experiments

May 28, 2020

[1]:
```
%load_ext autoreload
%autoreload 2
%matplotlib inline
```

[2]:
```
import networkx as nx
import EoN
import matplotlib.pyplot as plt
from simulation import *
from analysis import *
from end_to_end import *
```

1 SIR Model on G(n,p) Network

1.0.1 Resources

- Her colleague's paper
- Daily Bruin Article
- Epidemics on Networks paper

1.0.2 Coding Documentation

- https://networkx.github.io/documentation/stable/reference/index.html
- https://epidemicsonnetworks.readthedocs.io/en/latest/

1.0.3 Assumptions:

- Removed inmates can be any state
- Avg. degree of new nodes is correlated with current prison population (aka p is constant)
- Death rate (as in time it takes people to transfer from infected to dead) is equal to the recovery rate

1.1 Possible Things to Work On:

- Simulations are stochastic, so perhaps taking the average over multiple simulations would reduce noise?

1.2 Description of Parameters

- **background_inmate_turnover**: background # of inmates added/released at each time step
- **release_number**: # of inmates to release
- **number_infected_before_release**: number of infected at which to perform release on next integer time
- **rho**: percent of inmates that are initially infected
- **death_rate**: probability of dying after being infected
- **tau**: transmission rate
- **gamma**: recovery rate
- **max_time**: # of time steps to run simulation
- **N**: # of inmates initially
- **p**: probability of contact between inmate and other inmates
- **percent_infected**: percent of general population that is infected
- **percent_recovered**: percent of general population that is recovered
- **save_plot**: should plot of results be saved to computer?
- **stop_inflow_at_intervention**: should we stop the background inflow of inmates at intervention time?
- **title**: title of plot

1.3 Constant Parameters

These parameters are held constant througout the trials. * background_inmate_turnover=20 * rho=0.0003 * death_rate=0.012 * tau=0.03 * gamma=0.07 * max_time=60 * N=3000 * p=0.02 * percent_infected=0.0035 * percent_recovered=0.0015

2 Experimental Design

The cases we shall examine are as follows:

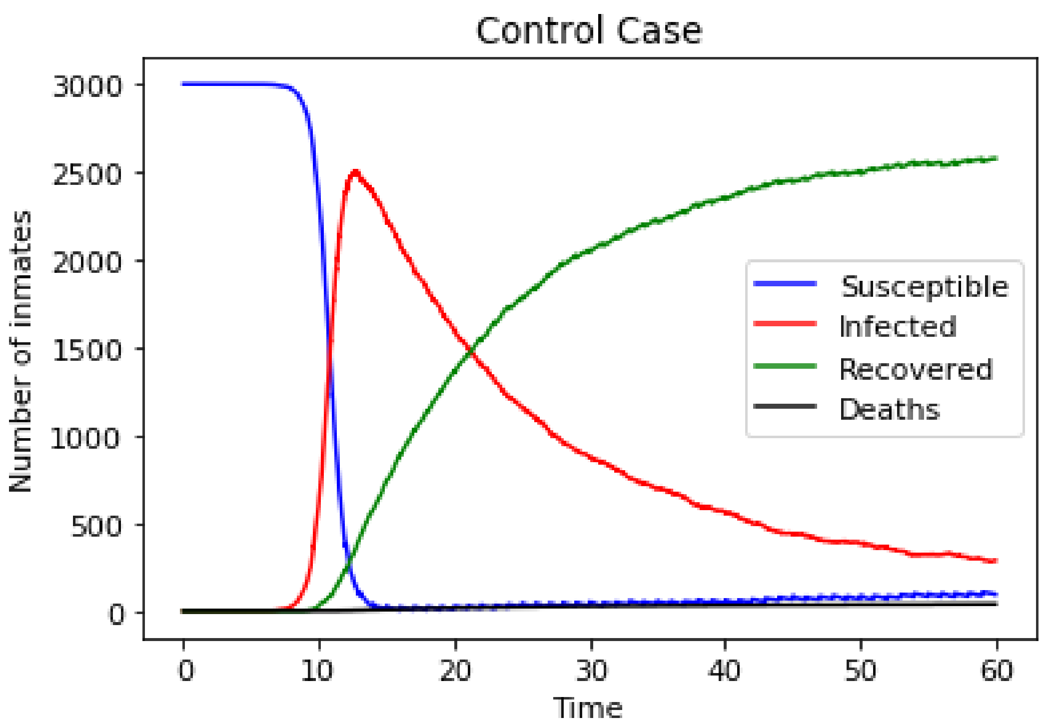
1. **Control case**: no release intervention, no stopping of inmate intake
2. **Intervention A**: no release intervention, but stopping of inmate intake
3. **Intervention B**: release intervention and stopping of inmate intake

For case 3, Intervention B, we shall experiment with a range of release numbers and release conditions.

