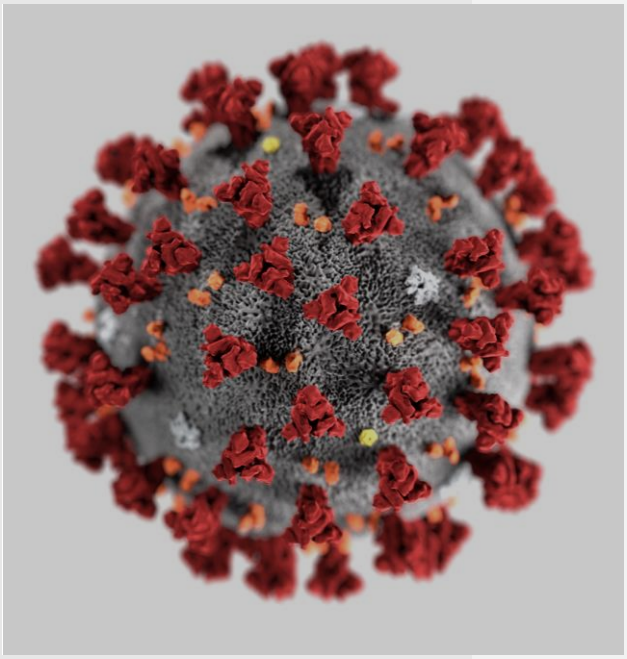


Project Report

Stay at Home

Halil Umut ÖZDEMİR

Umut KOCASARI

İbrahim ORHAN

Atakan DEMİRKAN

Introduction

Coronavirus disease 2019 (COVID-19) is the third coronavirus infection in two decades that was originally described in Asia, after severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). As the COVID-19 pandemic spreads worldwide, intensive care unit (ICU) practitioners, hospital administrators, governments, policy makers, and researchers must prepare for a surge in critically ill patients. We aim to provide an estimation about the effects of spreading COVID cases by evaluating in light of the usage and capacity of intensive care units (ICU) in Turkey.

Timeline of the Project

01 Data Collection

We collected reliable data about COVID spread, cases, deaths and the usages of ICUs from the world.

02 Estimation

We made estimates about the future of COVID-19 in Turkey with the help of machine learning algorithms.

03 Modeling & Simulation

We created a model that explain the ICU system. Then we simulated this model.

04 Analyzing

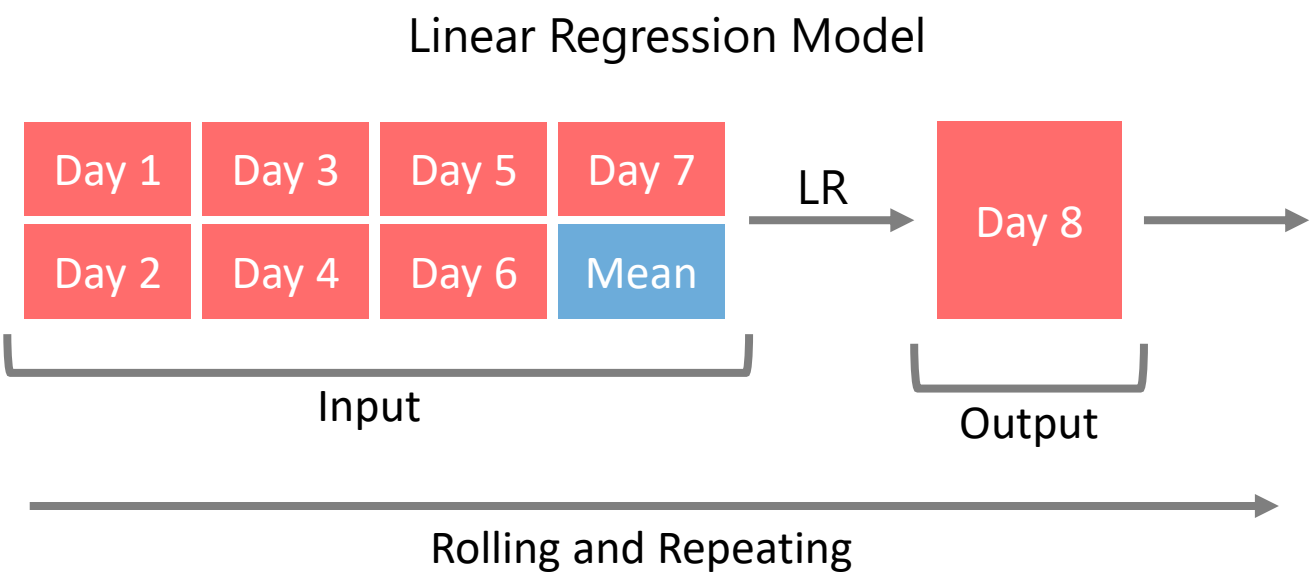
We analyzed the result of simulation.

