Corona Analyzer

Dr. Amit Garg, Founder and Chief Scientist, ORMAE

Metta Sai Siddhartha, Data Scientist II, ORMAE

Executive Summary:

The epidemic outbreaks in many countries caused by coronavirus COVID-19 are of great concern. As of 30 April 2020, it has infected over a 3 million humans, killed around 230,000 individuals, and has brought most of the world to a standstill in lockdowns. During this anti-epidemic battle, besides medical and biological research, theoretical studies based on either statistics or mathematical modeling may also play a non-negligible role in understanding the epidemic characteristics of the outbreak, in forecasting the infection point and ending time, and in deciding the measures to curb the spreading. A detailed scientific analysis of this phenomenon is still to come, but currently there is an immediate need to evaluate the parameters of the disease dynamics in order to organize the appropriate quarantine measures, to estimate the required number of places in hospitals, etc. by the respective nations. The corresponding mathematical models must be simple enough, since their parameters are unknown and must be estimated using limited statistical data sets. Here we present Corona Analyzer application which uses the classic deterministic SEIRD model to comprehend the current situation and show how it will affect different countries in near future.
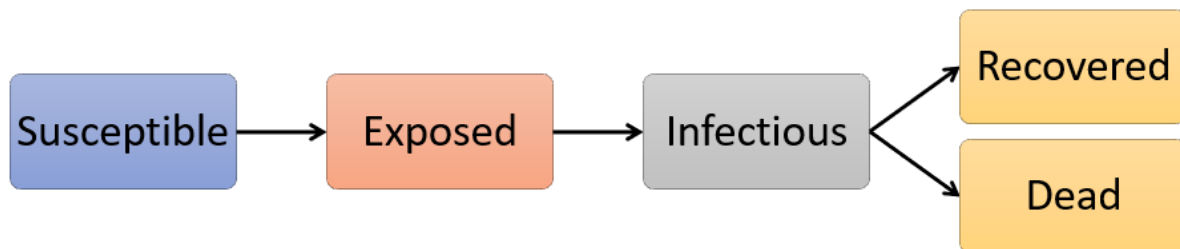
Introduction:

On 31 December 2019, the first reported case in the COVID-19 outbreak was reported in Wuhan, China. Since then, this ongoing outbreak has now spread to more than 100 other countries. The Corona Analyzer application consists of a model that captures the information from the historical data well and thereby makes relevant prediction for the number of active and death cases for the future under various restriction conditions of a country.

Features of Corona-Analyzer:

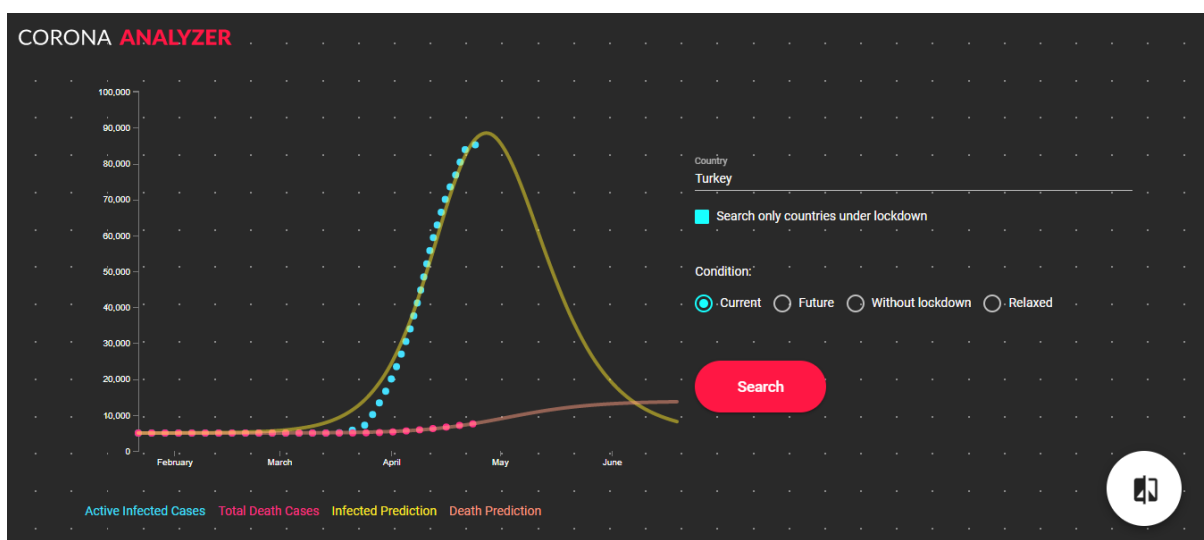| Prognosis of Active infected cases and total deaths under (over a 5-month period)	Country under lockdown?	
	Yes	No
Prevailing conditions	✔	✔
Without lockdown conditions	✔	✖
Imposing further restrictions	✔	✔
Relaxing current restrictions	✔	✖

