DATA MODELING AND ANALYZING CORONA VIRUS SPREAD USING DATA SCIENCE AND PYTHON

A J-Component Report

submitted by

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For the course

ECE-3999 TECHNICAL ANSWERS FOR REAL WORLD PROBLEMS

To

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VIT®

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(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING

SLOT: TD2

ACKNOWLEDGEMENT

We would like to express our special thanks of gratitude to our professor **ILAVARASAN T** who gave us the golden opportunity to do this wonderful project on the topic “**DATA MODELING AND ANALYZING COVID-19 SPREAD USING DATA SCIENCE**” and also for his continuing guidance and encouragement in carrying out this project work. This dissertation would not have been possible without the support of our professors. I would also like to thank and appreciate to one and all who directly or indirectly have lent their helping hand in this venture. Secondly, we would also like to thank our parents, our university, and our teammates who helped us a lot in finalizing this project within the limited time frame.

ABSTRACT

In this project we tried to gather the information on how the covid-19 has spread throughout the world and how it mainly affected the countries INDIA and ITALY as ITALY is the first one to be attacked after CHINA and INDIA well is the country we live in. So we did what we can to analyze the data of the covid-19 which was available online and are able to visualize how this covid-19 has spread and also were able to make a prediction on the new cases. we will be taking raw data from the most reliable sources and convert it into tables, graphs and to other forms of organized data for **machine learning engineers** or some other researchers which might help them a bit along their process of actively trying to fight COVID-19.We will be modelling and analyzing the data and try to predict the COVID-19 cases in the future, we will be fitting the data to a familiar model for pandemics called **SIR** (susceptible infected recovered) which is a part of compartmental model techniques. Data modeling is a set of tools and techniques used to understand and analyze how an organization should collect, update, and store data. It is a critical skill for the business analyst who is involved with discovering, analyzing, and specifying changes to how software systems create and maintain information.

OBJECTIVE

- In this present situation we are not able to understand how this COVID-19 is spreading around the world. One doesn't know how many cases are rising day by day in different places and the factors that are taken by governments in different countries.
- So our main idea is to make a SIR model to divide the people who are infected and recovered and who are susceptible to COVID-19 in countries like **India** and **Italy**.
- To provide a modelled data and to help people analyze and improve the current situation of the pandemic.
- Our Project is an attempt of data modelling and analyzing Coronavirus (COVID-19) spread with the help of data science and data analytics in python.

INTRODUCTION

- Presently, there are endless dashboards and measurements around the Coronavirus spread accessible everywhere on the web.
- With this so much data and master assessments, to see various countries receiving various procedures, from complete lockdown to social separating to crowd insusceptibility, Someone is left intuition concerning what the correct system is for them.
- So this is an endeavor of information displaying and dissecting Coronavirus (COVID-19) spread with the assistance of information science and information examination in python code.
- This examination will assist us with finding the premise behind basic ideas about the infection spread from absolutely a dataset point of view.

CORONA VIRUS IN ITALY

HOW COVID-19 STARTED IN ITALY:

The virus was first confirmed to have spread to Italy on 31 January 2020, when two Chinese tourists in Rome tested positive for the virus. One week later an Italian man repatriated back to Italy from the city of Wuhan, China, was hospitalized and confirmed as the third case in Italy. Clusters of cases were later detected in Lombardy and Veneto on 21 February, with the first deaths on 22 February. By the beginning of March, the virus had spread to all regions of Italy. On 6 March 2020, the Italian College of Anesthesia, Analgesia, Resuscitation and Intensive Care (SIAARTI) published medical ethics recommendations regarding triage protocols that needed to be employed.

TIMELINE

January 2020: First confirmed cases

February–March 2020: Clusters in Northern Italy

March 2020: Spread to other regions

March–May 2020: Under national lockdown

May–September 2020: Reduction of cases and loosening of restrictions

September 2020–ongoing: Arrival of the second wave

MEASURES TAKEN BY GOVERNMENT IN ITALY:

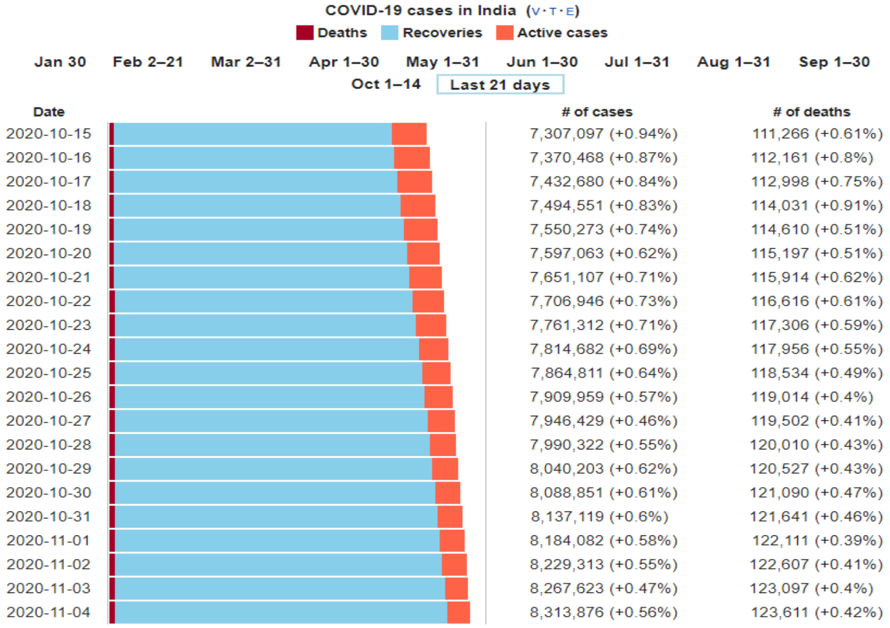
In Italy, after the shutdown of the educational system (schools and Universities will remain closed at least for one month) and the collapse of the touristic sector (90% of travels and reservations cancelled), the Government officially locked down residents of all the region of Milan (Lombardia) and other 11 provinces. To avoid the imprisonment, hundreds thousand people left those areas with any possible mean in the night of March 7th, just before the law was signed by the prime Minister Giuseppe Conte, thus turning his purpose of slowing down the epidemics exactly into the opposite. The Governors of Southern regions adopted limitations for this huge mass of potentially infected incoming people, with the risk of disseminating suspicion in the population ("hunting the greaser"). Violence exploded in several prisons, due to the cancellation of all the family visits and fear of the virus. Just 48 hours later, the Italian Government has extended these exceptional warlike measures to the entire nation: nobody is allowed to exit from home other than for compelling job or health reasons; museums, cinemas, theatres, sport facilities, and even churches have been closed; restaurants and bars must stop at 6 PM their activity. Further restrictions are probably going to be considered in next days. The Italian prime minister was clear in his video-message of March 5th: the emergency does not come from the lethality of the virus, but from the impossibility of the Italian healthcare system to cope with the impact of a rapid epidemic spreading of the Covid-19.

CORONA VIRUS IN INDIA

HOW COVID-19 STARTED IN INDIA:

The first case of COVID-19 in India, which originated from China, was reported on 30 January 2020. India currently has the largest number of confirmed cases in Asia, and has the second-highest number of confirmed cases in the world after the United States, with almost 8 million reported cases of COVID-19 infection, more than 1 lakh deaths and more than 7 million recovered. By mid of 2020, India had approached in position of conducting highest number of daily tests in the world which subsequently translated into highest number of daily new cases in world and has sustained highest number of daily cases spike since then.