Estimation

The first step of the project is estimation of number of COVID-19 cases in Turkey. We found that linear regression is the most suitable estimation method among all estimation methods according to R2 test, MSE,MAE metrics.

After the selection of estimation method, we made two linear regression(LR). Both LR perceives last 7 days case data and their average as inputs. The reason of using last 7 days data is that the symptoms of disease appear. In additon, to make model more stable, we made feature extraction by adding last mean value of 7 days After the estimation 8th day data, LR was made sequentially by rolling of days. As a result, we acquire the estimation of next 50 days case data for Turkey.

The difference between first and second LRs is whether Turkey is a succesful country in manner of battle of COVID or not. While second LR used data from countries that have high case increase rate, first LR perceives Turkey as an average country and includes data from all around the world. In second LR, we used clustering algorithms to determine the worst countries.



After two linear regression, we create the average and worst case data for Turkey to using simulation. The reason of making 2 linear regression is the measure of Turkey's ICU performance in different scenerios.

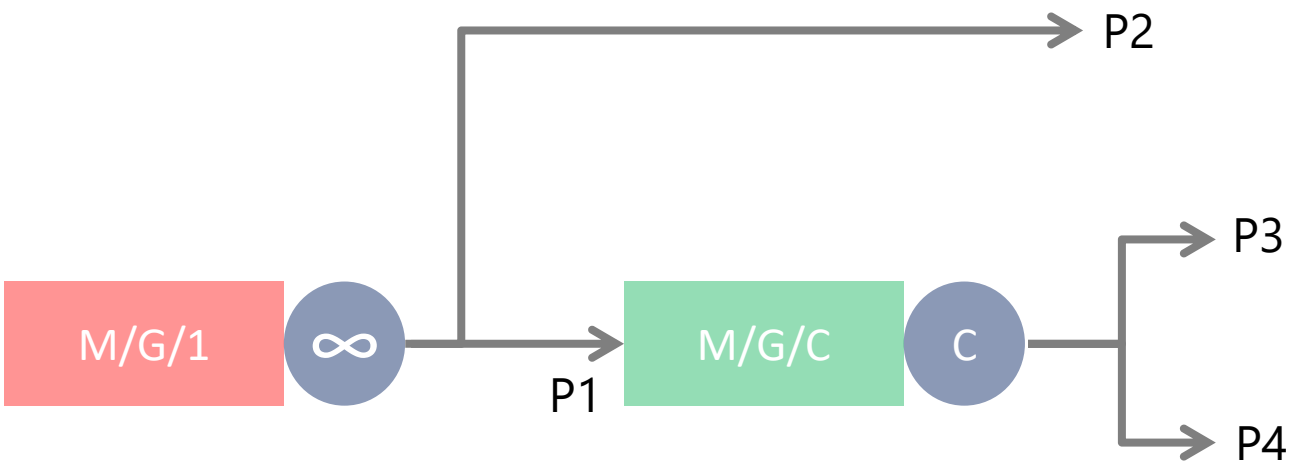
Technical details can be found our Jupyter Notebook.

Simulation

To explain the ICU system in Turkey, we created a queue model. The queue contains two server. The first queue in the system represents the COVID positive patients in Turkey. People who are infected wait at home until they shows symptom. While some people pull through the ilness without going to hospital (P2), ingravescent people are hospitalized and are taken to intensive care (P1). The second queue represents the infected people that treat in ICU system. Some of people in ICU unfornutanely die (P3) and remaining people can survive (P4).

In this simulation we assume that the arrival process of the patients to the hospital is a Poisson process. Because in the estimation we make, we take into account the effects between 2 patients. So in the simulation, probability of a new COVID positive patient is independent from other patients. Because the time between 2 poisson processes is an exponential distribution random variable, we use exponential distribution.

There is no restriction in the number of people who are infected(∞). However, the capacity of intensive care unit in Turkey is finite.(C)



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Assumptions

Assumptions of Clustering Part

* We look at countries which have cases more than 100 for more than 30 days. Because when we review the total case plots of countries, after 100th case the plots get stabilized. So We assume that a country really has epidemic inside if that country has cases more than 100. The 30 day threshold comes from the timeline of the epidemic in Turkey.

