Syrian Arab Republic
Distinction and Creativity Agency
National Center for the Distinguished

Simulation of COVID-19 Potential Outbreak in Lattakia

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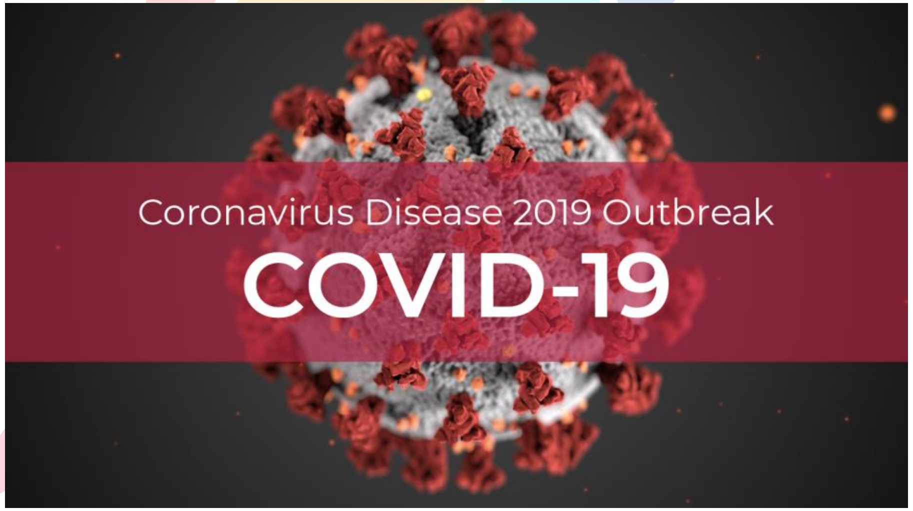
Introduction

The rapid spread of the coronavirus now called COVID-19 has sparked alarm worldwide. The World Health Organization (WHO) has declared it a global health emergency, and now a pandemic, with small chains of transmission in many countries and large chains resulting in extensive spread in a few countries.



Introduction

- Mathematical models have been used to simulate scenarios and predict the evolution of infectious diseases since the early 20th century.

- The key value of such modelling is to assist with planning and decision-making at an early stage – when prevention measures can have greater impact – but it is also at a time when we have limited information and modelling helps give the best guide to decision makers.