TIMELINE



COVID-19 cases in India (V · T · E)

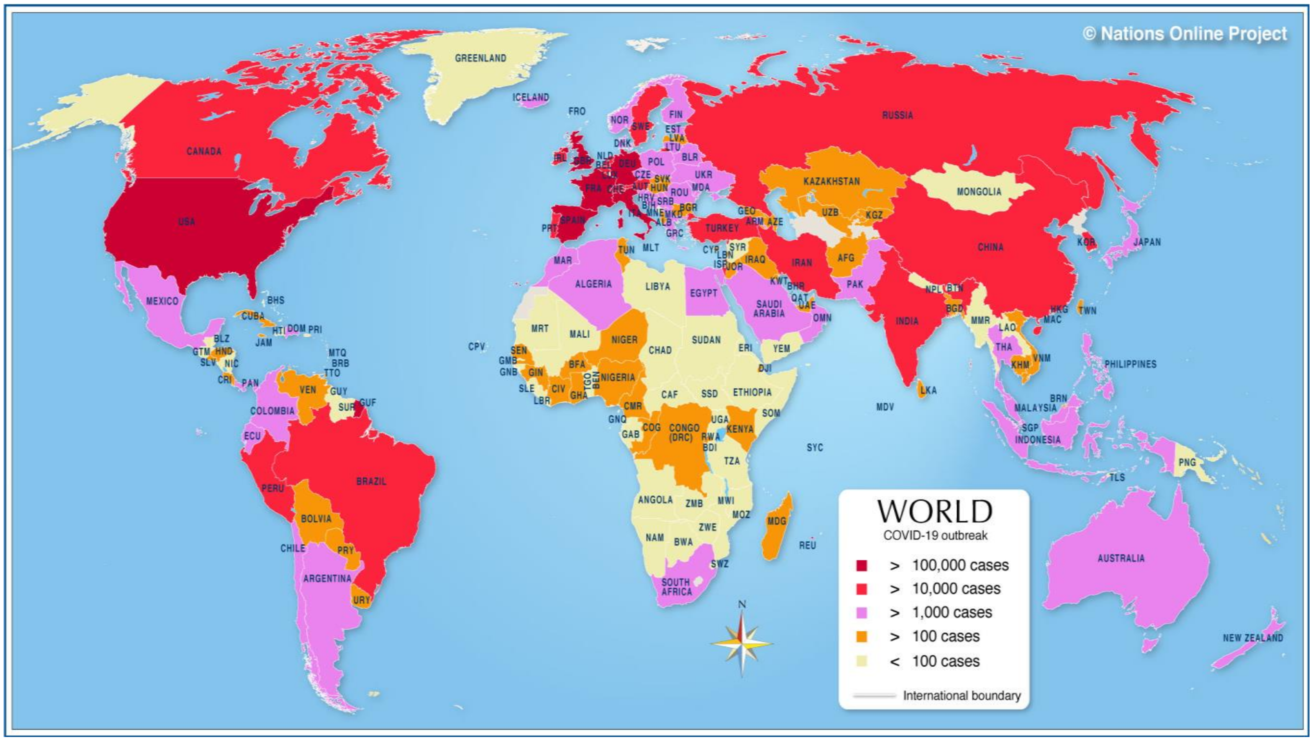
Date	# of cases	# of deaths
2020-10-15	7,307,097 (+0.94%)	111,266 (+0.61%)
2020-10-16	7,370,468 (+0.87%)	112,161 (+0.8%)
2020-10-17	7,432,680 (+0.84%)	112,998 (+0.75%)
2020-10-18	7,494,551 (+0.83%)	114,031 (+0.91%)
2020-10-19	7,550,273 (+0.74%)	114,610 (+0.51%)
2020-10-20	7,597,063 (+0.62%)	115,197 (+0.51%)
2020-10-21	7,651,107 (+0.71%)	115,914 (+0.62%)
2020-10-22	7,706,946 (+0.73%)	116,616 (+0.61%)
2020-10-23	7,761,312 (+0.71%)	117,306 (+0.59%)
2020-10-24	7,814,682 (+0.69%)	117,956 (+0.55%)
2020-10-25	7,864,811 (+0.64%)	118,534 (+0.49%)
2020-10-26	7,909,959 (+0.57%)	119,014 (+0.4%)
2020-10-27	7,946,429 (+0.46%)	119,502 (+0.41%)
2020-10-28	7,990,322 (+0.55%)	120,010 (+0.43%)
2020-10-29	8,040,203 (+0.62%)	120,527 (+0.43%)
2020-10-30	8,088,851 (+0.61%)	121,090 (+0.47%)
2020-10-31	8,137,119 (+0.6%)	121,641 (+0.46%)
2020-11-01	8,184,082 (+0.58%)	122,111 (+0.39%)
2020-11-02	8,229,313 (+0.55%)	122,607 (+0.41%)
2020-11-03	8,267,623 (+0.47%)	123,097 (+0.4%)
2020-11-04	8,313,876 (+0.56%)	123,611 (+0.42%)

MEASURES TAKEN BY GOVERNMENT IN INDIA:

- The Delhi government declared coronavirus as an epidemic in the state with 6 confirmed cases. All schools, colleges and cinema halls in Delhi will remain shut till March 31 as a measure to counter the coronavirus, Chief Minister Arvind Kejriwal announced on Thursday, March 12. The Delhi government had shut the primary schools earlier this month, the secondary classes were left open in view of the exams. The Chief Minister also declared that all cinema halls will remain shut in Delhi till 31st March. Schools and colleges where exams are not being held will also remain closed. Delhi government has also made disinfecting all public places, including government, private offices and shopping malls compulsory. Furthermore, vacant flats owned by Delhi Urban Shelter Improvement Board will be used for quarantine, says CM Kejriwal.
- Over 1,500 people under observation for coming in contact with 73 positive cases of coronavirus, as revealed by the Union Health Ministry. 10.5 lakh people screened so far at 30 designated airports in India, says the ministry.
- Union Ministry of Road Transport and Highways advised states and Union Territories to take all steps for sanitisation of public transport vehicles and terminals. This is to ensure sanitation of seats, handles and bars at all bus terminals are disinfected. The ministry also suggested that the public transport should display public health messages in vehicles, bus terminals and bus stops and asked states and UTs to take expeditious action and mobilise all necessary support in this regard.
- All educational institutions, stadiums and sports clubs in Srinagar are closed from till further orders amid the coronavirus scare as a precautionary step, the city administration has said. Srinagar Mayor Junaid Azim Mattu said that its “an unavoidable decision” to allow the Srinagar Municipal Corporation (SMC) to plan, sterilize and sanitize schools and colleges. Under a special set of statutory provisions, SMC has also ordered closure of all educational institutions, public clubs, sports clubs, indoor and open stadiums, coaching centres within Srinagar city limits till further orders. The mayor said the Corporation will procure 1,000 full quarantine body kits and spraying machines and all public as well as private

hospitals will go into heightened sanitation mode. The Corporation also ordered cancellation of all sports events within its limits and phased segregation of flea markets, including weekly markets, with an immediate effect. It has also issued an advisory asking people to desist shopping, especially eatables and garments, from roadside vendors.

COUNTRIES SUFFERING WITH COVID-19 DISEASE



HOW TO ANALYZE THIS COVID-19 EFFECTIVELY

So everyone looks at this problem in their own way. some will think of analyzing using different charts and online tools and some will think of some mathematical way of analyzing it.