* Because we use the mean of the ratios in 7 days period in countries, numbers less than 10 may give exaggerated and false rates, so we ignore them.

* We assume that the worst group of this clustering algorithm has the lowest prevention for the epidemic.

Simulation

* We assume that the interarrival times of the patients is exponential distribution with the mean which is calculated by the prediction part of the project. This mean value changes day by day with respect to the output of the prediction algorithm.

* Other interarrival time values are found as data whose sources can be found from the `README.md` file of our repository.

* We assume that If a patient has to go ICU bu ICU capacity is full, this patient dies.

Turkey

* We assume that all ICU can be accessible from everywhere in Turkey.

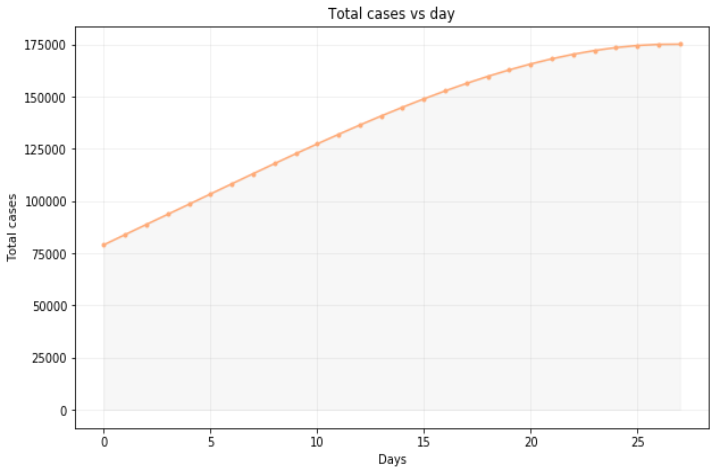
Istanbul

* We assume that 58.05% of the cases in the Turkey is and will be in the Istanbul during the duration of the epidemic. We calculate this ratio from the official total case values of Istanbul.

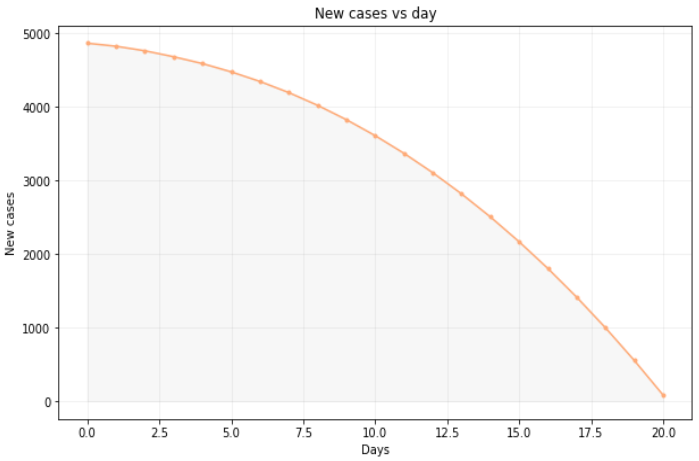
* We assume that 58.05% of the ICU patients in the Turkey is in the Istanbul.