Dynamic Predictive Modelling – SEIRD Model:

The model used for forecasting is SEIRD model which is a slight modification on the basic pandemic model SIR (used by WHO). Here the model consists of 5 components namely Susceptible(S), Exposed(E), Infectious(I), Recovered(R) and Dead(D).
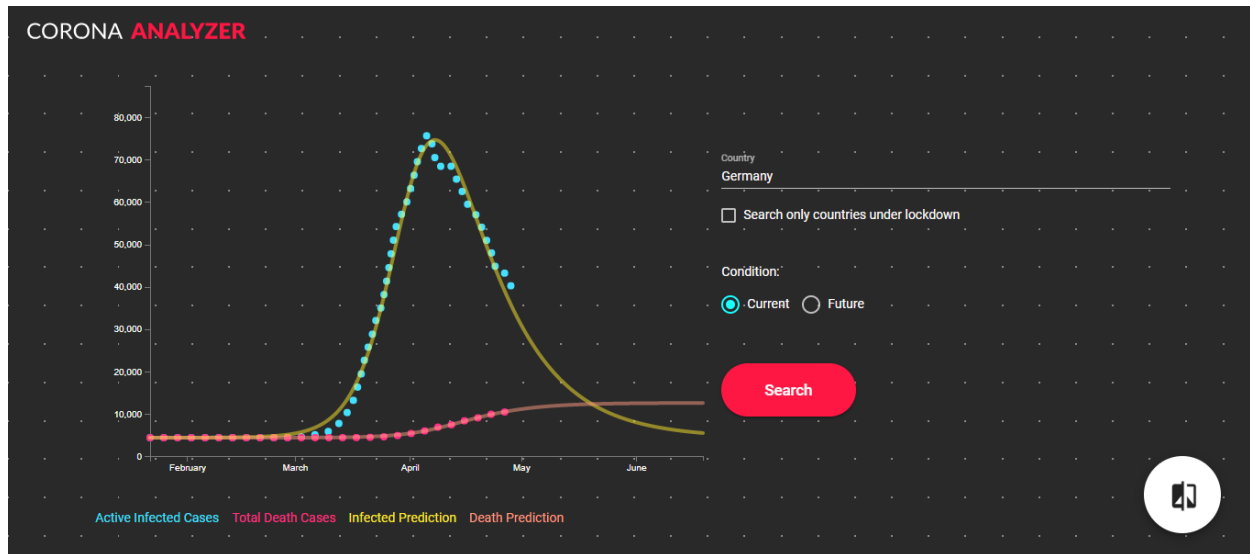

SEIRD model consists of a set of differential equations which describe the rate at which individual moves between compartments under certain assumptions. Iteratively solving this system of Ordinary differential equations, selection of initial parameters of the individual compartments and by defining a minimizer function, we obtain the best fitted curve for which the objective function yields least deviation from the real data. The corresponding model parameters which are obtained help in predicting the epidemic situation in future.

Results and Analysis:

In the following figures, we can observe that our model fits the a*ctive infected and death data* for the corresponding countries and forecast for near future.
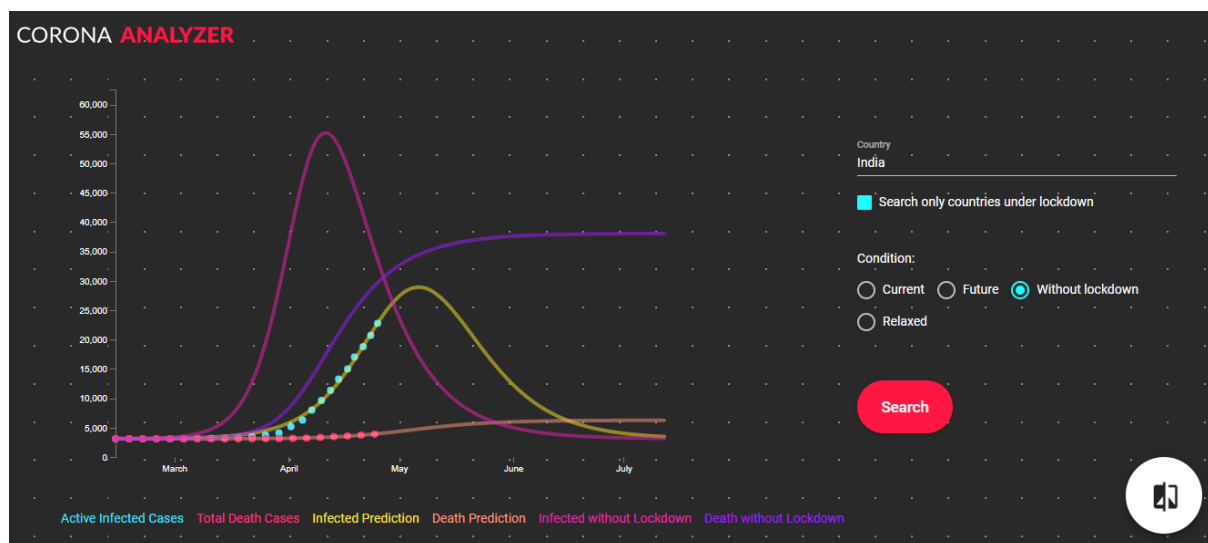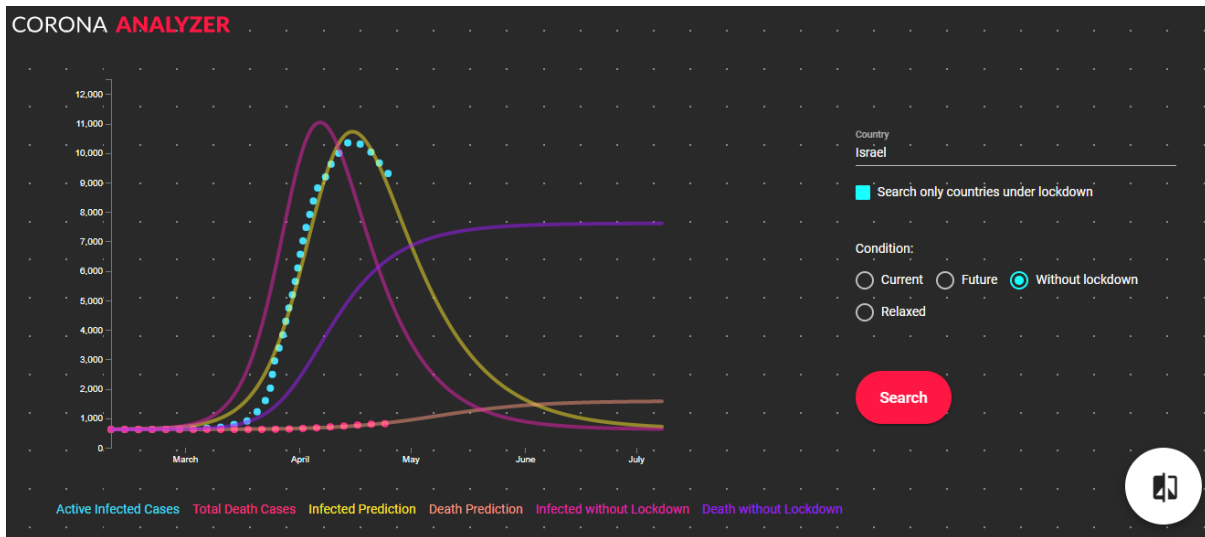