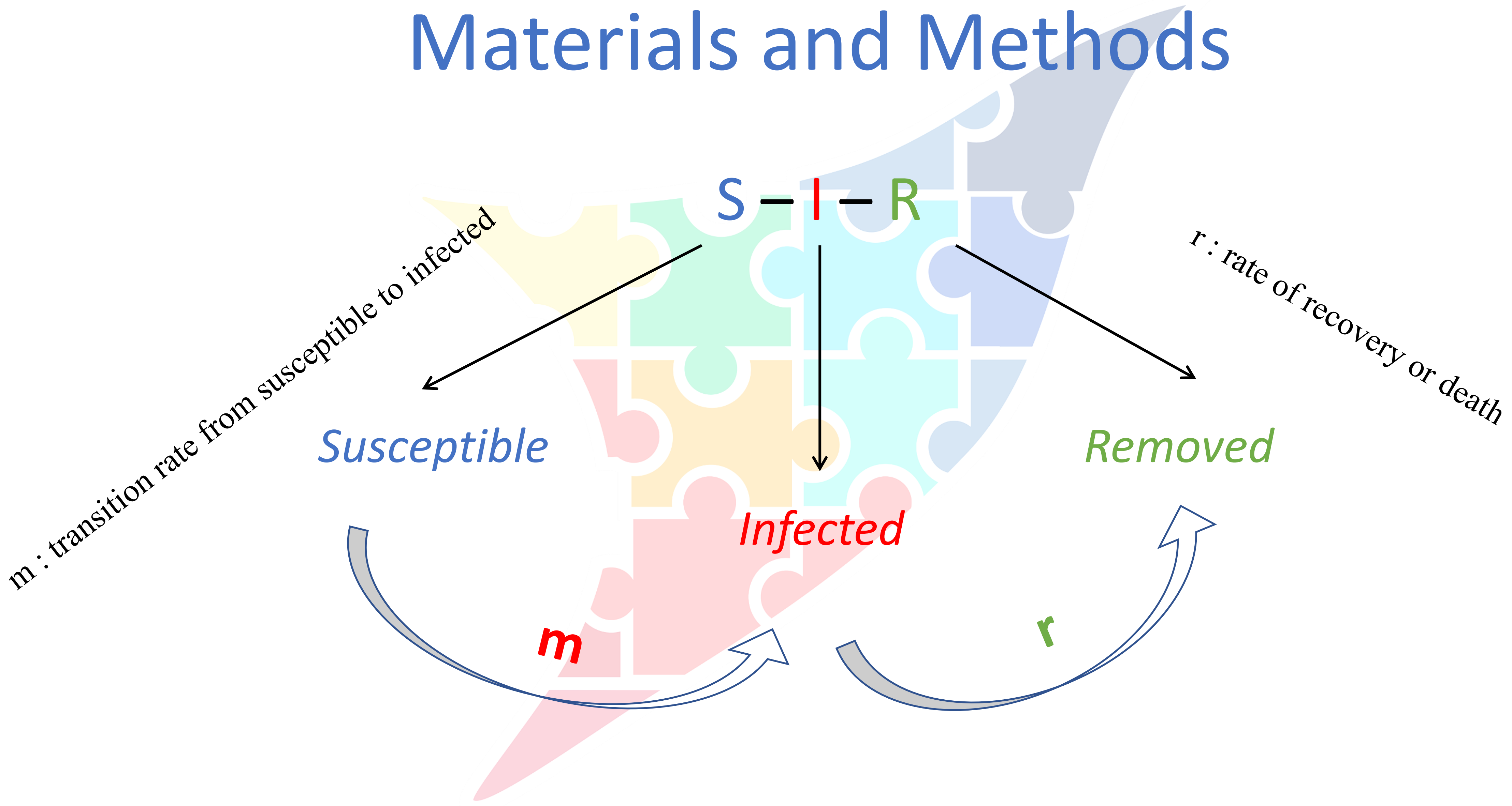
Introduction

- Until the time of writing this paper, no cases of the virus were recorded by the Syrian Ministry of Health (MoH) or the World Health Organization (WHO) in Lattakia.

- Yet the concerns by local community are rising about the readiness to contain the virus in case of a potential outbreak and the effectiveness of heath procedures to be taken.

- In our research, these concerns were investigated using the classical SIR model.

Materials and Methods



Materials and Methods

$$m = a.b.\frac{I}{N}$$

(m) is :

(a) the average percentage of hours per day spent out per person times (b.I/N) the probability of disease transmission in a contact between a susceptible and an infectious subject.

$$r = \frac{1}{D}$$

And (r) is the rate of recovery or death; one over recovery time (D). For COVID-19 D=14.

$$N = S + I + R$$

Note that (N) is the total population. We assume it to be constant because the dynamics of birth and death are omitted.

Materials and Methods

Let’s do the math.. 3 ordinary differential equations (ODEs)

$$\frac{dS}{dt} = -m.S = -\mathrm{a.b.}\frac{\mathrm{I}}{\mathrm{N}}.\mathrm{S}$$

$$\frac{dR}{dt} = r.I = \frac{I}{D}$$

$$\frac{dI}{dt} = m.S - r.I = \mathrm{I}\ .(\mathrm{a.b.}\frac{\mathrm{S}}{\mathrm{N}} - \frac{1}{D})$$

Materials and Methods

How does a pandemic start in the first place?