Turkey- Average Case Plots

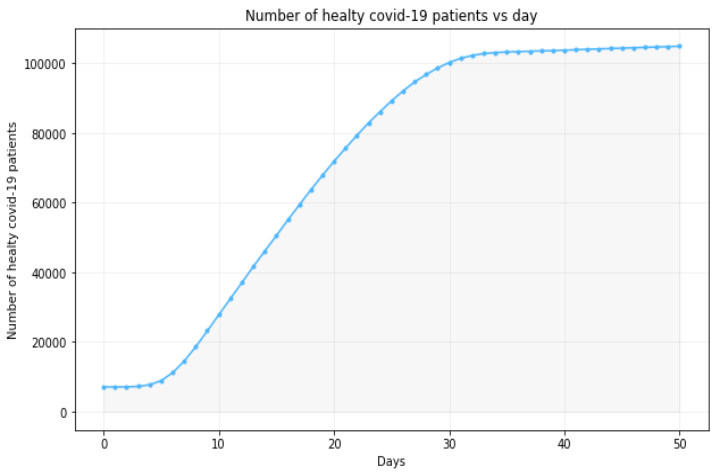
Total Cases



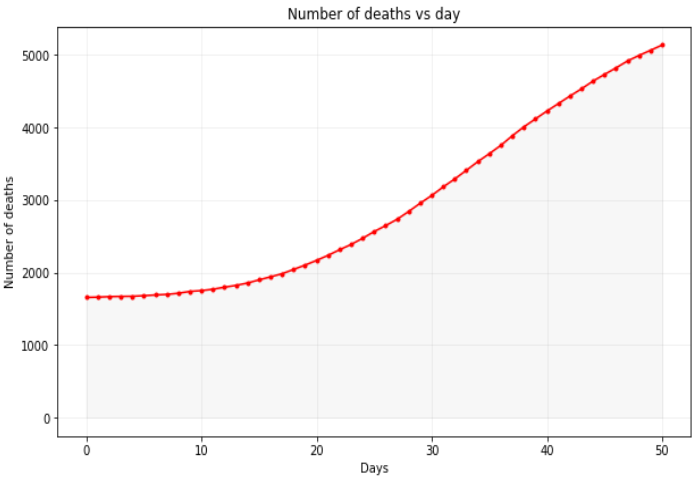
New Cases



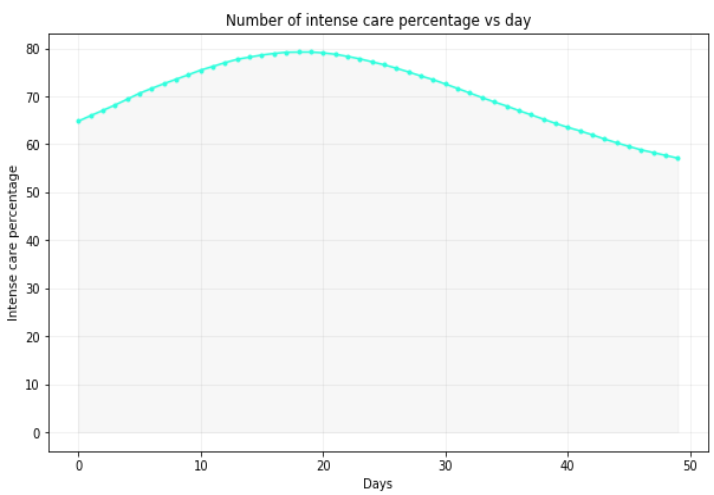
of Healthy Covid Patients



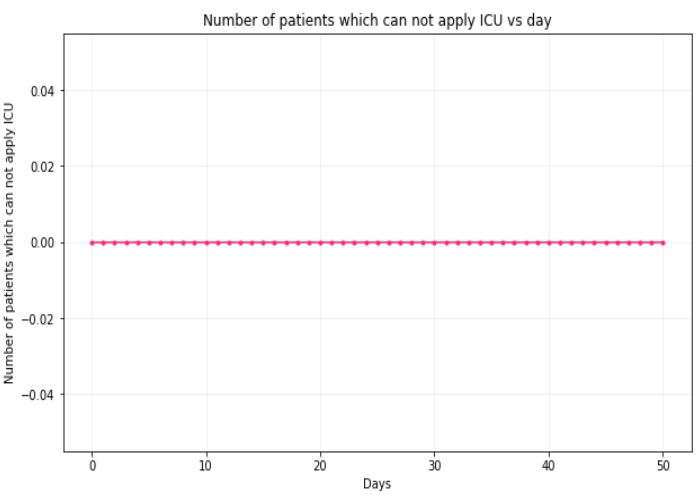
of Deaths



% of ICU Usage

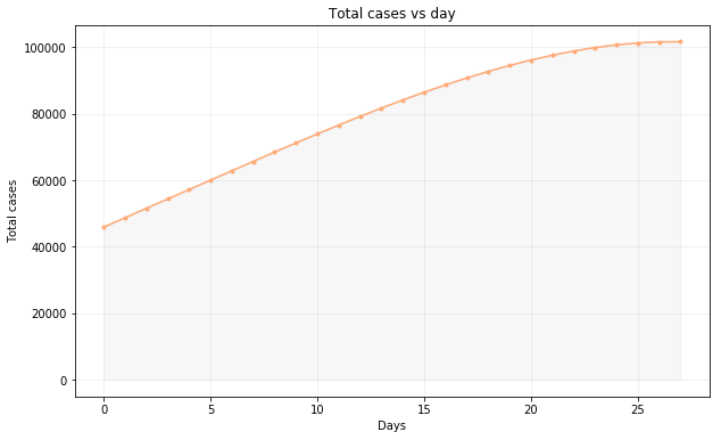


