Covid Model Simulation

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SIR

S I R

Susceptible

Infected

Recovered

“A SIR model assumption for the spread of COVID-19 in different communities”

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7321055/

$$
\begin{aligned}
\frac{dS(t)}{dt} &= -aS(t)I(t), \\
\frac{dI(t)}{dt} &= aS(t)I(t) - bI(t), \qquad (1) \\
\frac{dR_m(t)}{dt} &= bI(t),
\end{aligned}
$$

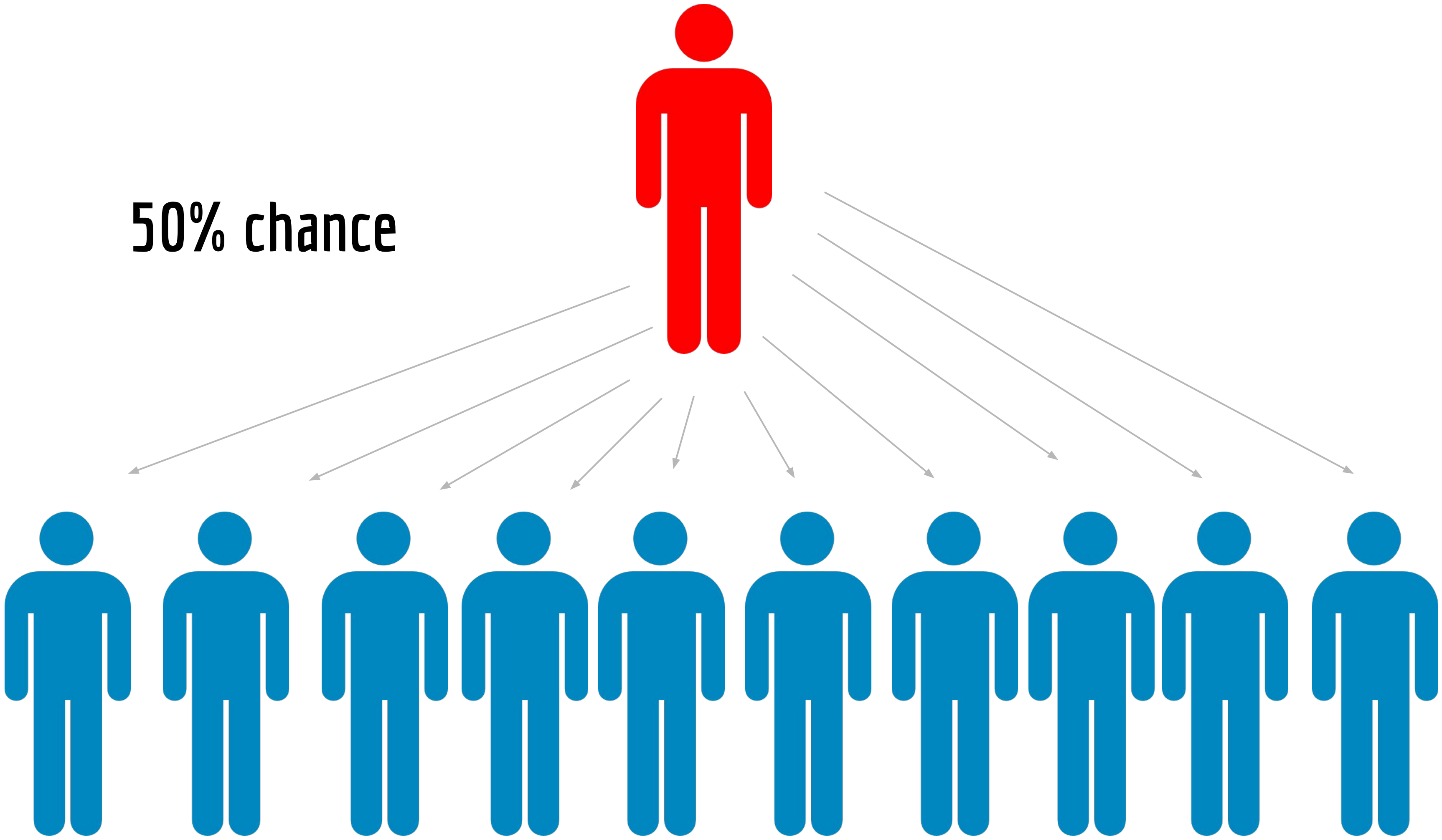
Variables

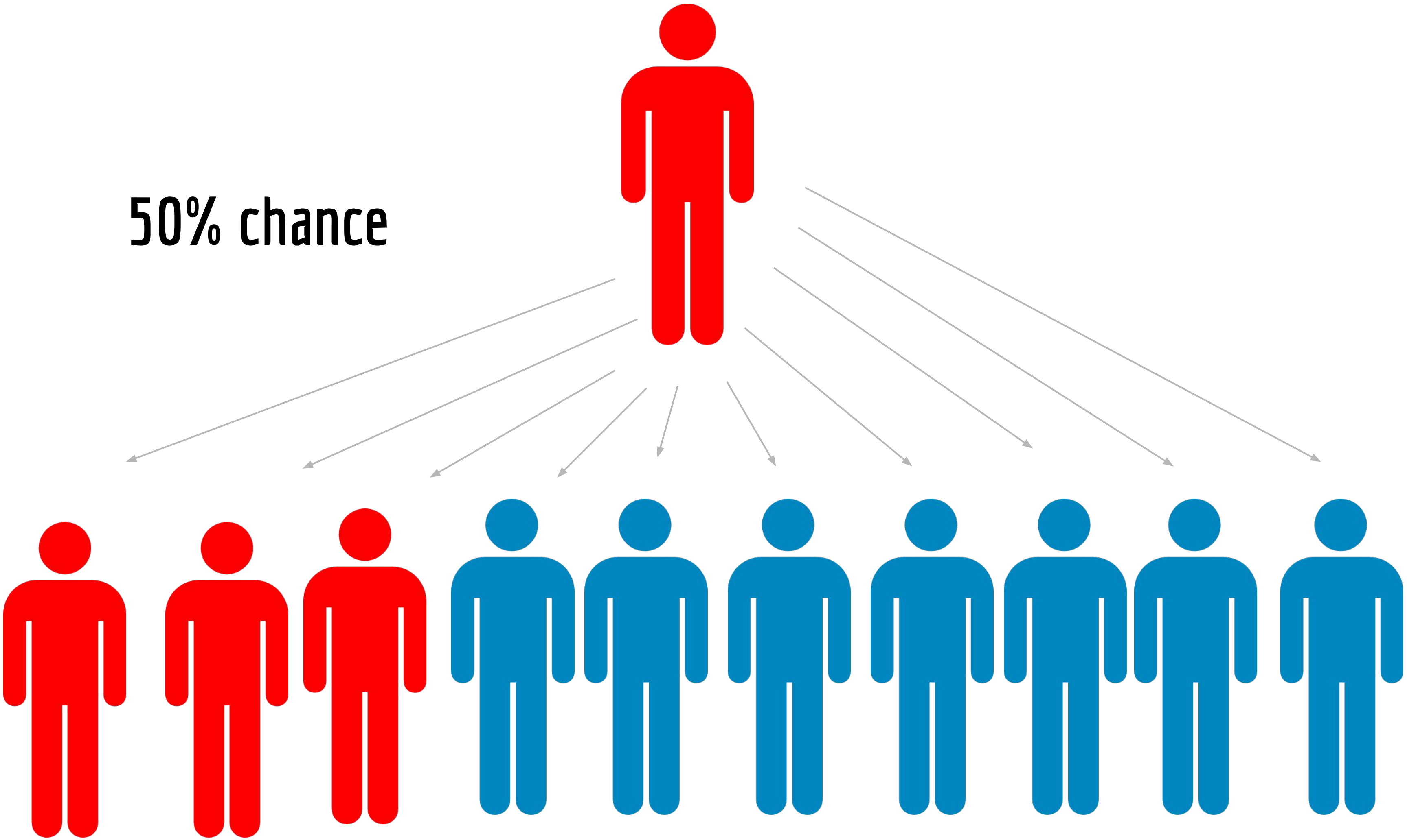
```
#define some variables that will be useful
total_pop = 1e6
people = [total_pop - 1, 1, 0]

people_interact = 10
infect_chance = 0.5
days_infectious = 3
```

S I R

one_day

- ❖ Runs 1 day of simulation
- ❖ Starts with only one infected person
- ❖ Infected person interacts with 10 people
- ❖ Infect_today = number of people infected on that day
- ❖ Infected people get subtracted from total population and added to infected pool


50% chance


50% chance

fourteen_days

- Runs 14 days of simulation

Fourteen_days = one_day x 14

people_recovered

people_infected = [1,2,3,4,5,6,7,8,9,10...]

people_recovered = [0,0,0,1,2,3,4,5,6,7...]