$$\frac{dI}{dt} = I\ .(a.b.\frac{S}{N} - \frac{1}{D})$$

At time $t \approx 0 \ \rightarrow S \approx N \ \rightarrow$

$$\frac{dI}{dt} = \frac{I}{D}\ .(a.b.D - 1)$$

$$\frac{dI}{dt} > 0 \ \leftrightarrow a.b.D \ > 1$$

$a.b.D$ is called R_0 or basic reproduction number

Materials and Methods

Time for MATLAB.. Let’s apply sequences

The differential equations were revised into discrete time difference equations:

$$S(t+1) - S(t) = - a * b * (I(t)/N)$$

$$I(t+1) - I(t) = S(t) * a * b/N - (1/d)$$

$$R(t+1) - R(t) = (I(t)/d)$$

Materials and Methods

```
 prompt = 'percentage of hours per
day spent out ?';
 a = input(prompt);
 prompt = 'the possibility of
getting the epidemic when meeting
an infected person?';
 b = input(prompt);
 prompt = 'the recovery time?';
 d = input(prompt);
 prompt = 'the total population?';
 N = input(prompt);
 prompt = 'the susceptible
population?';
 S0 = input(prompt);
 prompt = 'the Infected
population?';
 I0 = input(prompt);
 prompt = 'the Recovered
population?';
 R0 = input(prompt);
 prompt = 'How long would you like
to run the simulation for?';
```

```
t_max = input(prompt);
S = zeros (1, t_max);
I = zeros (1, t_max);
R = zeros (1, t_max);

S (1) = S0;  I (1) = I0;

R (1) = R0;  T (1) = 0;
for t=1 :1: t_max;
   T(t+1) =t;
   S(t+1) =S(t)*(1-
a*b*(I(t)/N));
   I(t+1) =I(t)*(1 +
S(t)*a*b/N - (1/d));
    R(t+1) =R(t)+(I(t)/d);
end
```

```
 disp(max(I));
 disp(min(S));
 disp(max(R));
 plot (T, S, T, I, T,
R);
 title ('SIR Model');
 legend('S(t)','I(t)','R
(t)');
 xlabel ('time, t');
 ylabel('Population');
```

Let always be: N is a million, S_0=999990, I_0 = 10, time of the simulation is 365 days, recovery or death time is 14 days and 6% of *(R)* are dead and 94% are recovered

Results and Discussion

	a	b	R_0	Never infected%	Infected then recovered%	Infected then died%	Peak time
Case 1	8 hours/ 0.33	without wearing masks or taking any health measurements/ 0.9	4.158	1.383	92.699	5.918	between days 60 and 65

