Modeling Covid-19
SIR Model

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The SIR Model

Aim : Estimate how the number of individuals in each compartment grows

$$N = S(t) + I(t) + R(t)$$

N : Number of people in the population

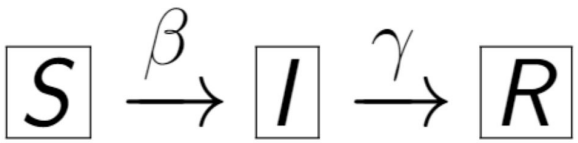
S : susceptible people

I : Infected people

R: Removed people

The equations

$$\begin{cases} \dfrac{dS(t)}{dt} = -\beta S(t)I(t) & (1.1) \\ \dfrac{dI(t)}{dt} = \beta S(t)I(t) - \gamma I(t) & (1.2) \\ \dfrac{dR(t)}{dt} = \gamma I(t) & (1.3) \end{cases}$$



Euler's method

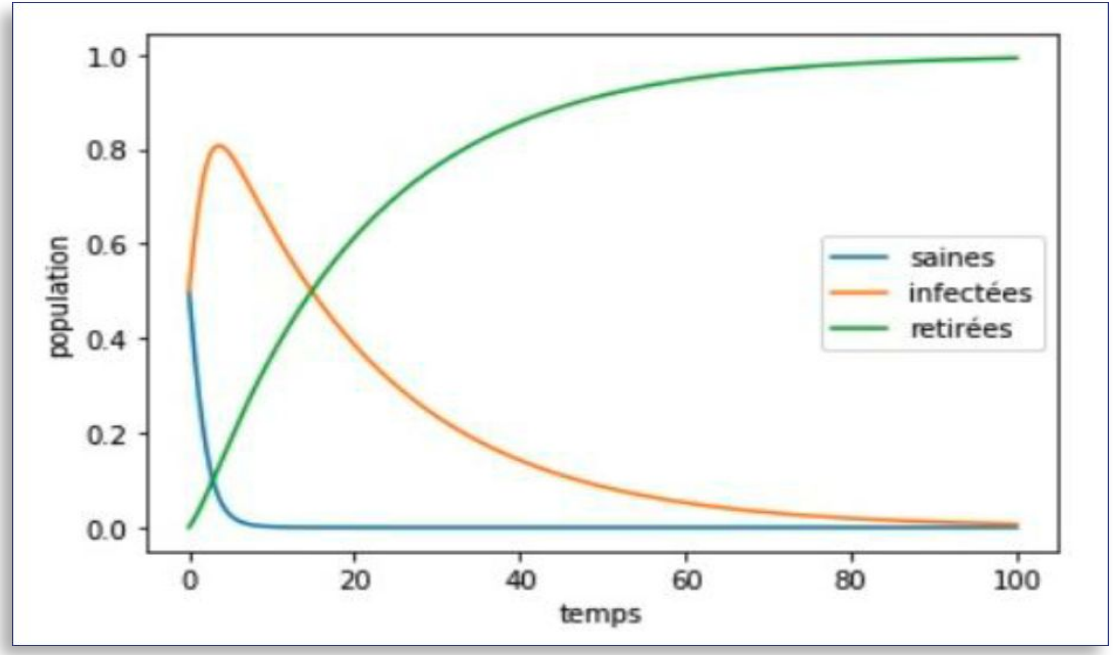
General case : $y'(t) = f(t,y(t))$, $y(t_0) = y_0$

