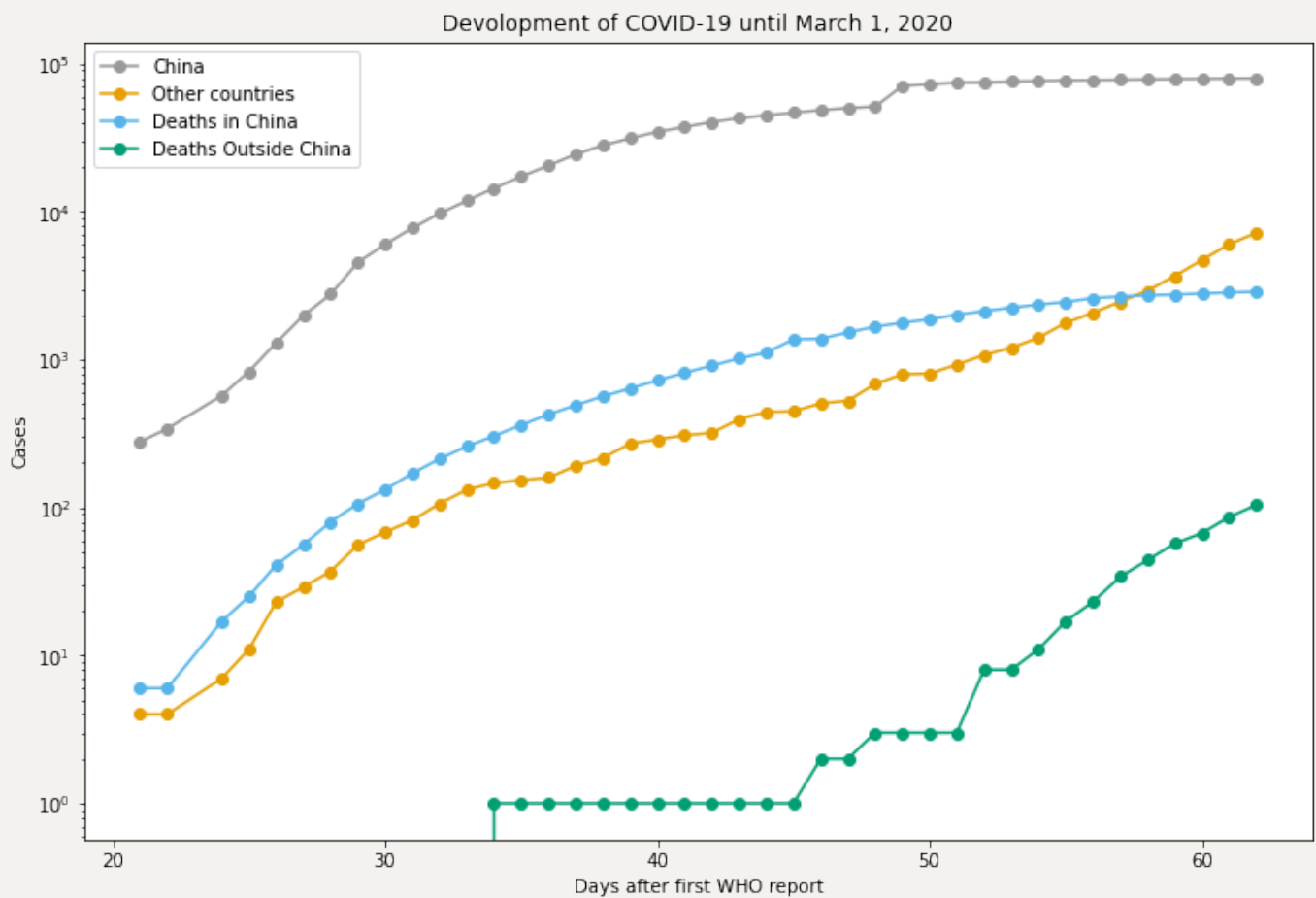


Project 2 - Coronavirus

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Introduction



In the context of an epidemi and data era we want to use mathematical tools to model what the outcome might be. The image at the top is the information of cases and deaths (in china and in the rest of the world) vs days after the first WHO report.

Mathematical model

Using known models for epidemiology we want to make inferences or conclusions. We use a SIR model:

$$\begin{aligned}\frac{dS}{dt} &= -\beta \frac{SI}{N} \\ \frac{dI}{dt} &= \beta \frac{SI}{N} - \gamma I \\ \frac{dR}{dt} &= \gamma I\end{aligned}$$

Susceptible -> Infected -> Recovered

β = Contact Rate \times Probability of Transmission

γ = Recovery Rate

To simplify the data notice how

$$\frac{dS}{dt} + \frac{dR}{dt} + \frac{dI}{dt} = 0$$

That means the amount of populations is constant over the days, say a population N .

