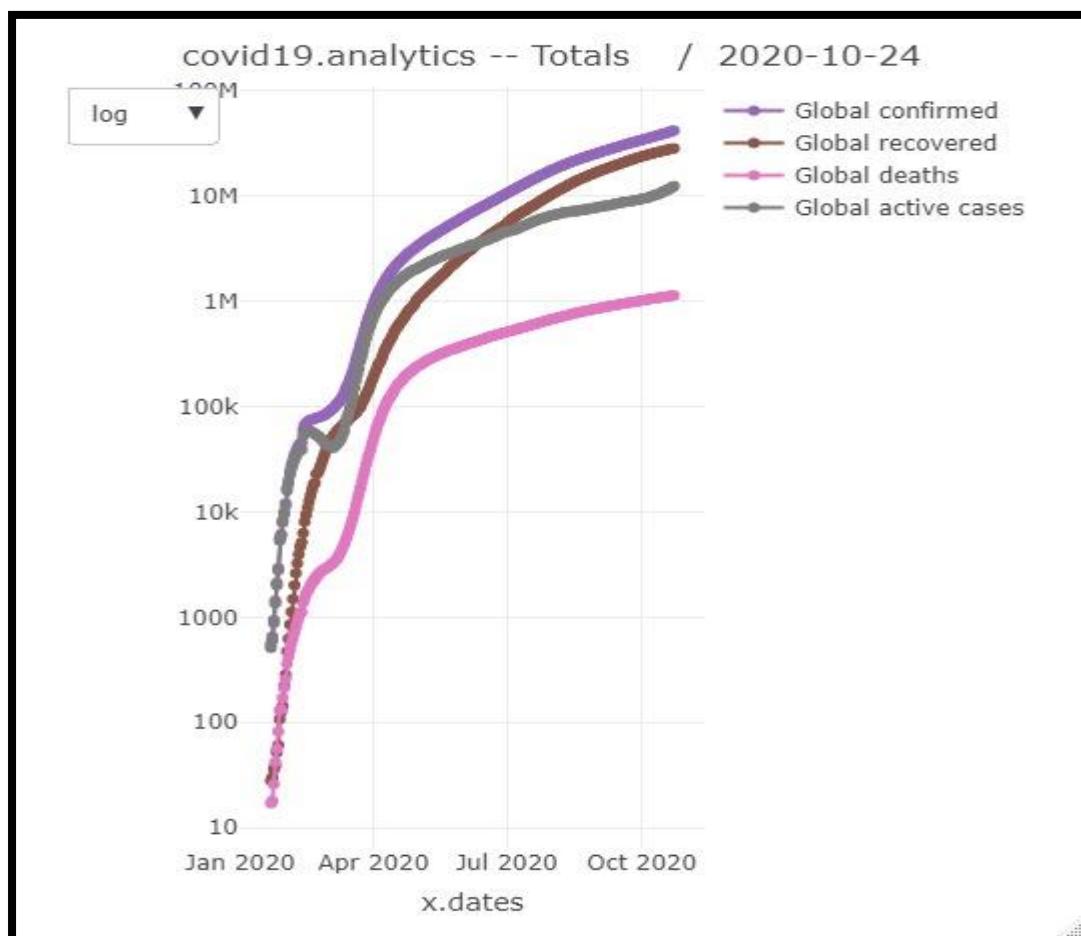
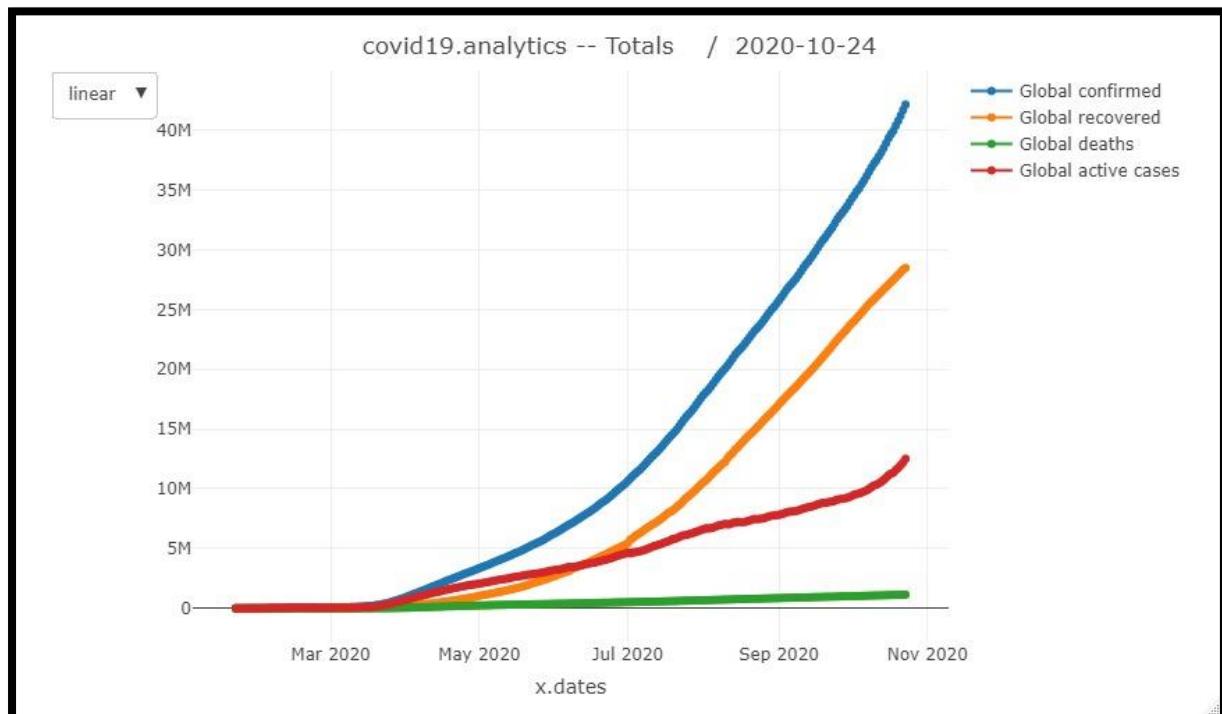
TOTALS PER LOCATION