of Patients who can’t apply ICU

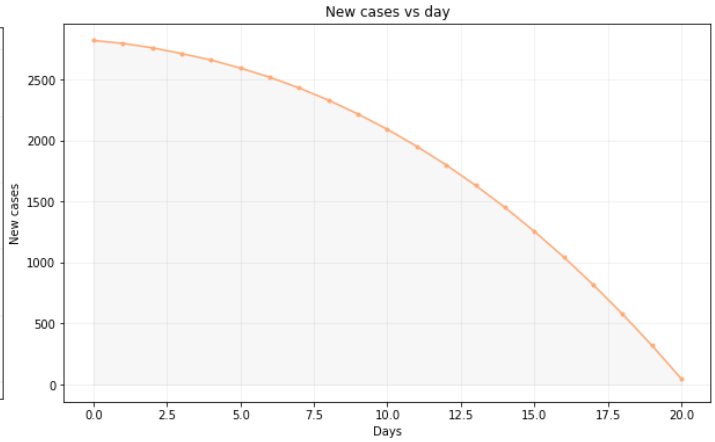


İstanbul- Average Case Plots

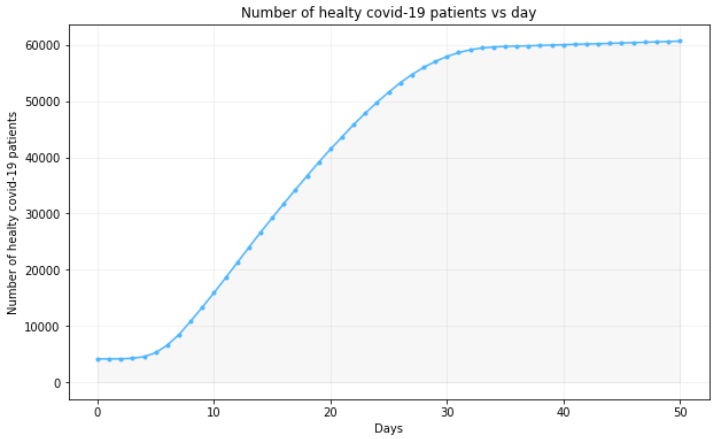
Total Cases



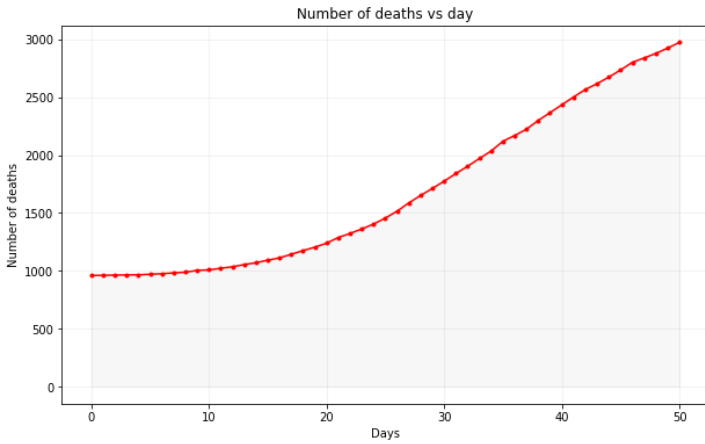
New Cases



of Healthy Covid Patients



of Deaths



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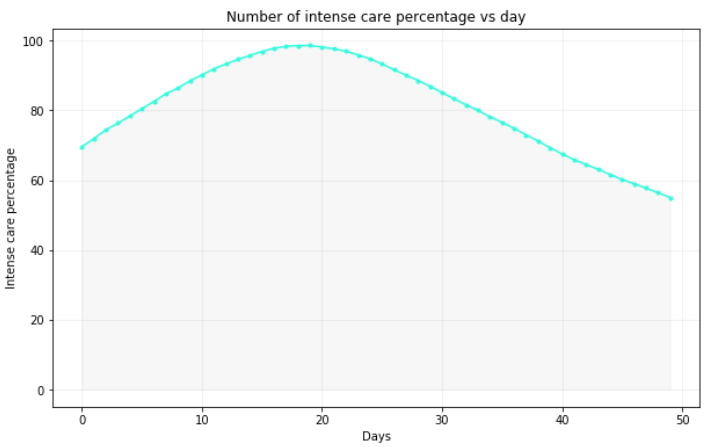