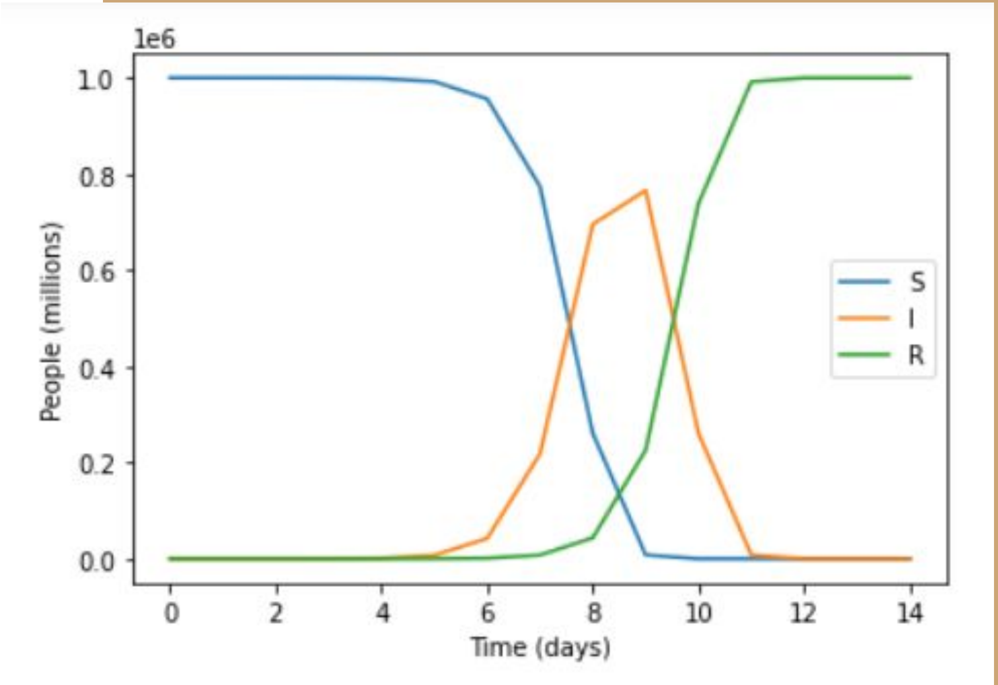
- Runs 14 days
- Stores infected and recovered people into respective lists
- Updates S, I, R each day

```python
def fourteen_days(people = [total_pop - 1, 1, 0]):
    people_all = []
    people_all.append(people.copy())
    people_infected=np.zeros((days_infectious))
    people_infected[-2] = people[1]

    for n in range(14):
        (people, infect_today) = one_day(people)

        people_infected[-1] = infect_today

        #move people from I to R
        people[2] += people_infected[0]
        people[1] -= people_infected[0]
        people_infected = np.roll(people_infected,-1)
        people_infected[-1]=0

        people_all.append(people.copy())

    return np.array(people_all)

people_all = fourteen_days()
```

people_interact= 10

Infect_chance= 0.5

days_infectious=3



https://scipython.com/book/chapter-8-scipy/additional-examples/the-sir-epidemic-model/