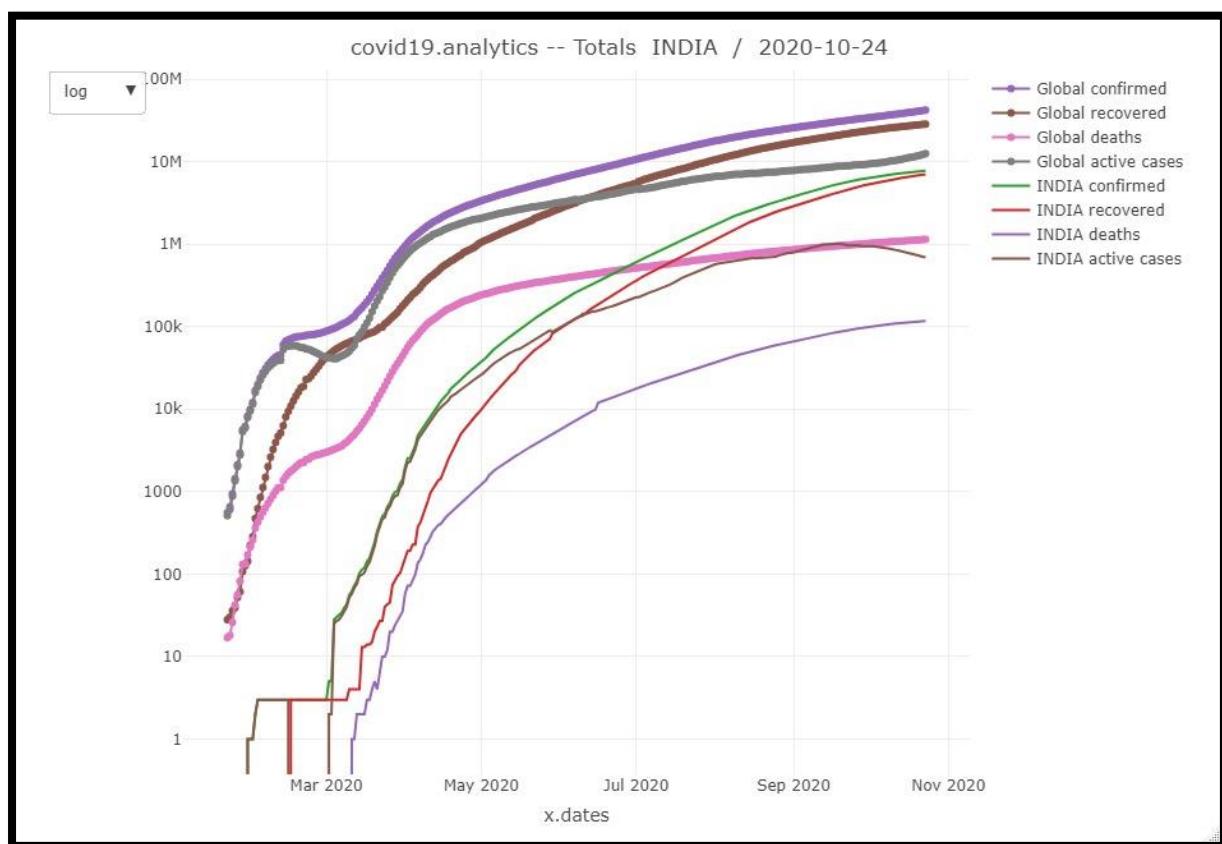