And $N = S + I + R$. So we can reduce our system of equations by changing

$S = N - (I + R)$. Now the system is:

$$\begin{aligned}\frac{dI}{dt} &= \beta \frac{(N - (I + R))I}{N} - \gamma I \\ \frac{dR}{dt} &= \gamma I\end{aligned}$$

Even more, we will consider the initial conditions to be $I(0) = 1$ y $R(0) = 1$.

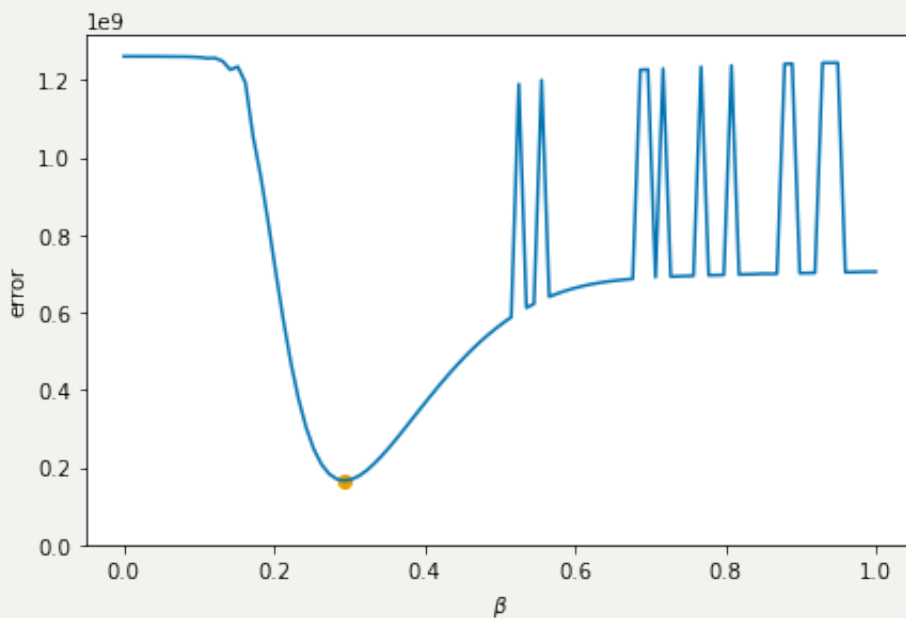
Now the problem is in terms of the number of cases and the number of deaths.

We will use the [PDEparams library](#) to have an approx of parameters.

Results

First configuration

Taking an initial guess of the population of 56×10^3 people. With that in mind we calculate the best parameters for β and γ . The results were not the best. For $\beta = 0.2891$ while for $\gamma = 0$. That indicate deaths are better to just be some noise on the system. Which is an unrealistic scenario since those deaths were well studied. In the next image why β has that value.



Second configuration

Given that N is an estimation now we will intend to estimate ourselves. We think that the population involve is between a million (1×10^6) and a billion (1×10^9). The results improve. The best values are

β γ

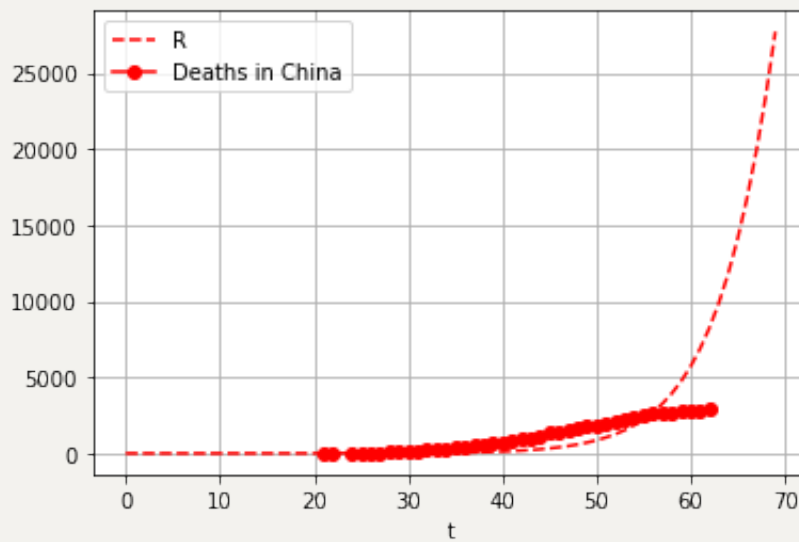
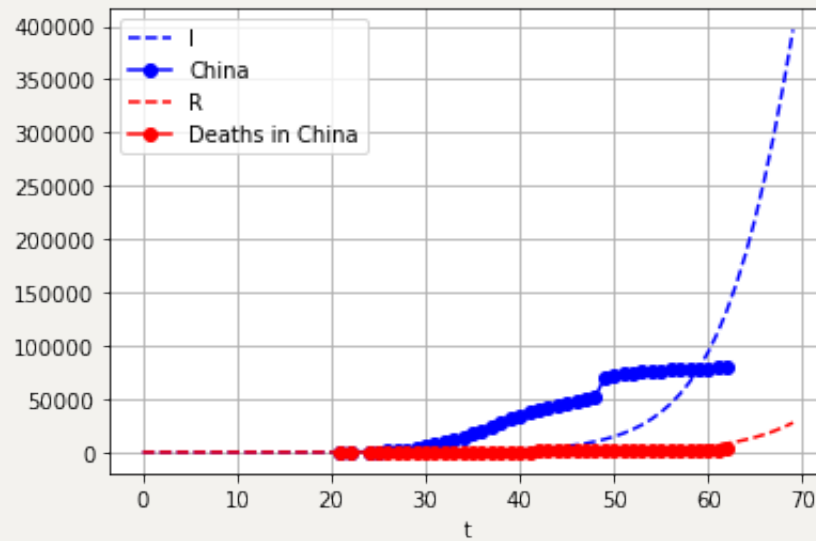
N