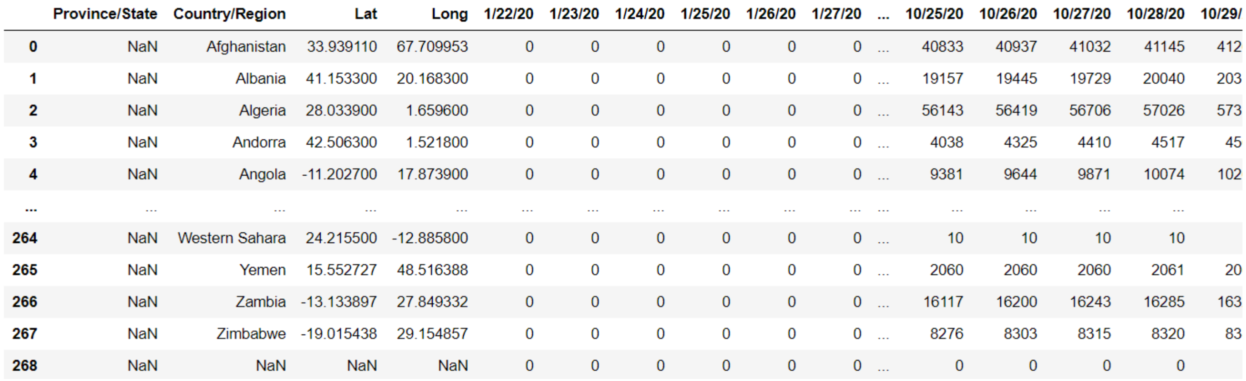
We came up with a solution of analyzing this COVID-19 by using the data modelling which is a part of data science and which helps us in viewing this problem easily.

HOW DID WE START?

- We first gone through the tools required in order to perform the data modelling and get to know the tool as python which is used by the software **Anaconda.**
- So in order to create a model we need a IDE so we started our search for that and found the best suitable one as **Jupyter Notebook**.
- Now we require a base for analyzing that is nothing but the **data.** So we started collecting the datasets from a trusted site and started our working.
- The datasets we used are:

  https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_confirmed_global.csv
  https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_deaths_global.csv
  https://raw.githubusercontent.com/CSSEGISandData/COVID-19/master/csse_covid_19_data/csse_covid_19_time_series/time_series_covid19_recovered_global.csv
  https://raw.githubusercontent.com/CSSEGISandData/COVID-19/web-data/data/cases_country.csv

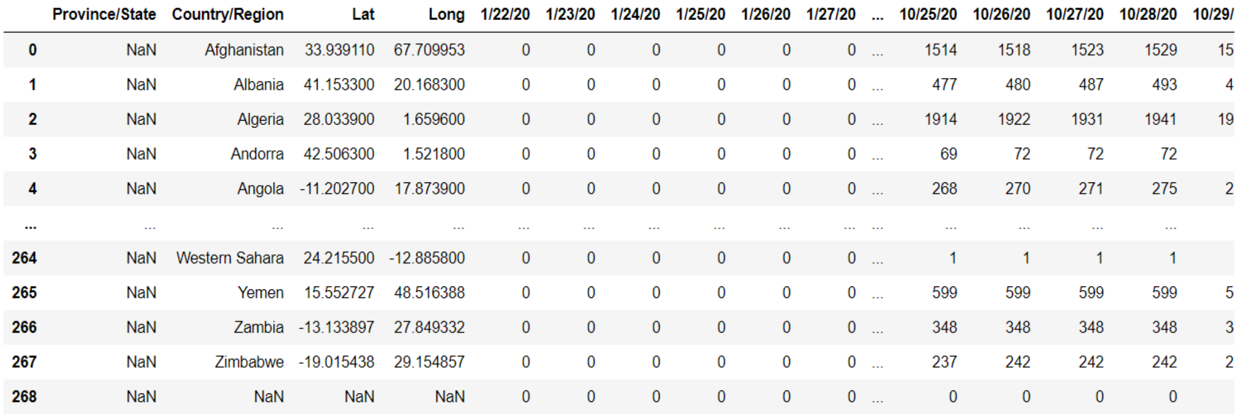
CONFIRMED CASES:



	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	...	10/25/20	10/26/20	10/27/20	10/28/20	10/29/
0	NaN	Afghanistan	33.939110	67.709953	0	0	0	0	0	0	...	40833	40937	41032	41145	412
1	NaN	Albania	41.153300	20.168300	0	0	0	0	0	0	...	19157	19445	19729	20040	203
2	NaN	Algeria	28.033900	1.659600	0	0	0	0	0	0	...	56143	56419	56706	57026	573
3	NaN	Andorra	42.506300	1.521800	0	0	0	0	0	0	...	4038	4325	4410	4517	45
4	NaN	Angola	-11.202700	17.873900	0	0	0	0	0	0	...	9381	9644	9871	10074	102
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
264	NaN	Western Sahara	24.215500	-12.885800	0	0	0	0	0	0	...	10	10	10	10	
265	NaN	Yemen	15.552727	48.516388	0	0	0	0	0	0	...	2060	2060	2060	2061	20
266	NaN	Zambia	-13.133897	27.849332	0	0	0	0	0	0	...	16117	16200	16243	16285	163
267	NaN	Zimbabwe	-19.015438	29.154857	0	0	0	0	0	0	...	8276	8303	8315	8320	83
268	NaN	NaN	NaN	NaN	0	0	0	0	0	0	...	0	0	0	0	

And it will be continued till present day

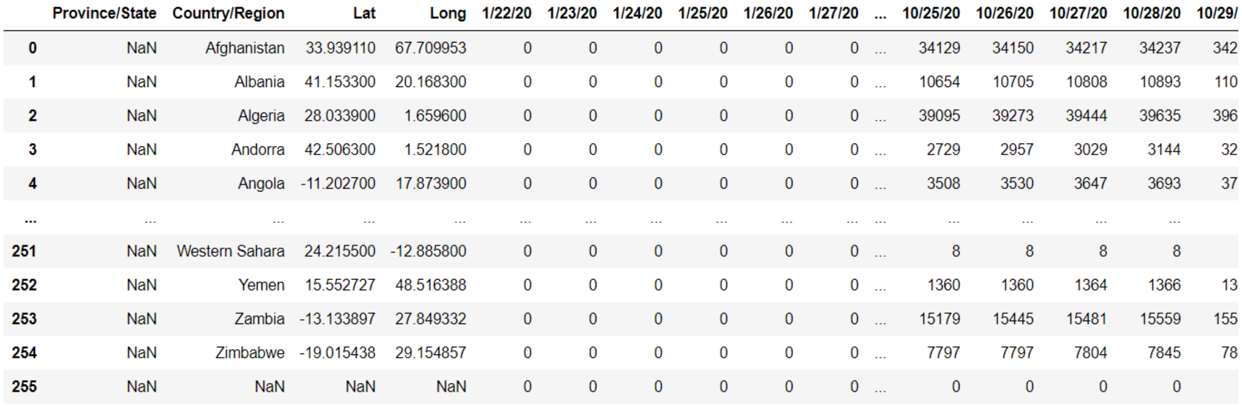
DEATHS GLOBAL:



	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	...	10/25/20	10/26/20	10/27/20	10/28/20	10/29/
0	NaN	Afghanistan	33.939110	67.709953	0	0	0	0	0	0	...	1514	1518	1523	1529	15
1	NaN	Albania	41.153300	20.168300	0	0	0	0	0	0	...	477	480	487	493	4
2	NaN	Algeria	28.033900	1.659600	0	0	0	0	0	0	...	1914	1922	1931	1941	19
3	NaN	Andorra	42.506300	1.521800	0	0	0	0	0	0	...	69	72	72	72	
4	NaN	Angola	-11.202700	17.873900	0	0	0	0	0	0	...	268	270	271	275	2
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
264	NaN	Western Sahara	24.215500	-12.885800	0	0	0	0	0	0	...	1	1	1	1	
265	NaN	Yemen	15.552727	48.516388	0	0	0	0	0	0	...	599	599	599	599	5
266	NaN	Zambia	-13.133897	27.849332	0	0	0	0	0	0	...	348	348	348	348	3
267	NaN	Zimbabwe	-19.015438	29.154857	0	0	0	0	0	0	...	237	242	242	242	2
268	NaN	NaN	NaN	NaN	0	0	0	0	0	0	...	0	0	0	0	