$$\frac{\mathrm{d}S}{\mathrm{d}t} = -\frac{\beta S I}{N},$$

$$\frac{\mathrm{d}I}{\mathrm{d}t} = \frac{\beta S I}{N} - \gamma I,$$

$$\frac{\mathrm{d}R}{\mathrm{d}t} = \gamma I.$$

N = POPULATION SIZE

β = EFFECTIVE *CONTACT RATE*

γ = MEAN RECOVERY RATE

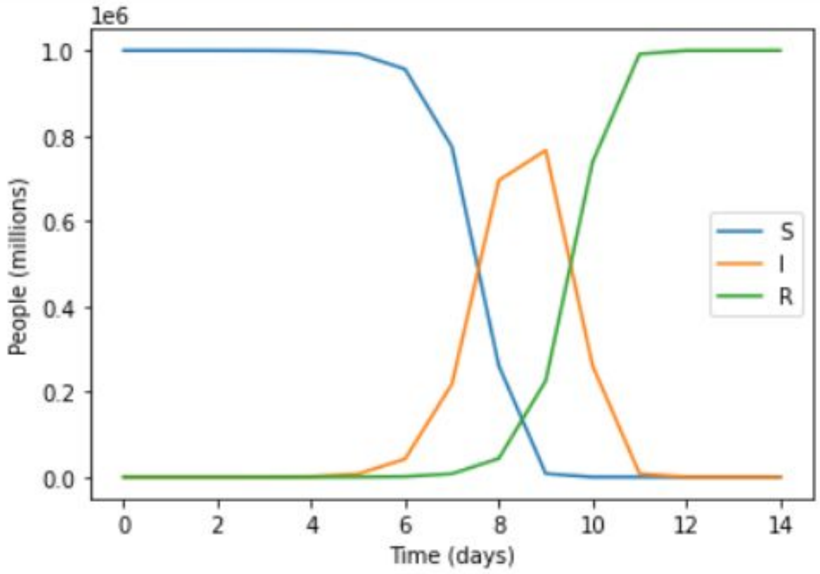
1/γ = MEAN PERIOD OF TIME DURING WHICH AN INFECTED INDIVIDUAL CAN PASS IT ON

N= 1000 PEOPLE

β=0.2

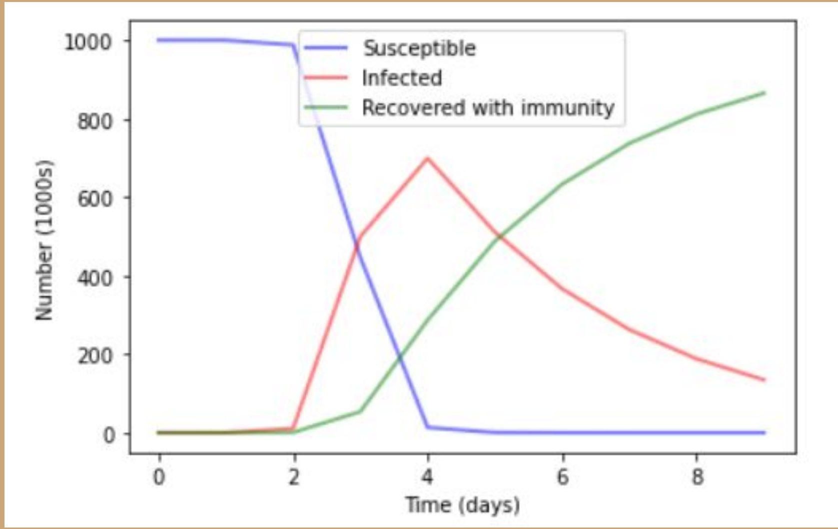
1/γ=10 DAYS

OURS



1e6
1.0
0.8
0.6
0.4
0.2
0.0
People (millions)
0
2
4
6
8
10
12
14
Time (days)
S
I
R

THEIRS

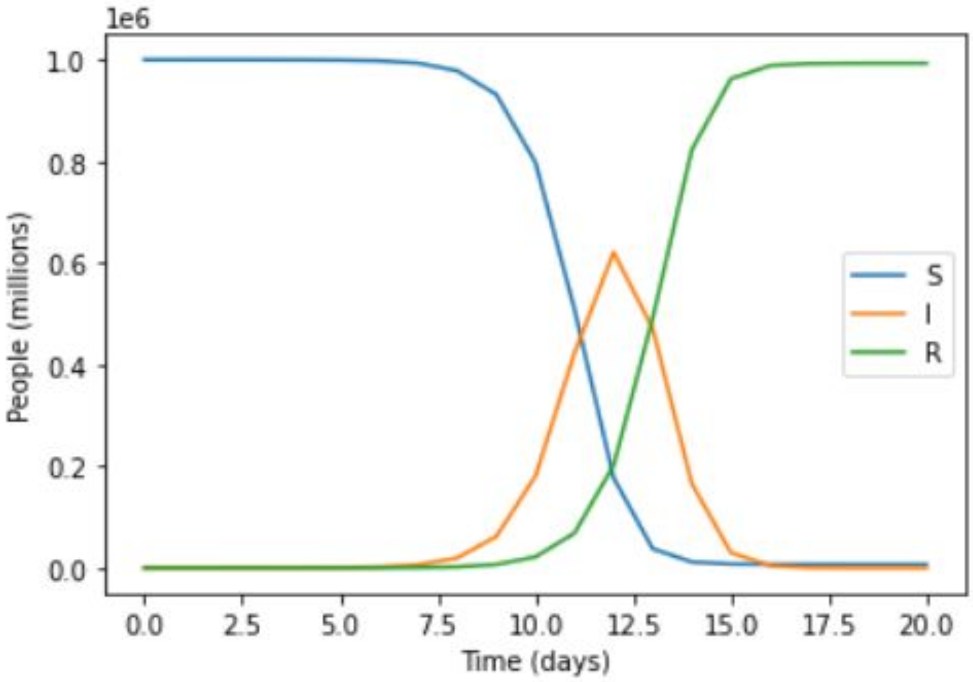


1000
800
600
400
200
0
Number (1000s)
0
2
4
6
8
Time (days)
Susceptible
Infected
Recovered with immunity