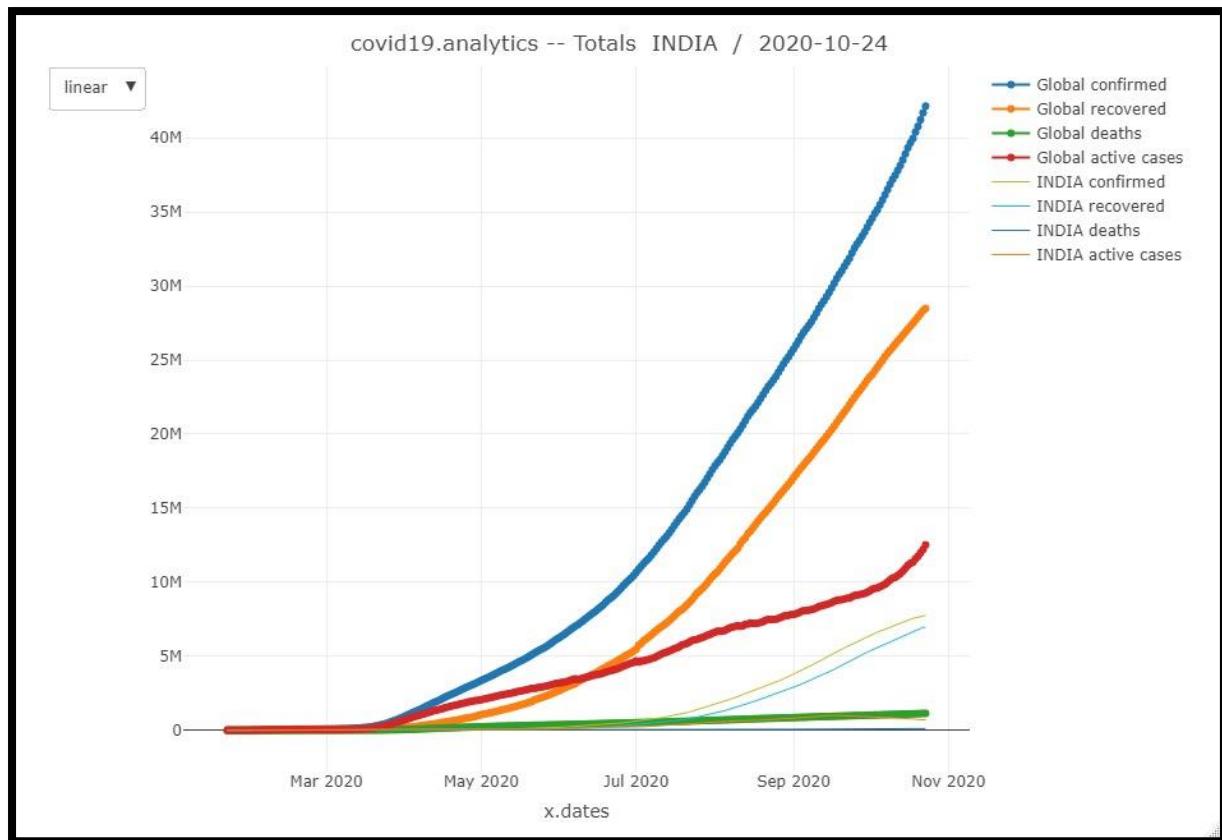