and it will be continued to the present day

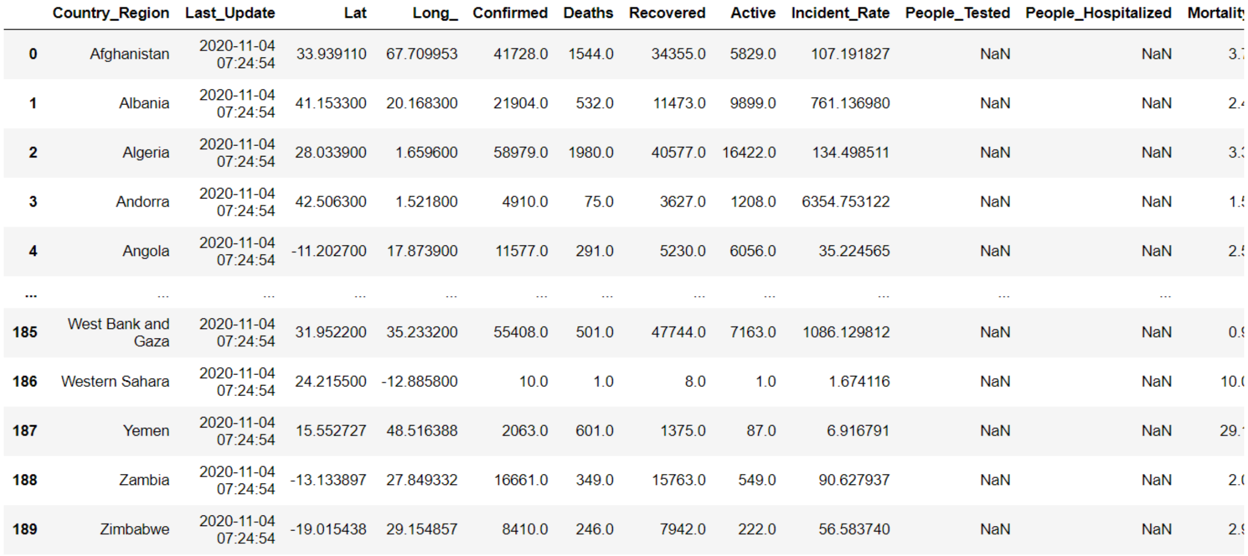
RECOVERED CASES:



	Province/State	Country/Region	Lat	Long	1/22/20	1/23/20	1/24/20	1/25/20	1/26/20	1/27/20	...	10/25/20	10/26/20	10/27/20	10/28/20	10/29/
0	NaN	Afghanistan	33.939110	67.709953	0	0	0	0	0	0	...	34129	34150	34217	34237	342
1	NaN	Albania	41.153300	20.168300	0	0	0	0	0	0	...	10654	10705	10808	10893	110
2	NaN	Algeria	28.033900	1.659600	0	0	0	0	0	0	...	39095	39273	39444	39635	396
3	NaN	Andorra	42.506300	1.521800	0	0	0	0	0	0	...	2729	2957	3029	3144	32
4	NaN	Angola	-11.202700	17.873900	0	0	0	0	0	0	...	3508	3530	3647	3693	37
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
251	NaN	Western Sahara	24.215500	-12.885800	0	0	0	0	0	0	...	8	8	8	8	
252	NaN	Yemen	15.552727	48.516388	0	0	0	0	0	0	...	1360	1360	1364	1366	13
253	NaN	Zambia	-13.133897	27.849332	0	0	0	0	0	0	...	15179	15445	15481	15559	155
254	NaN	Zimbabwe	-19.015438	29.154857	0	0	0	0	0	0	...	7797	7797	7804	7845	78
255	NaN	NaN	NaN	NaN	0	0	0	0	0	0	...	0	0	0	0	

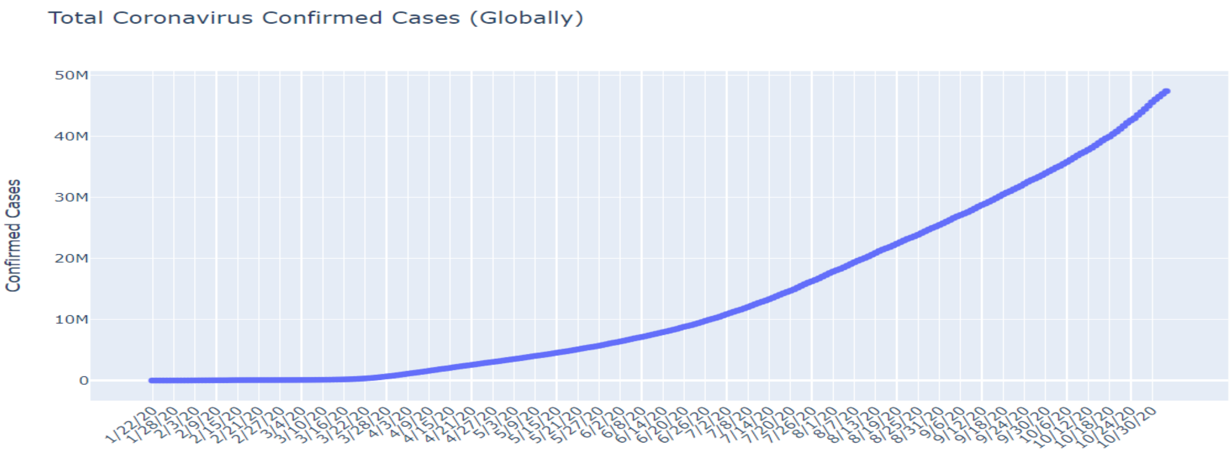
And it will be continued to the present day

COUNTRY WIDE CASES:

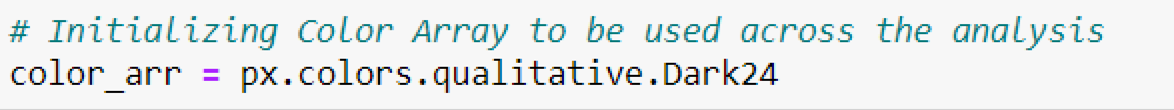


	Country_Region	Last_Update	Lat	Long_	Confirmed	Deaths	Recovered	Active	Incident_Rate	People_Tested	People_Hospitalized	Mortality
0	Afghanistan	2020-11-04 07:24:54	33.939110	67.709953	41728.0	1544.0	34355.0	5829.0	107.191827	NaN	NaN	3.7
1	Albania	2020-11-04 07:24:54	41.153300	20.168300	21904.0	532.0	11473.0	9899.0	761.136980	NaN	NaN	2.4
2	Algeria	2020-11-04 07:24:54	28.033900	1.659600	58979.0	1980.0	40577.0	16422.0	134.498511	NaN	NaN	3.3
3	Andorra	2020-11-04 07:24:54	42.506300	1.521800	4910.0	75.0	3627.0	1208.0	6354.753122	NaN	NaN	1.5
4	Angola	2020-11-04 07:24:54	-11.202700	17.873900	11577.0	291.0	5230.0	6056.0	35.224565	NaN	NaN	2.5
...	...	...	...	...	...	...	...	...	...	...	...	
185	West Bank and Gaza	2020-11-04 07:24:54	31.952200	35.233200	55408.0	501.0	47744.0	7163.0	1086.129812	NaN	NaN	0.9
186	Western Sahara	2020-11-04 07:24:54	24.215500	-12.885800	10.0	1.0	8.0	1.0	1.674116	NaN	NaN	10.0
187	Yemen	2020-11-04 07:24:54	15.552727	48.516388	2063.0	601.0	1375.0	87.0	6.916791	NaN	NaN	29.1
188	Zambia	2020-11-04 07:24:54	-13.133897	27.849332	16661.0	349.0	15763.0	549.0	90.627937	NaN	NaN	2.0
189	Zimbabwe	2020-11-04 07:24:54	-19.015438	29.154857	8410.0	246.0	7942.0	222.0	56.583740	NaN	NaN	2.9