people_interact= 5

Infect_chance= 0.5

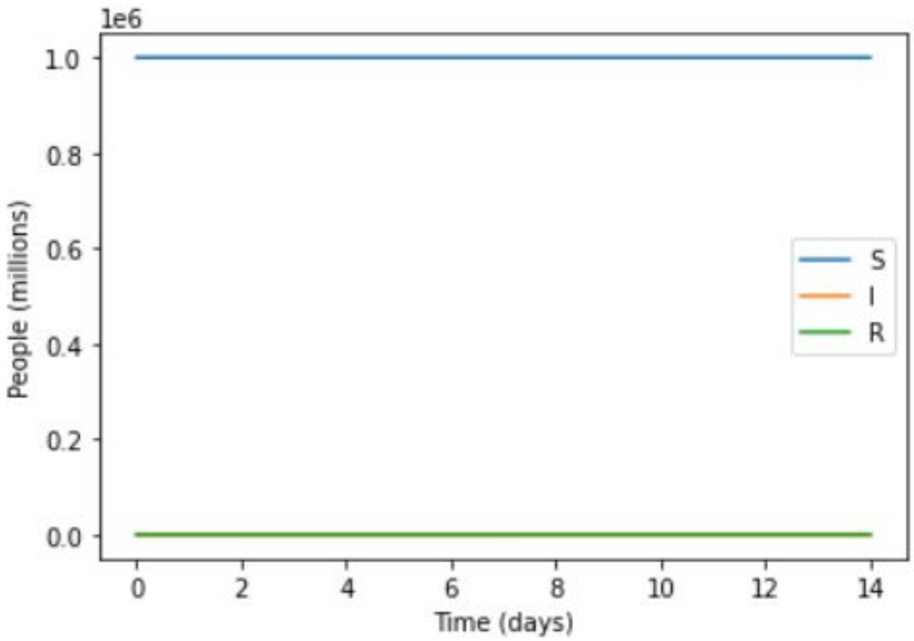
days_infectious=3



people_interact= 1

Infect_chance= 0.5

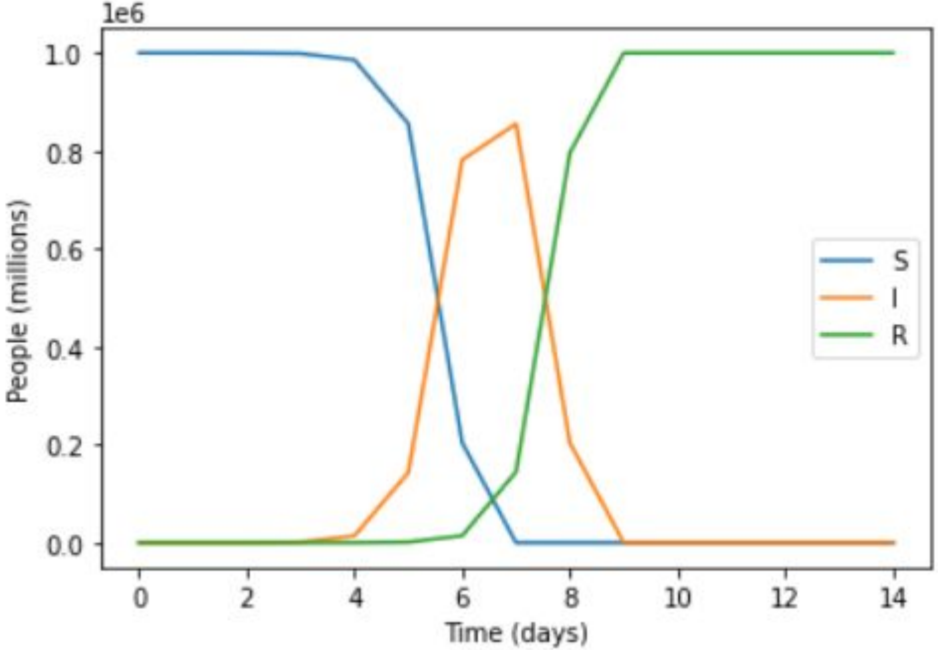
days_infectious=3



people_interact= 10

Infect_chance= 1.0

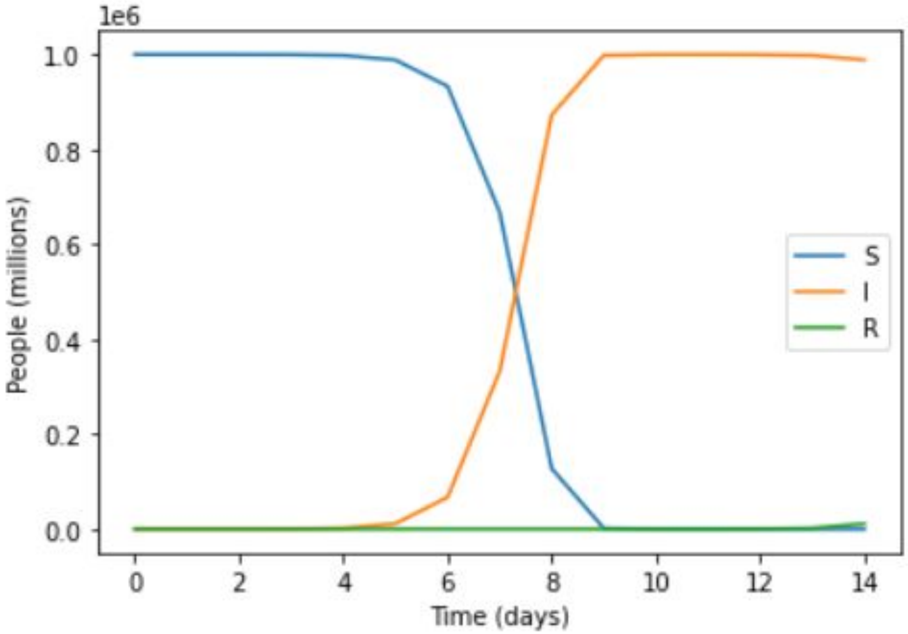