Max (I) : 4.3204e+05

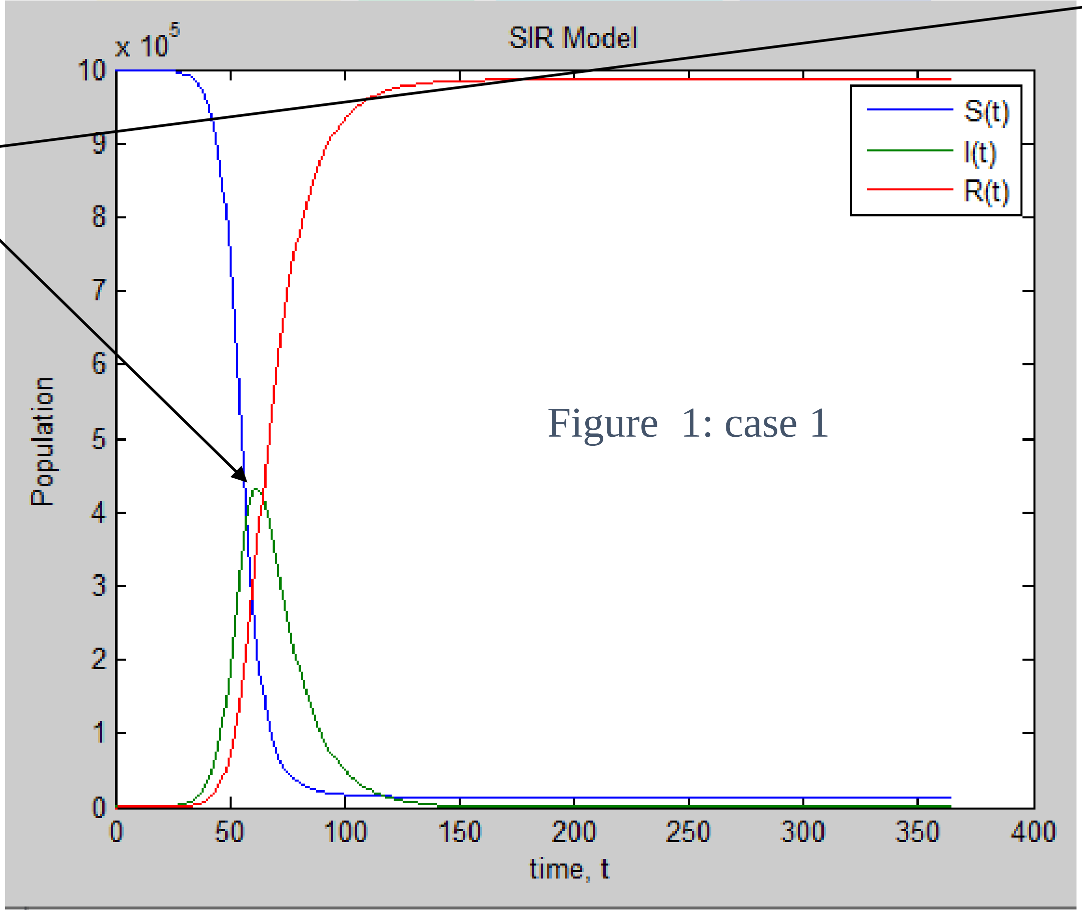


Figure 1: case 1

Results and Discussion

	a	b	R0	Never infected%	Infected then recovered%	Infected then died%	Peak time
Case 2	8 hours/ 0.33	wearing masks or taking any health measurements/ 0.5	2.31	13.137	81.651	5.212	between days 128 and 133