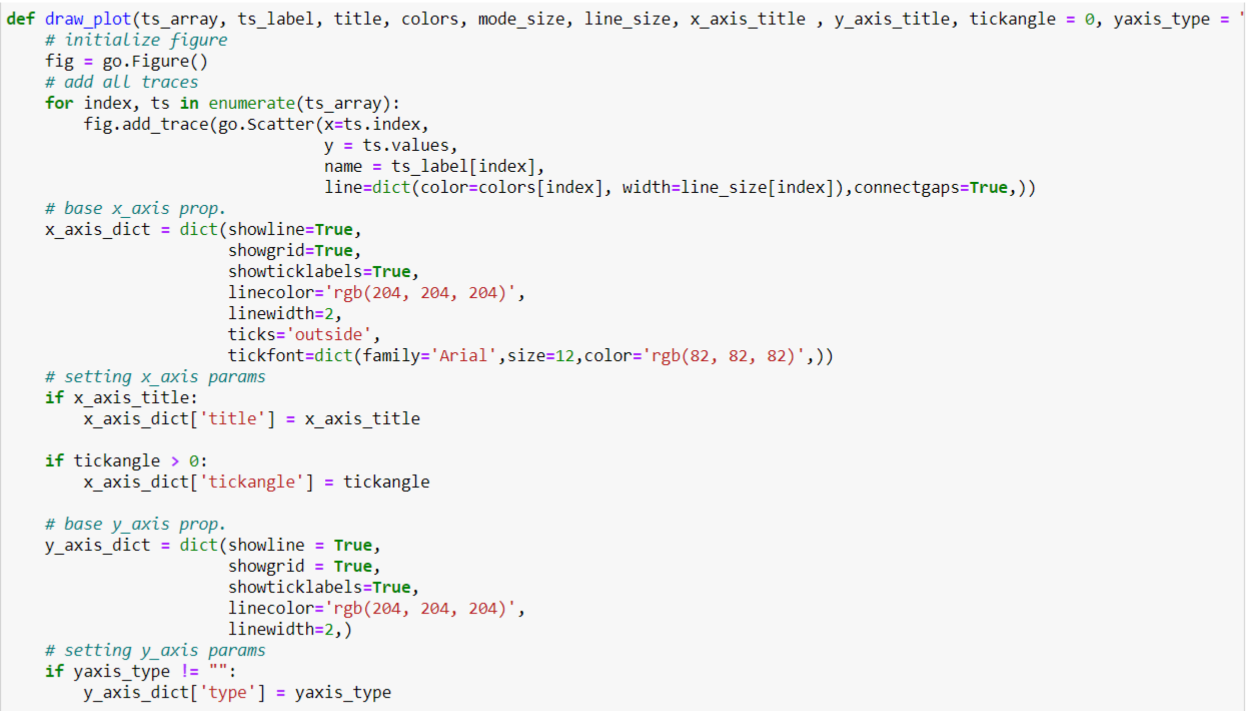
- So we successfully collected the required datasets but it has to be modelled in such a way that it can be visualized.
- In order to do that we have to undergo some advanced python coding and use some of the online resources which help us reach our desired result.
- So first we tried to eliminate the empty data values which we can see as NA or NaN because they shouldn’t be in a model which is going to undergo machine learning this process is called **imputing**.
- Next we tried to group all the data into one to plot the graphs required to visualize.
- Now we first tried to plot the total confirmed cases around the globe by removing the unnecessary data from the dataset we have and arrived at the graph shown below:



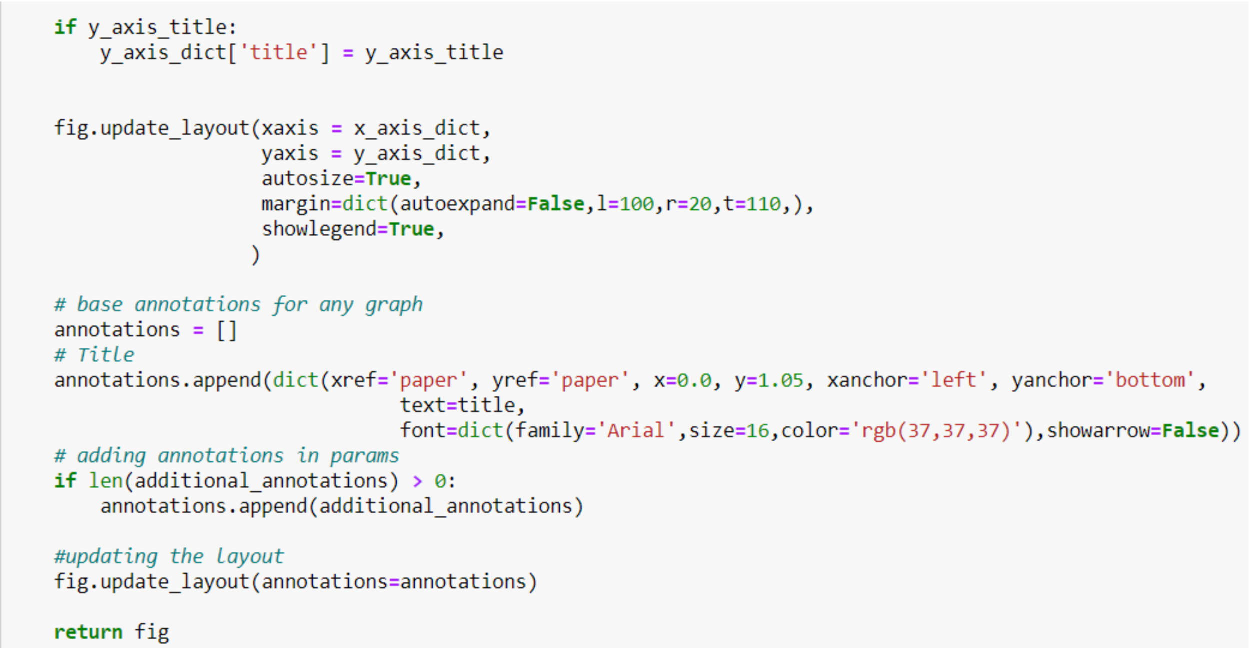
- Now we started working on how to create a custom plot function with the help of the online resources and also understood what is color array and how it is useful in plotting the graph.



```
# Initializing Color Array to be used across the analysis
color_arr = px.colors.qualitative.Dark24
```



```
def draw_plot(ts_array, ts_label, title, colors, mode_size, line_size, x_axis_title , y_axis_title, tickangle = 0, yaxis_type = '
    # initialize figure
    fig = go.Figure()
    # add all traces
    for index, ts in enumerate(ts_array):
        fig.add_trace(go.Scatter(x=ts.index,
                                 y = ts.values,
                                 name = ts_label[index],
                                 line=dict(color=colors[index], width=line_size[index]),connectgaps=True,))
    # base x_axis prop.
    x_axis_dict = dict(showline=True,
                       showgrid=True,
                       showticklabels=True,
                       linecolor='rgb(204, 204, 204)',
                       linewidth=2,
                       ticks='outside',
                       tickfont=dict(family='Arial',size=12,color='rgb(82, 82, 82)',))
    # setting x_axis params
    if x_axis_title:
        x_axis_dict['title'] = x_axis_title

    if tickangle > 0:
        x_axis_dict['tickangle'] = tickangle

    # base y_axis prop.
    y_axis_dict = dict(showline = True,
                       showgrid = True,
                       showticklabels=True,
                       linecolor='rgb(204, 204, 204)',
                       linewidth=2,)
    # setting y_axis params
    if yaxis_type != "":
        y_axis_dict['type'] = yaxis_type
```