days_infectious=3



people_interact= 10

Infect_chance= 0.5

days_infectious=10

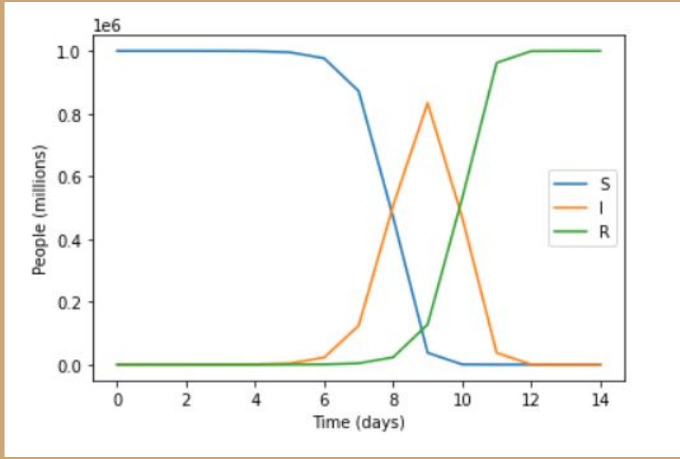


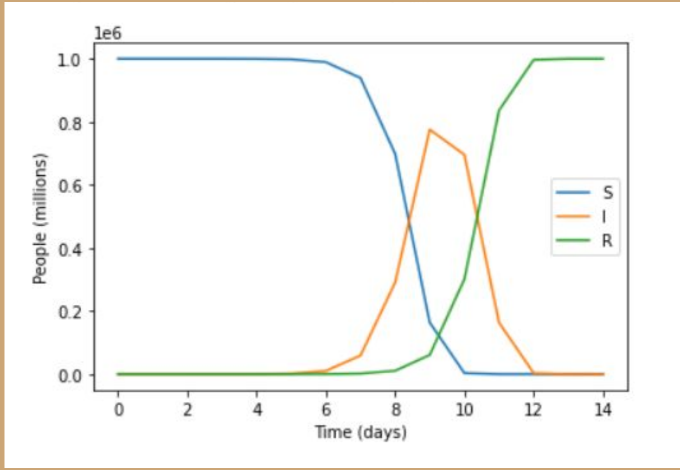
people_interact= 10

Infect_chance= 0.5

days_infectious=3

Initial people infected= 50, 1000





What's Next?

Thank you