Max I : 2.0894e+05

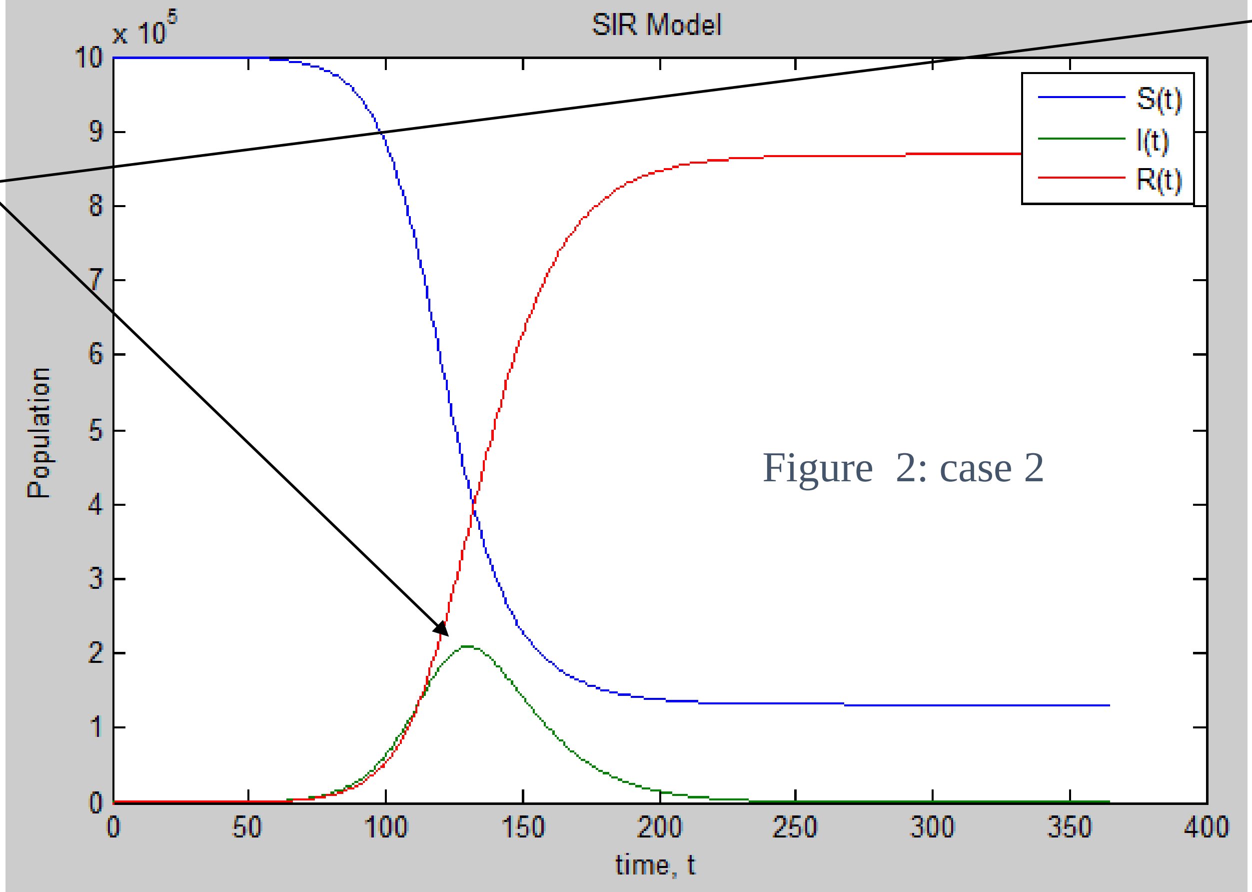


Figure 2: case 2

Results and Discussion

	a	b	R0	Never infected%	Infected then recovered%	Infected then died%	Peak time
Case 3	4 hours/ 0.166	without wearing masks or taking any health measurements/ 0.9	2.0916	17.571	77.483	4.946	between days 149 and 154