h : the size of every step

and set $t_n = t_0 + nh$

Now one step of the Euler's method is : $y_{n+1} = y_n + hf(t_n,y_n)$

Applied here : $S_{n+1} = S_n - \square S_n I_n$



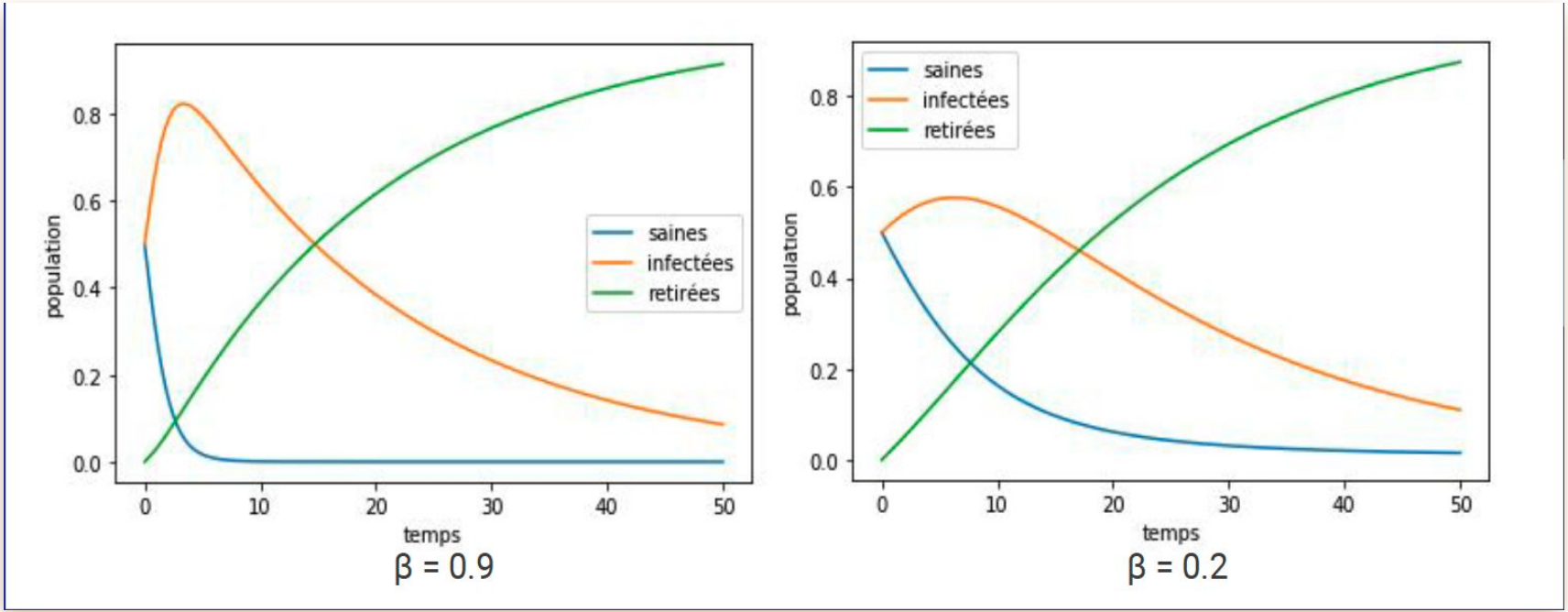
SIR model prediction for transmission rate = 0.8 and healing rate = 0.05

Source : images.math.cnrs.fr

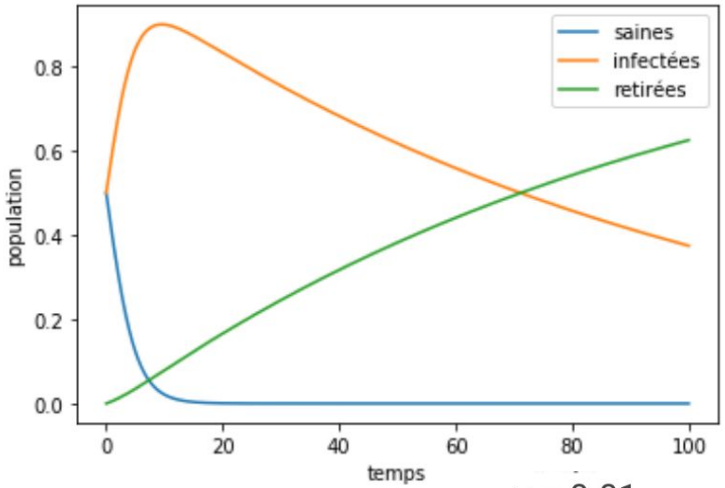
DECISION MAKING

How could we see the effects of decisions under the evolution of the epidemic ?