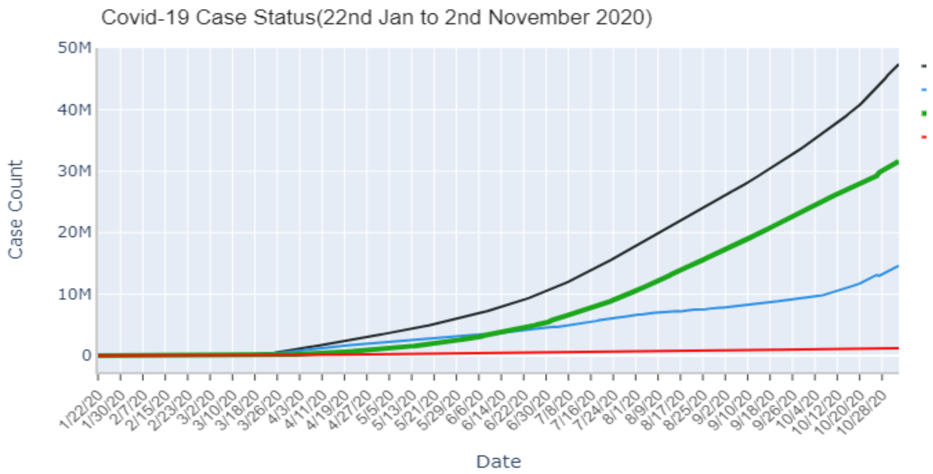
```
    if y_axis_title:
        y_axis_dict['title'] = y_axis_title


    fig.update_layout(xaxis = x_axis_dict,
                      yaxis = y_axis_dict,
                      autosize=True,
                      margin=dict(autoexpand=False,l=100,r=20,t=110,),
                      showlegend=True,
                     )

    # base annotations for any graph
    annotations = []
    # Title
    annotations.append(dict(xref='paper', yref='paper', x=0.0, y=1.05, xanchor='left', yanchor='bottom',
                            text=title,
                            font=dict(family='Arial',size=16,color='rgb(37,37,37)'),showarrow=False))
    # adding annotations in params
    if len(additional_annotations) > 0:
        annotations.append(additional_annotations)

    #updating the layout
    fig.update_layout(annotations=annotations)

    return fig
```

With this we arrived at creating a custom plot function.

- Now we tried to analyze the total active cases count on each day the problem that we faced here is there is no dataset of active cases in our list so we found out the active cases using the formula

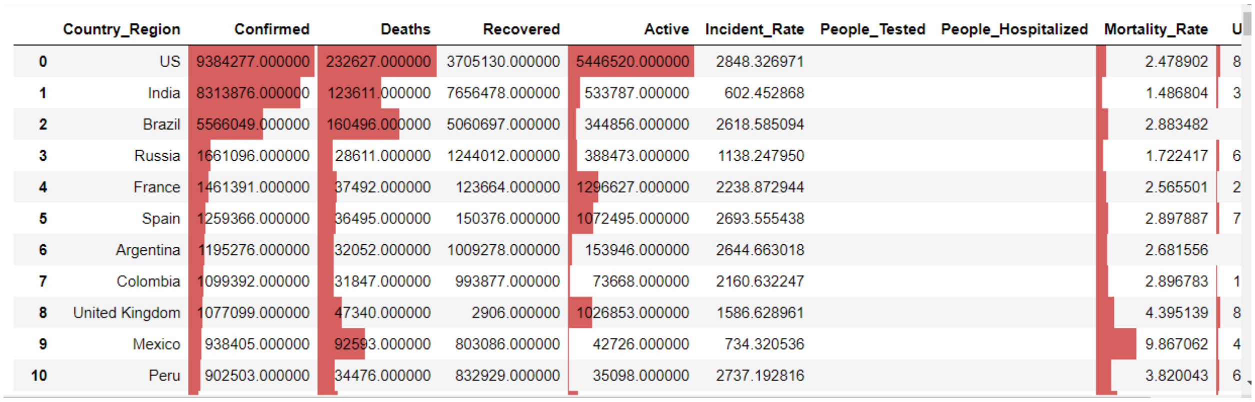
  Active_cases = Confirmed_cases – deaths – recovered.

- We tried to plot these active cases using our custom plot function and you can observe the figure shown below:



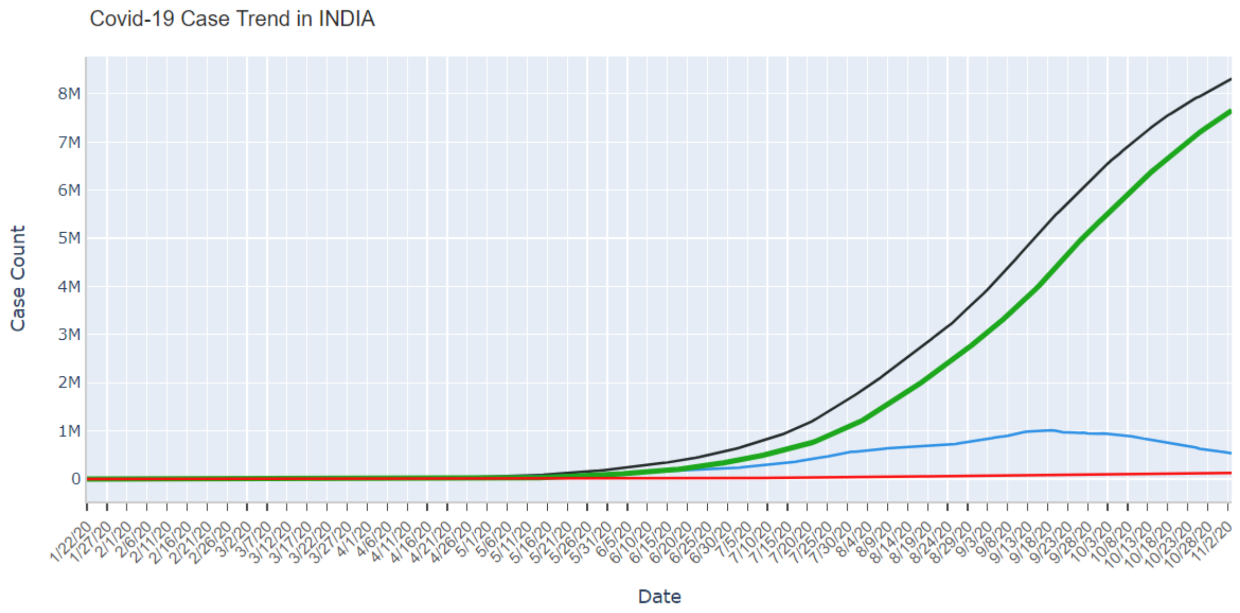
Covid-19 Case Status(22nd Jan to 2nd November 2020)