Max I : 1.7220e+05

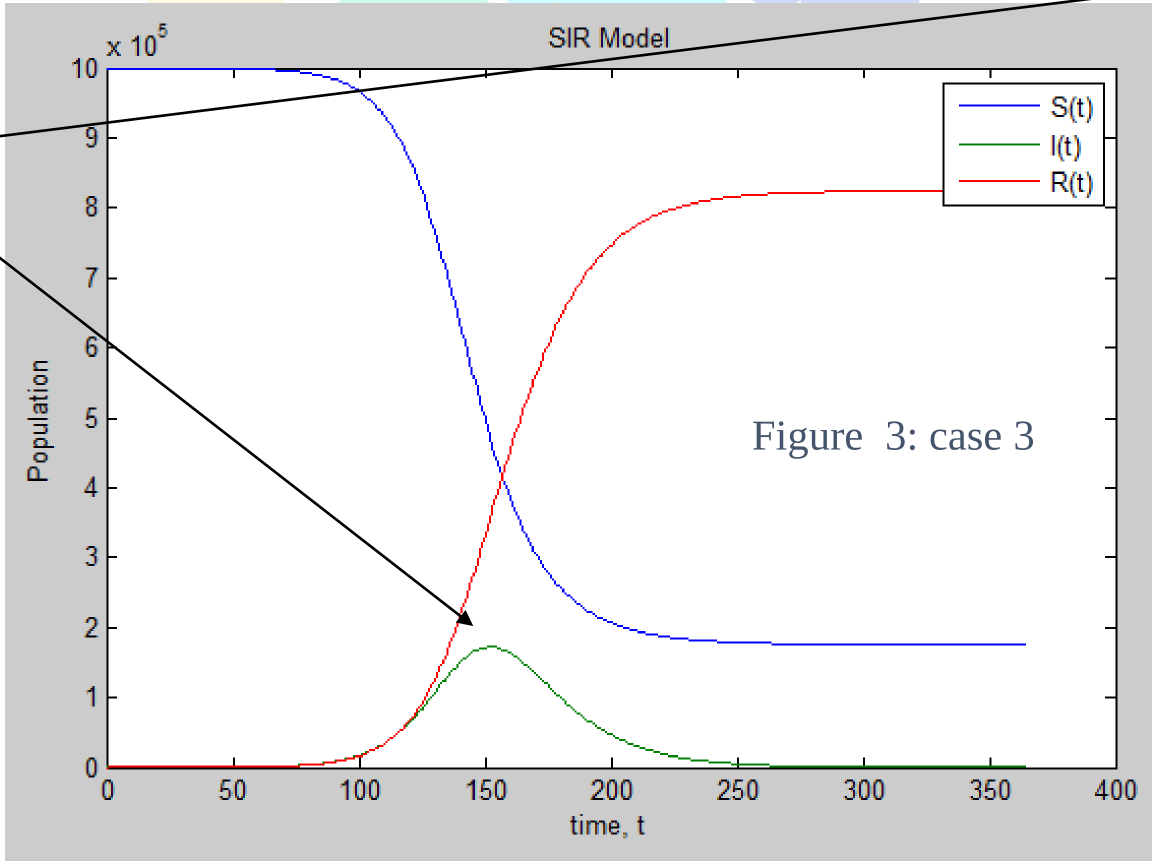


Figure 3: case 3

Results and Discussion

	a	b	R0	Never infected%	Infected then recovered%	Infected then died%	Peak time
Case 4	3.75 hours/ 0.157	enough wearing masks or taking any health measurements/ 0.7	1.54	39.06	57.283	3.657	between days 274 and 279