Expected Peak	End by 97%	End by 99%
28-04-2020	04-06-2020	15-06-2020

Expected Peak	End by 97%	End by 99%
08-04-2020	25-05-2020	06-06-2020

Also, we can check different hypothetical scenarios if we impose some restrictions. In some country's lockdown has already started, our model suggests how devastating the situate ion of those countries could have been if they would not have taken preventive measures. The following countries taken under consideration are India and Israel. We can see how the countries' situation could get worsen and social distancing factor came into play. Due to lockdown the possible total number of infected and death cases deflated.
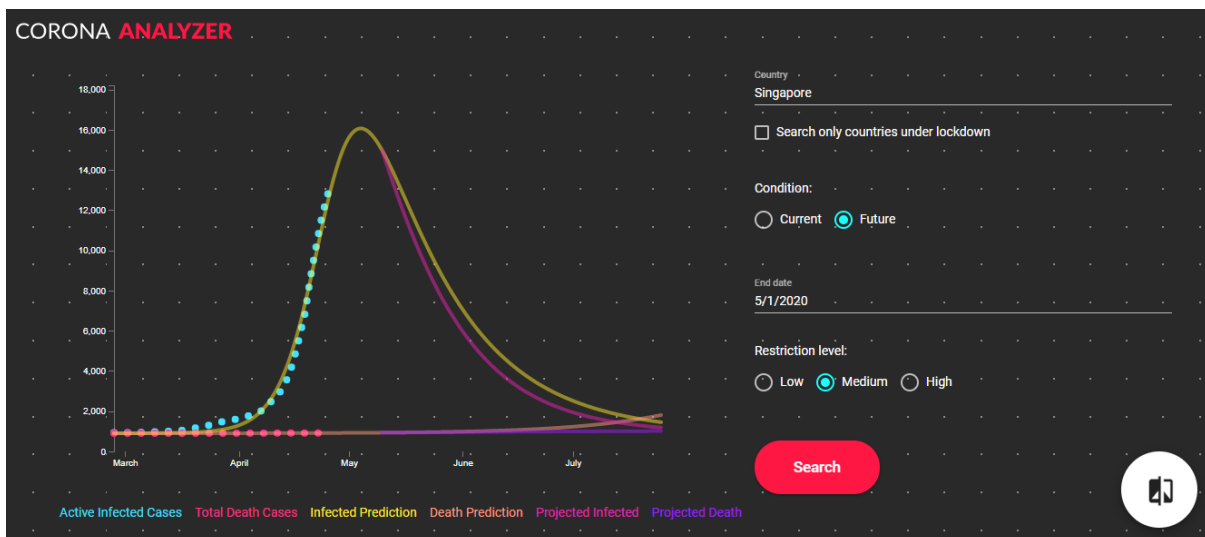

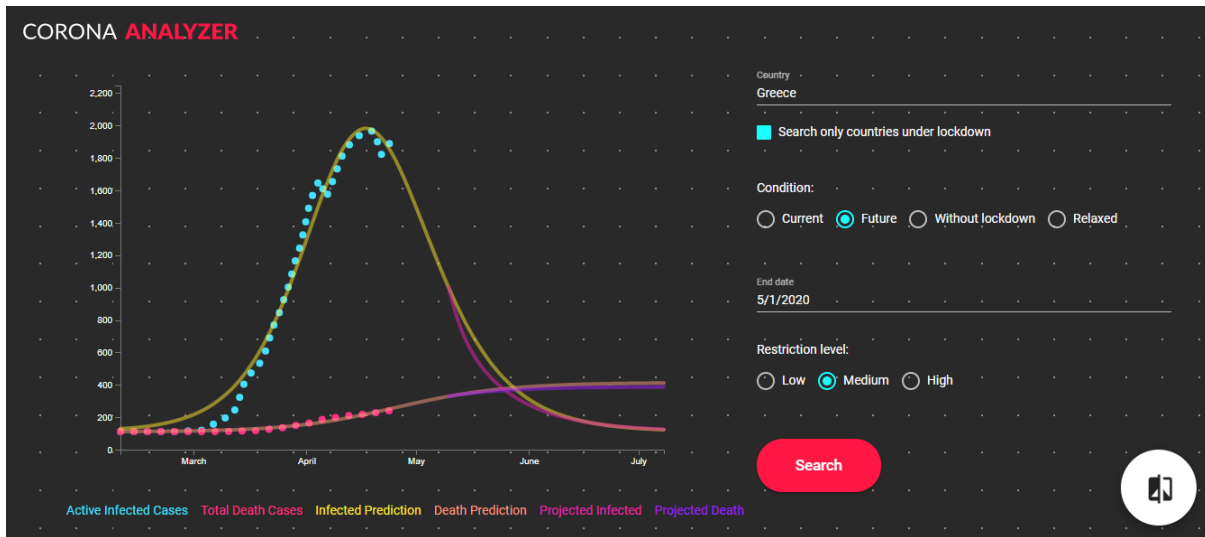| Expected Peak	End by 97%	End by 99%
05-05-2020	15-06-2020	27-06-2020