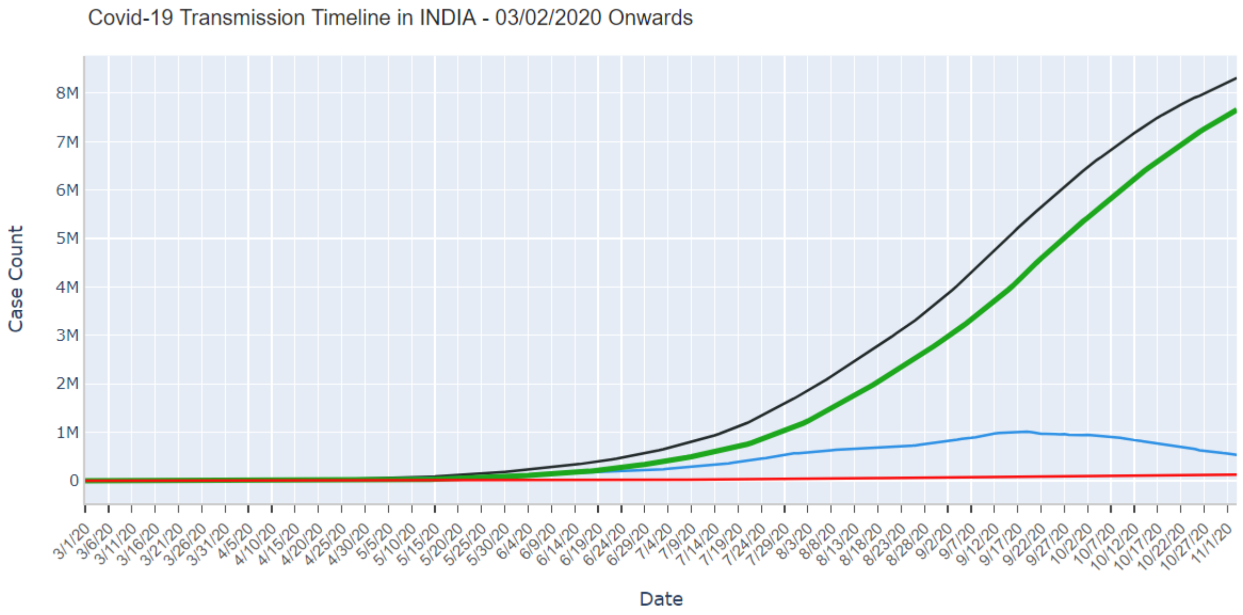
- Here we tried to give total case count of confirmed, deaths, recovered of all the countries summed up.

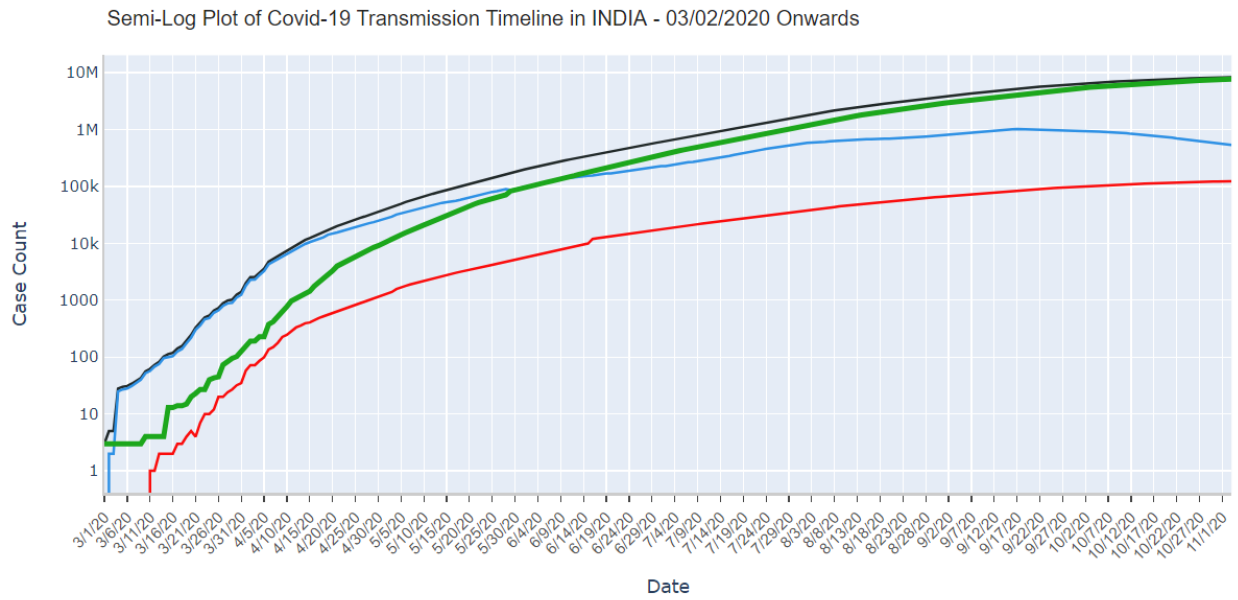


	Country_Region	Confirmed	Deaths	Recovered	Active	Incident_Rate	People_Tested	People_Hospitalized	Mortality_Rate	U
0	US	9384277.000000	232627.000000	3705130.000000	5446520.000000	2848.326971			2.478902	8
1	India	8313876.000000	123611.000000	7656478.000000	533787.000000	602.452868			1.486804	3
2	Brazil	5566049.000000	160496.000000	5060697.000000	344856.000000	2618.585094			2.883482	
3	Russia	1661096.000000	28611.000000	1244012.000000	388473.000000	1138.247950			1.722417	6
4	France	1461391.000000	37492.000000	123664.000000	1296627.000000	2238.872944			2.565501	2
5	Spain	1259366.000000	36495.000000	150376.000000	1072495.000000	2693.555438			2.897887	7
6	Argentina	1195276.000000	32052.000000	1009278.000000	153946.000000	2644.663018			2.681556	
7	Colombia	1099392.000000	31847.000000	993877.000000	73668.000000	2160.632247			2.896783	1
8	United Kingdom	1077099.000000	47340.000000	2906.000000	1026853.000000	1586.628961			4.395139	8
9	Mexico	938405.000000	92593.000000	803086.000000	42726.000000	734.320536			9.867062	4
10	Peru	902503.000000	34476.000000	832929.000000	35098.000000	2737.192816			3.820043	6

- Now we started our focus mainly on INDIA and tried to visualize the data whatever we have related to it