GROWTH RATE

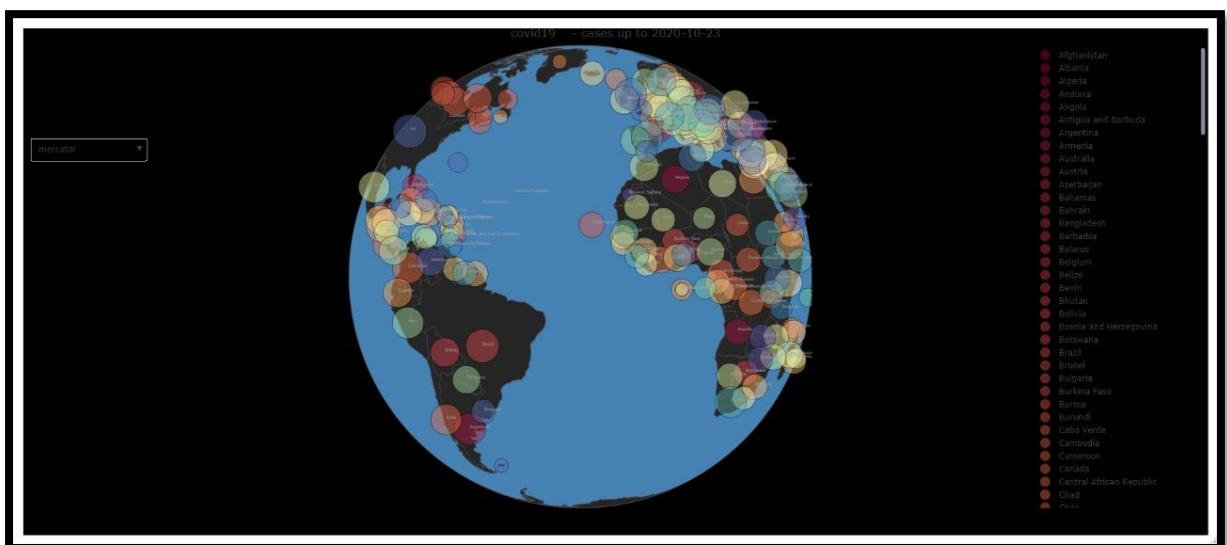
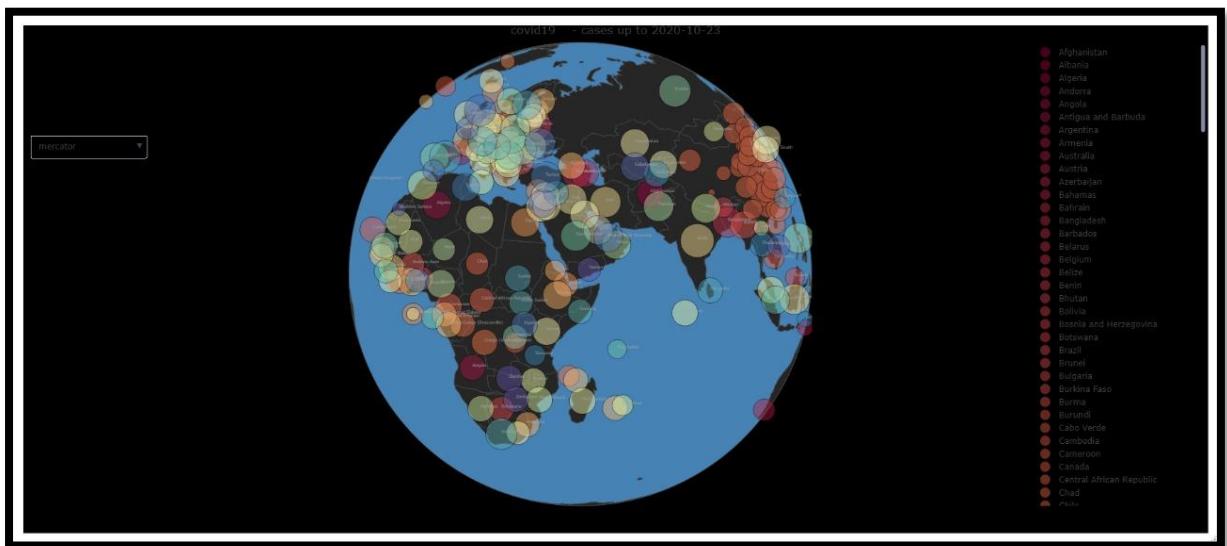