Expected Peak	End by 97%	End by 99%
15-04-2020	06-06-2020	17-06-2020

In some countries, lockdown dates are still, and some possible dates are taken under consideration. Some countries with lockdown may want to take more restricted precautions. We try to portray those circumstances with the order of restriction being in the hand of the user. Following are some examples of such scenarios.
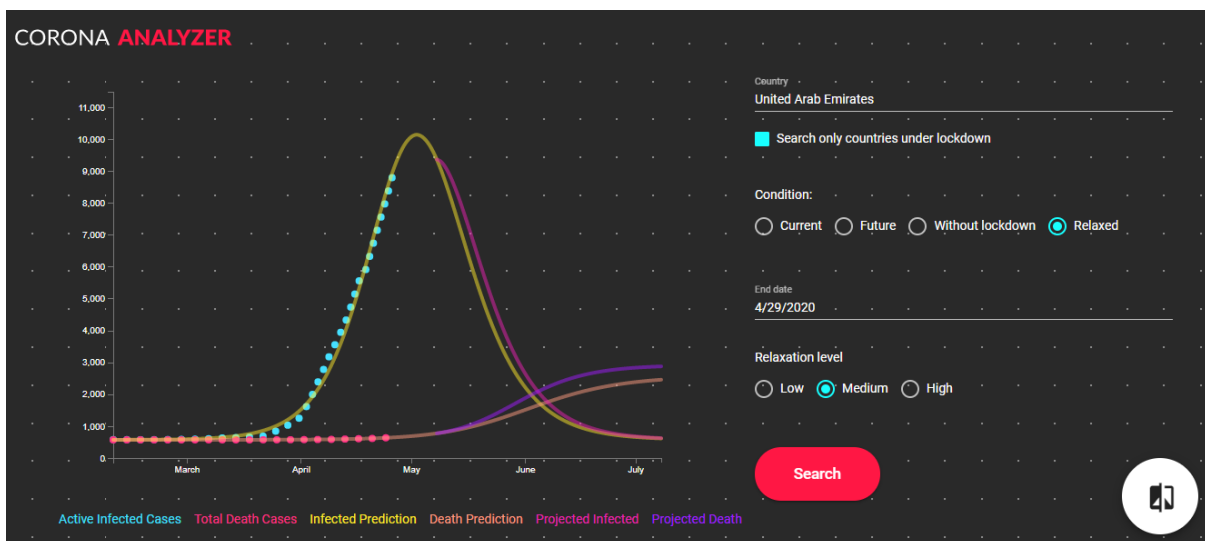

Expected Peak	End by 97%	End by 99%
04-05-2020	03-07-2020	15-07-2020

Expected Peak	End by 97%	End by 99%
17-04-2020	31-05-2020	13-06-2020

Whereas, in some other countries the current lockdown state is planned to be relaxed due to different economical or domestic issues. The following examples show the scenario where the lockdown restrictions are relaxed from given day.

Expected Peak	End by 97%	End by 99%
03-05-2020	06-06-2020	17-06-2020

Expected Peak	End by 97%	End by 99%
04-05-2020	04-06-2020	14-06-2020

Conclusions:

The characteristics of the coronavirus epidemic outbreak in the different countries were estimated using the SEIRD model and statistical methods of the parameter identification. It seems that the secret of success lies in the rapid isolation of patients.

References:

1. WHO research: https://www.who.int/bulletin/online_first/20-255695.pdf

2. Covid-19 data: https://github.com/ExpDev07/coronavirus-tracker-api

3. Population data: https://github.com/samayo/country-json

4. Guide to epidemiology: https://en.wikipedia.org/wiki/Compartmental_models_in_epidemiology

5. SEIRD Model: https://www.nature.com/articles/srep08751.pdf, https://staff.math.su.se/tom.britton/papers/stochmod4.pdf