Covid-19 Case Trend in INDIA


Covid-19 Transmission Timeline in INDIA - 03/02/2020 Onwards

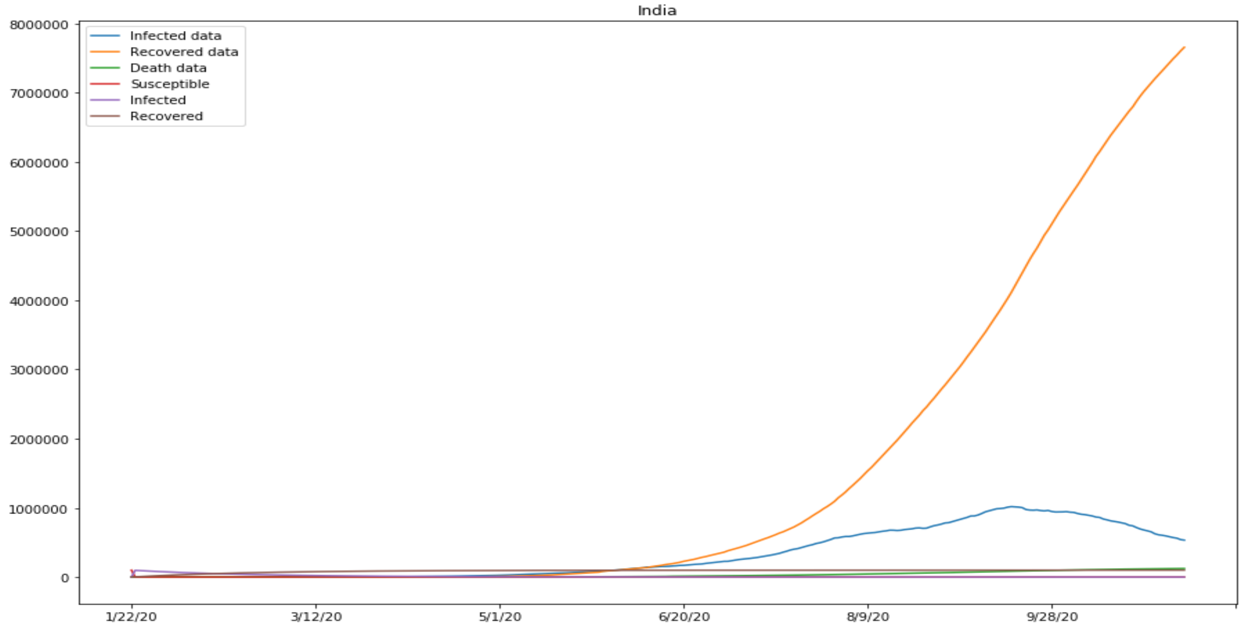


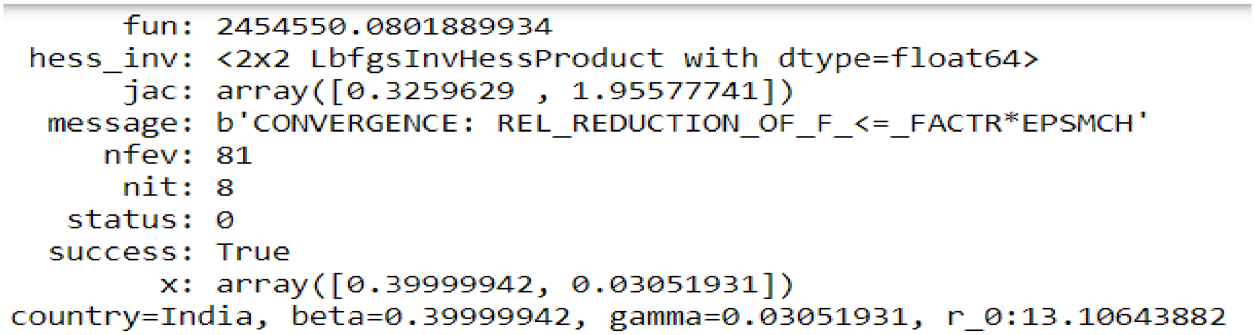
- Now we started making a predictive SIR model with using L-BFGS-B(large scale bound constrained optimization) for comparing different variables and the SIR model that is used is differential equation model.

What is a SIR model?

The **SIR** model is a simple mathematical model of epidemics. An epidemic is when the number of people infected with a disease is increasing in a population. S, I, and R stand for: S – susceptible, I – infected, R – recovered.

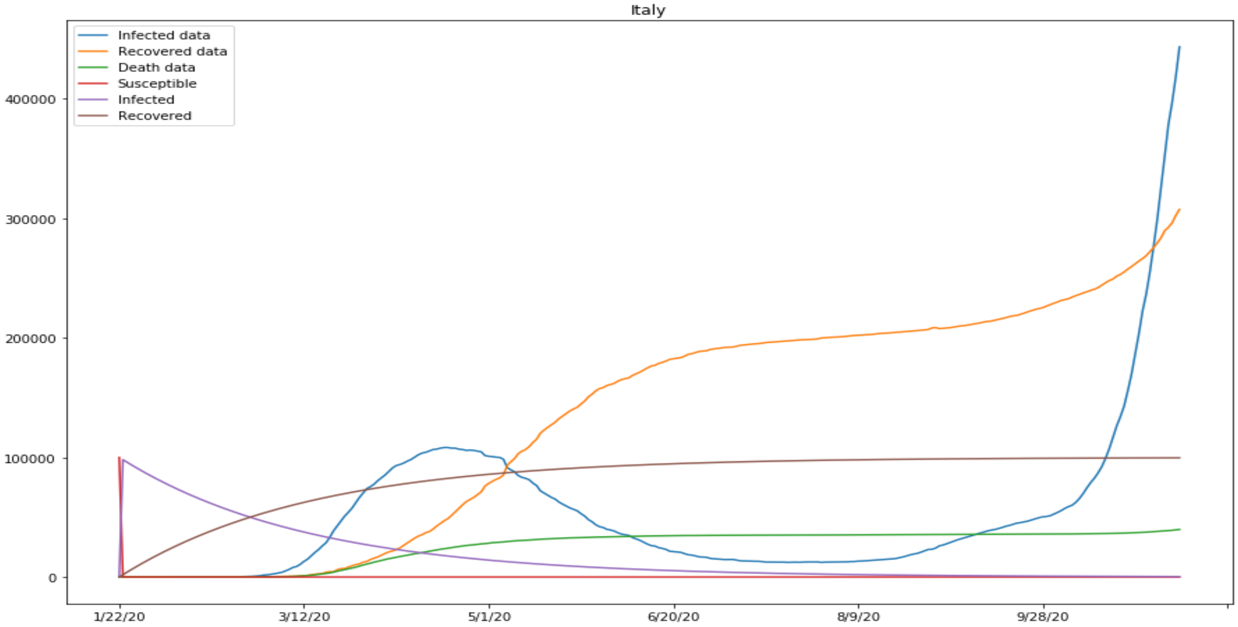
SIR MODEL PREDICTION FOR INDIA

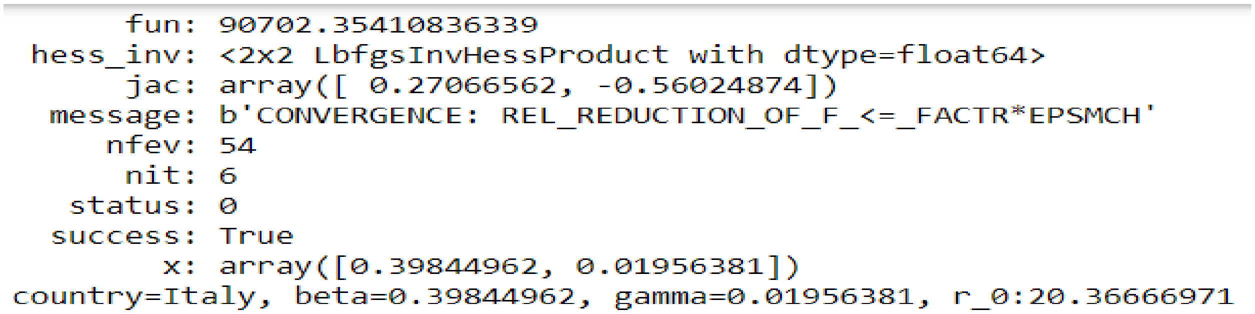




```
      fun: 2454550.0801889934
 hess_inv: <2x2 LbfgsInvHessProduct with dtype=float64>
      jac: array([0.3259629 , 1.95577741])
  message: b'CONVERGENCE: REL_REDUCTION_OF_F_<=_FACTR*EPSMCH'
     nfev: 81
      nit: 8
   status: 0
  success: True
        x: array([0.39999942, 0.03051931])
country=India, beta=0.39999942, gamma=0.03051931, r_0:13.10643882
```

SIR MODEL PREDICTION FOR ITALY





```
      fun: 90702.35410836339
 hess_inv: <2x2 LbfgsInvHessProduct with dtype=float64>
      jac: array([ 0.27066562, -0.56024874])
  message: b'CONVERGENCE: REL_REDUCTION_OF_F_<=_FACTR*EPSMCH'
     nfev: 54
      nit: 6
   status: 0
  success: True
        x: array([0.39844962, 0.01956381])
country=Italy, beta=0.39844962, gamma=0.01956381, r_0:20.36666971
```

CONCLUSION

As our model has shown an increase in the rise of cases in INDIA the country has to take utmost measures in order to stop this pandemic COVID-19 or else there will be a huge risk ahead. However as our plots shown the number of recovered people is rising gradually so we can understand that the people are starting to develop immunity in their bodies which helps in fighting the COVID-19 as we can also see that the number of deaths are decreasing so we can predict that the world is getting back to normal state but this has to be continued till the arrival of the corona virus vaccine.

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THANK YOU.