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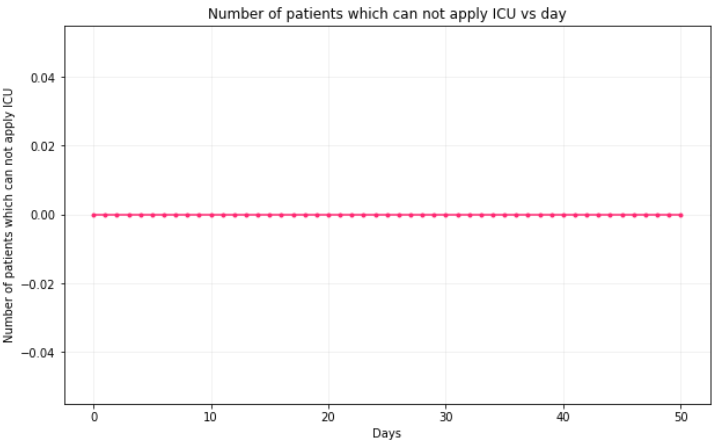
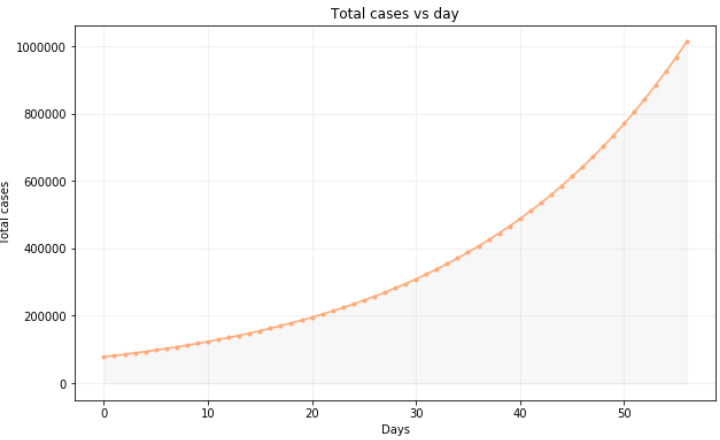
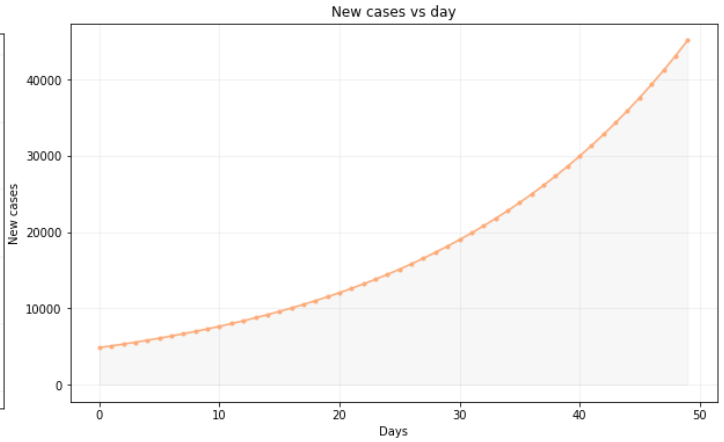