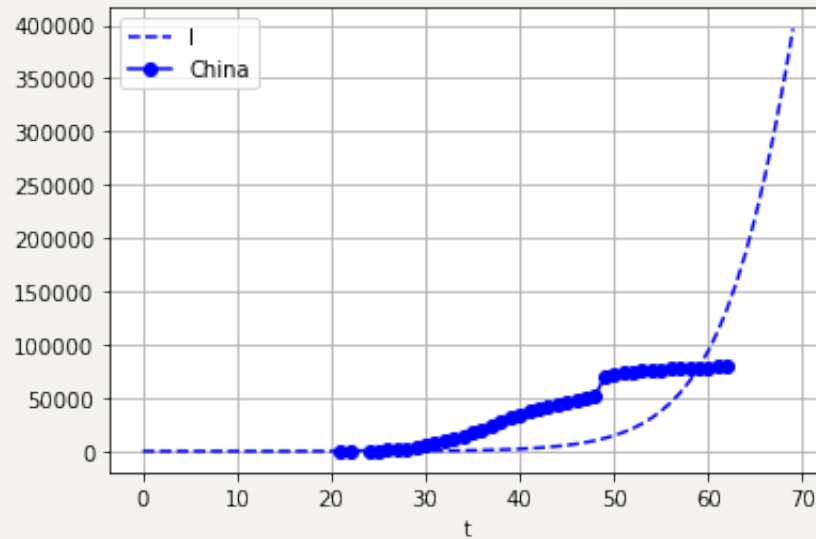
0.2033

0.01125

 1.4×10^6

The problem persists that when we plot the results, the qualitative behavior doesn't seem to fit.





Third configuration: Wuhan

Given that the start of the epidemic was in Wuhan we will consider a population of 11.08×10^6 , we obtain:

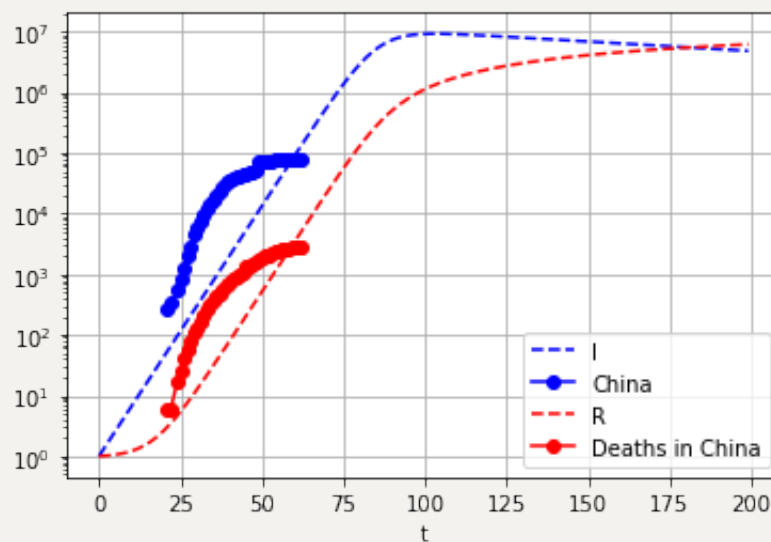
β

0.1971

γ

0.007265

the error remain big across all simulations (526017604.044).



The tendencies doesn't improve.

Conclusions

Even though the SIR model is a nice explanation of how a pandemic evolves it is too simple to recreate all pandemic scenarios. That is why with only two parameters is difficult to give conclusion of how things will evolve. What is more, is difficult to adjust the data to the model.