Max I : 7.0759e+04

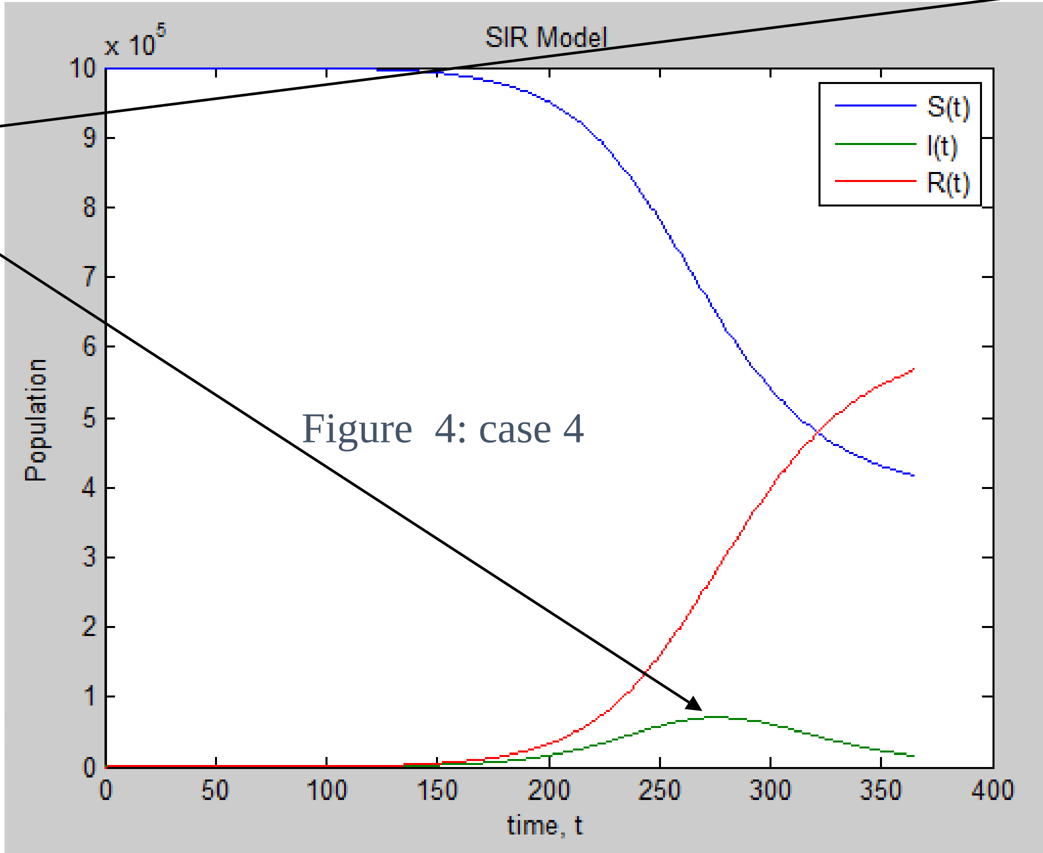


Figure 4: case 4

Results and Discussion

	a	b	R0	Never infected%	Infected then recovered%	Infected then died%	Peak time
Case 5	2.4 hours/ 0.100	enough wearing masks or taking any health measurements/ 0.7	0.98	99.967	0.0303	0.002	The first day