Turkey- Worst Case Plots

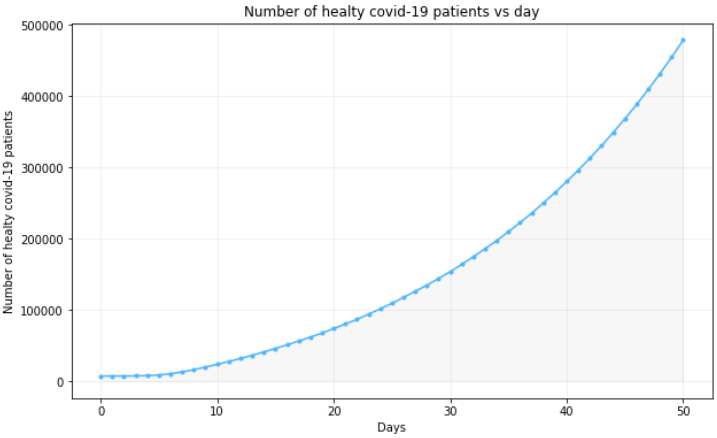
Total Cases



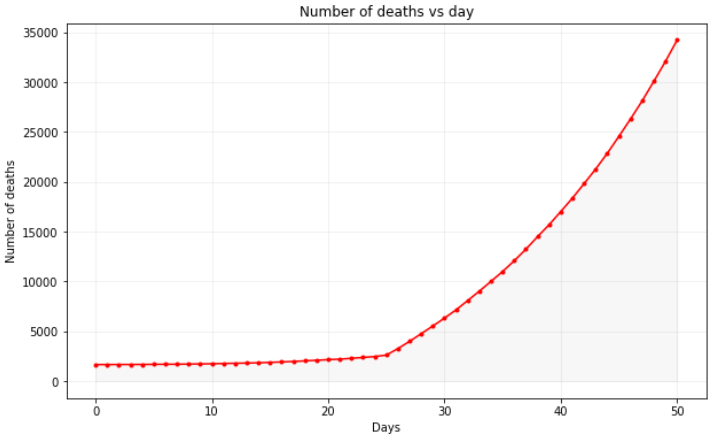
New Cases



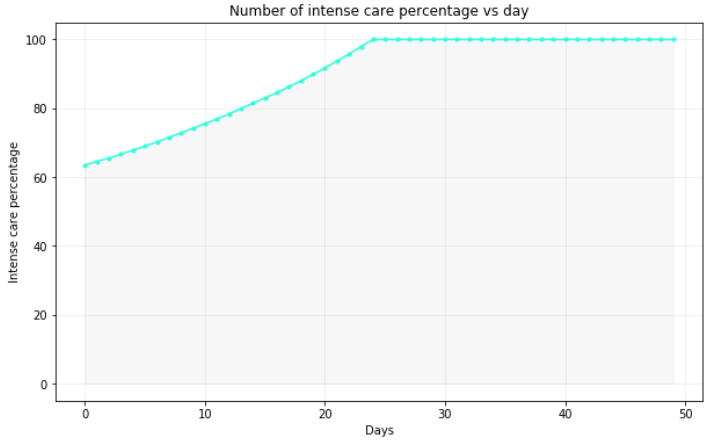
of Healthy Covid Patients



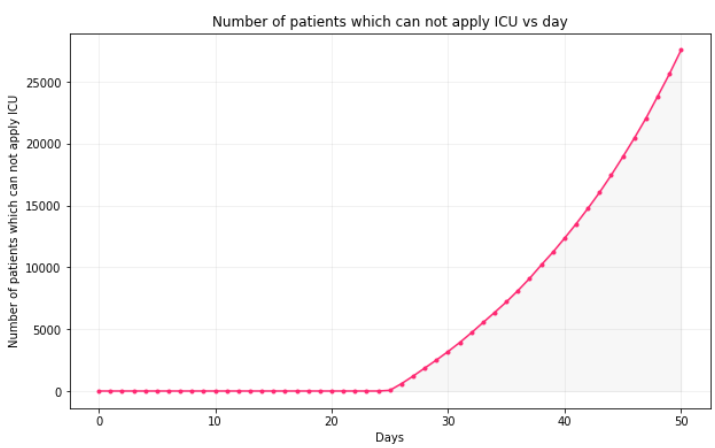
of Deaths



% of ICU Usage

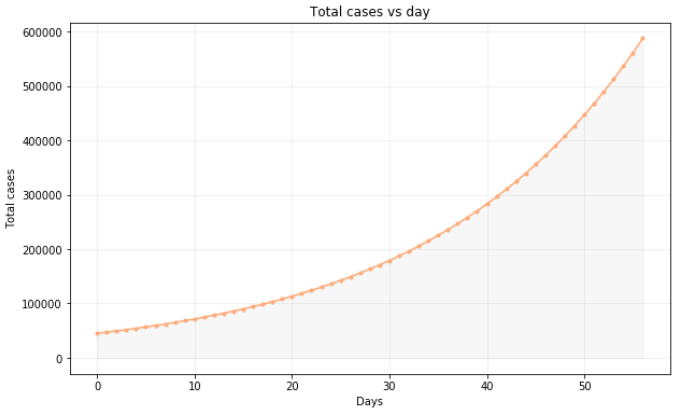


of Patients who can’t apply ICU

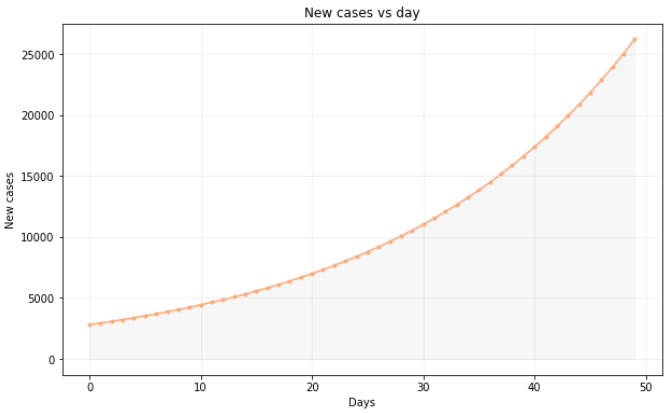


İstanbul- Worst Case Plots

Total Cases



New Cases



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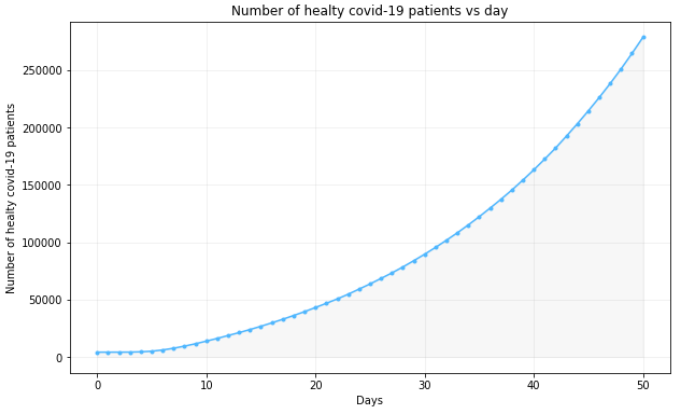

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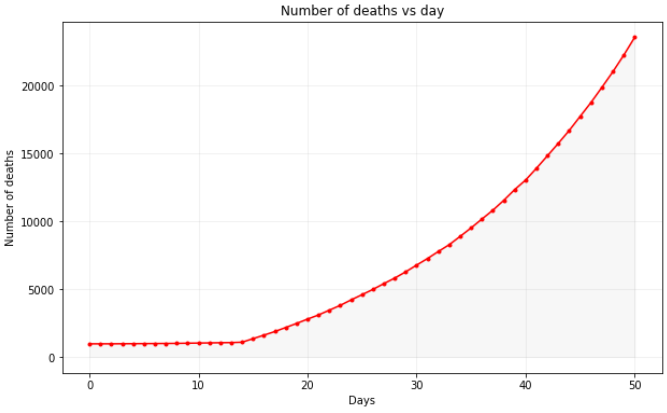
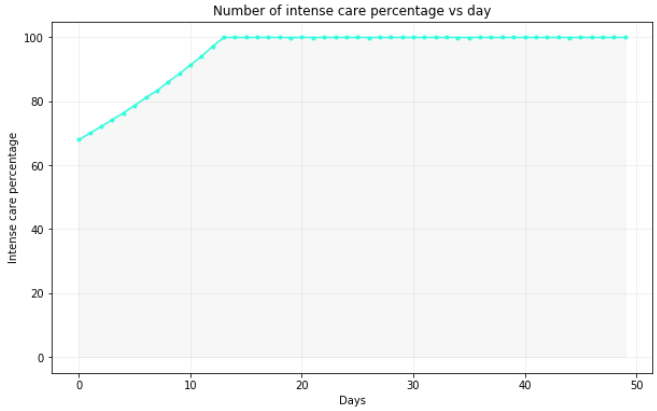


% of ICU Usage



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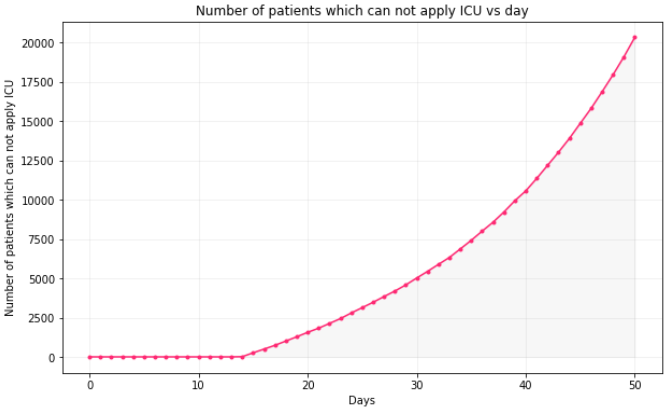

Conclusion

COVID is one of the biggest pandemics in the history of the world that cause death, disrupt supply chains and cause bankruptcy, and also radically change people's lives. Although COVID has a lot of detrimental effects on economies and peoples social life, its most destructive effect is on human life. It is very important that the intensive care capacity of the countries is sufficient for the infected people to recover. We tried to answer whether there is sufficient capacity in Turkey and Istanbul’s intensive care according to various spread scenarios in this study.

According to the analysis results, in case of a rate of increase in world average spread rate, intensive care capacity usage of Turkey does not exceed 80% However, this analysis was based upon all of the country. There might be some deficiencies from city to city. For instance, with the average rate of increase in Istanbul, the percentage of ICU usage approaches %100. This situtation requires additional precausion for Istanbul. At the worst case scenerios in both Turkey and Istanbul, the capacity usage reached %100.