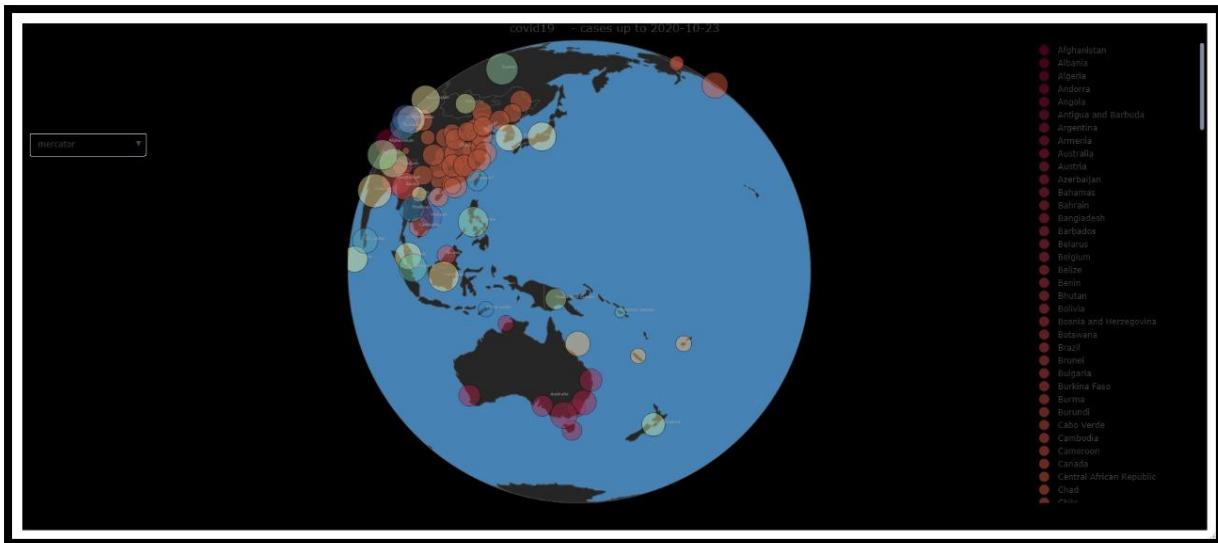
TOTALS PLOT



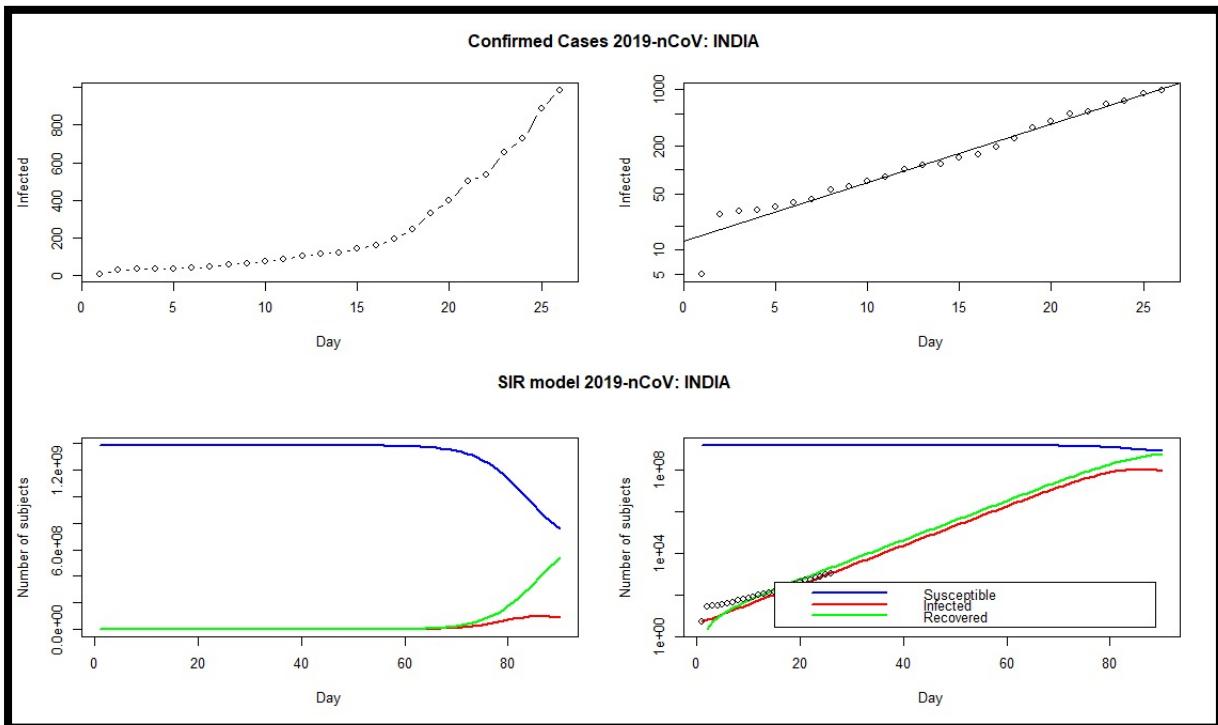


WORLD MAP VISUALIZATION





SIR MODEL



CONCLUSION AND FUTURE WORK:

From the analysis of the latest COVID-19 data, we can conclude that the pandemic has decreased significantly over the weeks which has made many governments to unlock the lockdowns in their countries. Vaccines are also to be introduced in the forthcoming months, so the impact caused by the pandemic is getting reduced gradually. The data is updated frequently in covid19.analytics. So it could be useful for future work on analysis of covid19. We can calculate the economical losses and the changes in environmental conditions due to the lockdown and extend it as an future work.

REFERENCES:

<https://www.ncbi.nlm.nih.gov>

<https://www.researchgate.net>

<https://www.cebm.net>

<http://www.who.int>

APPENDIX (CODE)

```
#library  
library(covid19.analytics)
```

```
#Data  
ag <- covid19.data(case = 'aggregated')  
tsc <- covid19.data(case = 'ts-confirmed')  
tsa <- covid19.data(case = 'ts-ALL')
```

```
#Summary  
report.summary(Nentries = 10,graphical.output = T)
```

```
#Totals per location  
tots.per.location(tsc,geo.loc = 'US')
```

```
#Growth rate  
growth.rate(tsc,geo.loc ='US')
```

```
#Totals plot  
totals.plt(tsa)  
totals.plt(tsa,c('India'))
```

```
#World Map  
live.map(tsc)
```

```
#SIR Model  
generate.SIR.model(tsc,'India',tot.population = 1380004385)
```