Max I : 10

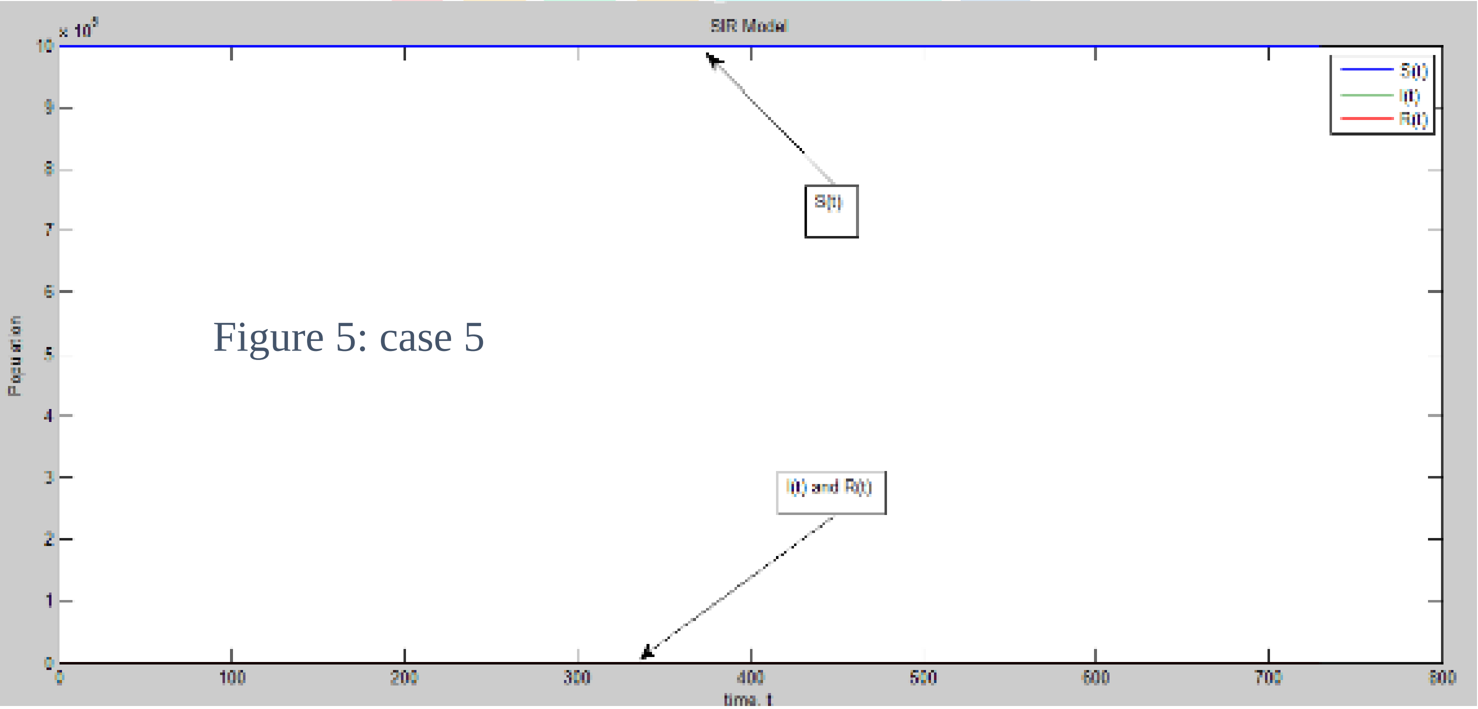
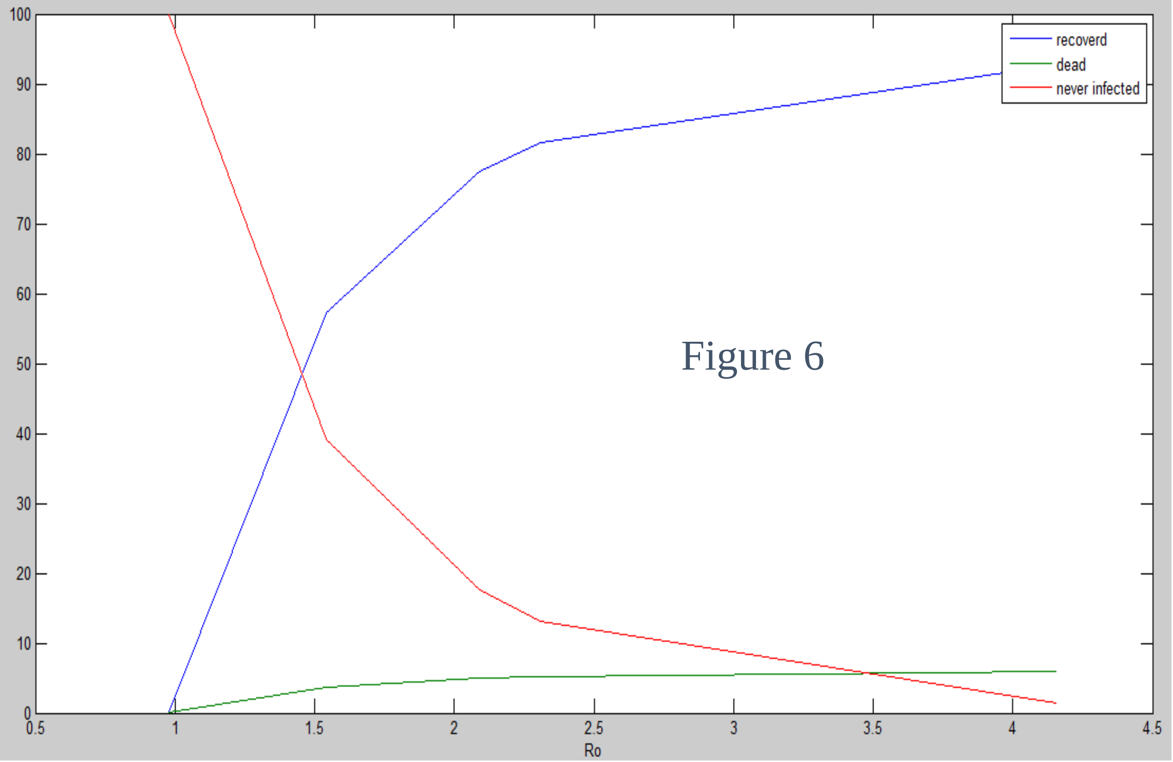


Figure 5: case 5

Results and Discussion

So, imposing quarantine, social distancing and strict health measurements reduce the value of R_0, therefore reduce the spread of the pandemic and increase the number of people who are never infected, which is compatible with the literature.

Figure 6 represents the percentage of people who are never infected, recovered and dead depending on the values of R_0.



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Thank you for your attention :D