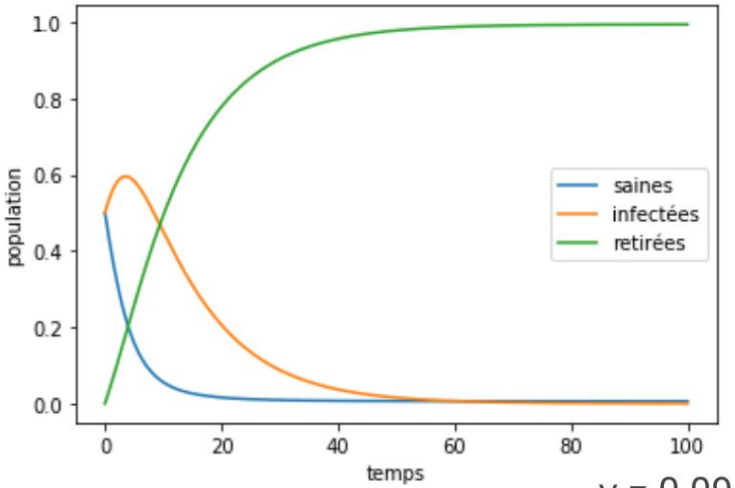
Changing the transmission rate



Changing the healing rate

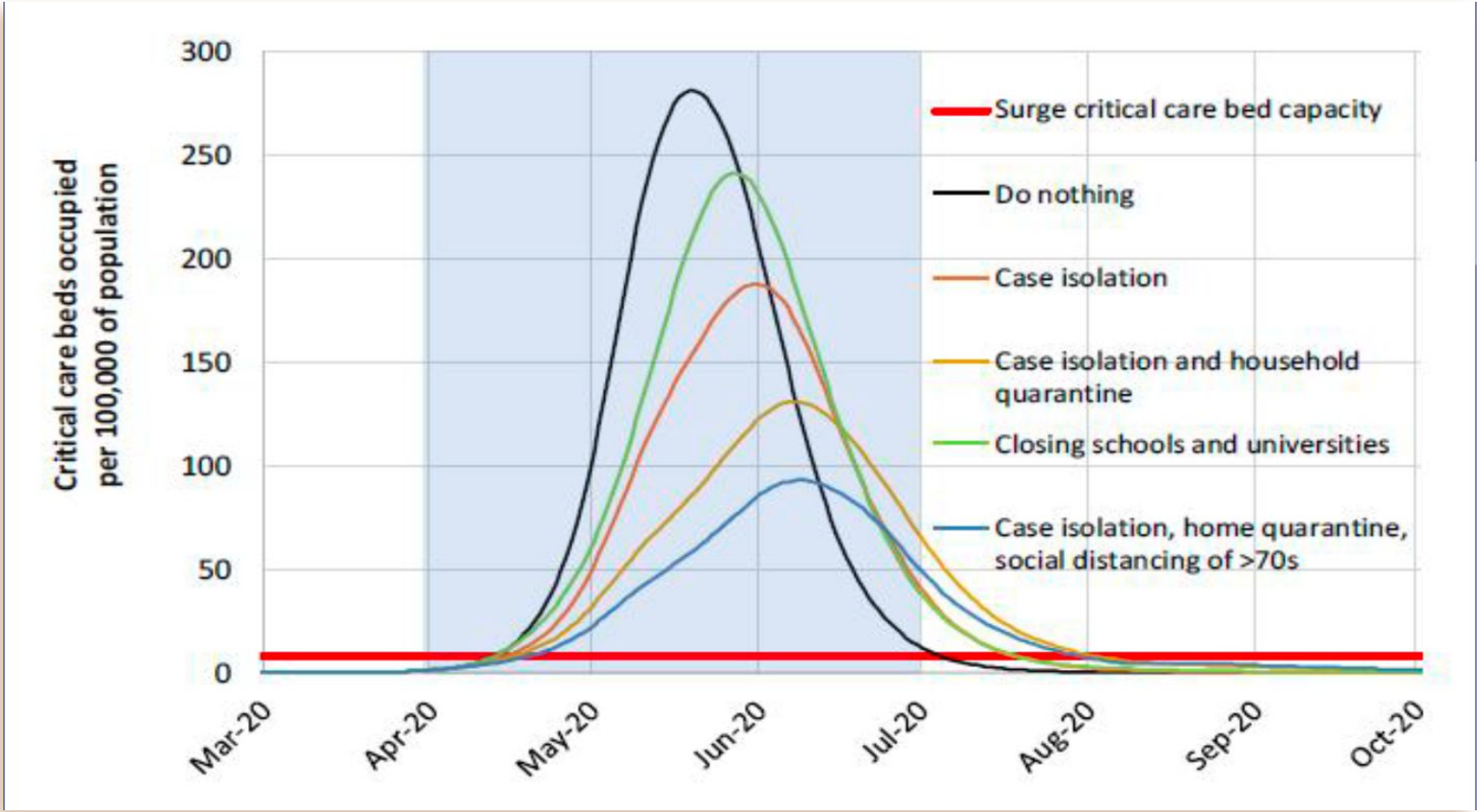


γ = 0.01



γ = 0.09

SIR model's limits


Critical care beds occupied per 100,000 of population
300
250
200
150
100
50
0
Mar-20
Apr-20
May-20
Jun-20
Jul-20
Aug-20
Sep-20
Oct-20
Surge critical care bed capacity
Do nothing
Case isolation
Case isolation and household quarantine
Closing schools and universities
Case isolation, home quarantine, social distancing of >70s

THANK YOU FOR YOUR ATTENTION

https://images.math.cnrs.fr/Modelisation-d-une-epidemie-partie-1.html#nb17

https://www.imperial.ac.uk/media/imperial-college/medicine/sph/ide/gida-fellowships/Imperial-College-COVID19-NPI-modelling-16-03-2020.pdf