2.1 Control Case

[93]:
```
t, S, I, R, D = (end_to_end(release_number=0,
                            number_infected_before_release=5000,
                            stop_inflow_at_intervention=False,
                            save_plot=True,
                            title='Control Case'))
```

```
Starting simulation...
Simulation completed.

##################### Parameters #####################
{'release_number': 0, 'number_infected_before_release': 5000,
'stop_inflow_at_intervention': False, 'background_inmate_turnover': 20, 'rho':
0.0003, 'death_rate': 0.012, 'tau': 0.03, 'gamma': 0.07, 'max_time': 60, 'N':
3000, 'p': 0.02, 'percent_infected': 0.0035, 'percent_recovered': 0.0015,
'save_plot': True, 'title': 'Control Case'}

##################### Results #####################
Total # of infections:  3861
Total # of deaths:  40.0
```




```
Plot saved with filename:
simulation_plot_release_number-0__num_inf_bf_release-5000__stp_in_at_int-False__
```

```
bck_turnover-20__rho-0.0003__death_rate-0.012__tau-0.03__gamma-0.07__max_time-60
__N-3000__p-0.02__percent_infected-0.0035__percent_recovered-0.0015__title-
Control Case_
```

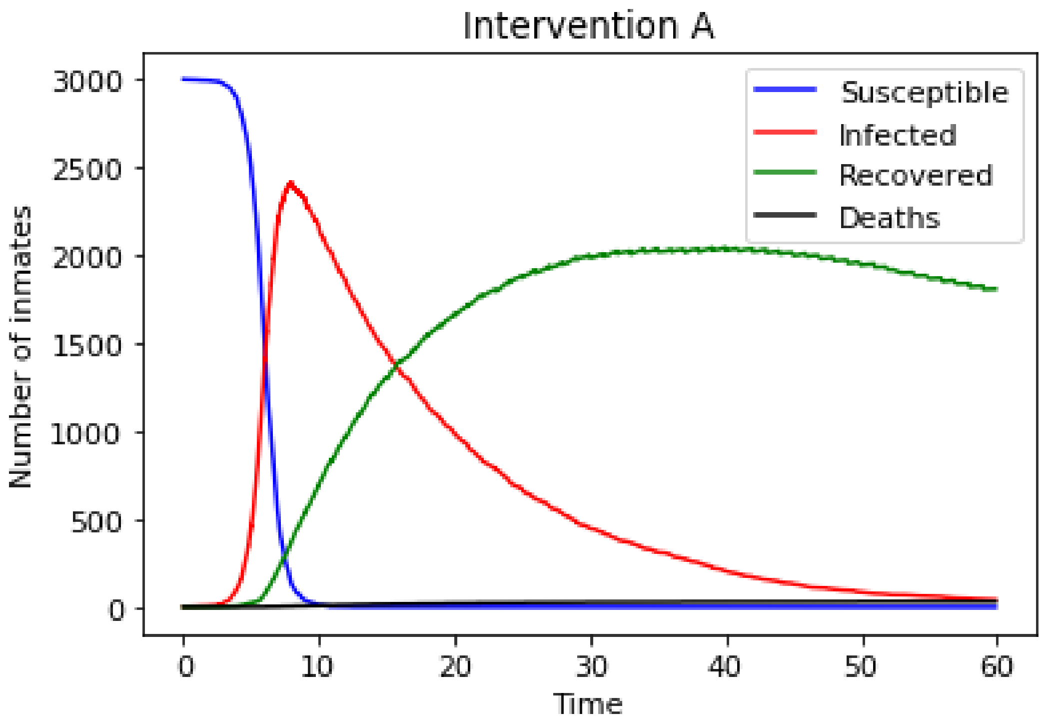
```
<Figure size 432x288 with 0 Axes>
```

2.2 Intervention A: no release intervention, but stop inmate inflow

NOTE: For the intervention trials, the intervention does not occur exactly when there are `number_infected_before_release` infected inmates. Instead, the actual intervention occurs at the next integer-valued time step after the `number_infected_before_release` condition has been met. By the time it occurs, the '# of infected' may be much higher than `number_infected_before_release` (I've seen it being 4.5x higher). So, I have ran trials repeatedly until the intervention kicks in at a similar # of infected for each experiment case (around 110 - 120 infected people when the intervention kicks in).

[99]:
```
t, S, I, R, D = (end_to_end(release_number=0,
                            number_infected_before_release=100,
                            stop_inflow_at_intervention=True,
                            save_plot=True,
                            title='Intervention A'))
```

```
Starting simulation...
Release intervention condition met.
        Time: 4
        # of infected: 110
Stopping inmate inflow.
Simulation completed.

##################### Parameters #####################
{'release_number': 0, 'number_infected_before_release': 100,
'stop_inflow_at_intervention': True, 'background_inmate_turnover': 20, 'rho':
0.0003, 'death_rate': 0.012, 'tau': 0.03, 'gamma': 0.07, 'max_time': 60, 'N':
3000, 'p': 0.02, 'percent_infected': 0.0035, 'percent_recovered': 0.0015,
'save_plot': True, 'title': 'Intervention A'}

##################### Results #####################
Total # of infections:  2948
Total # of deaths:  32.0
```



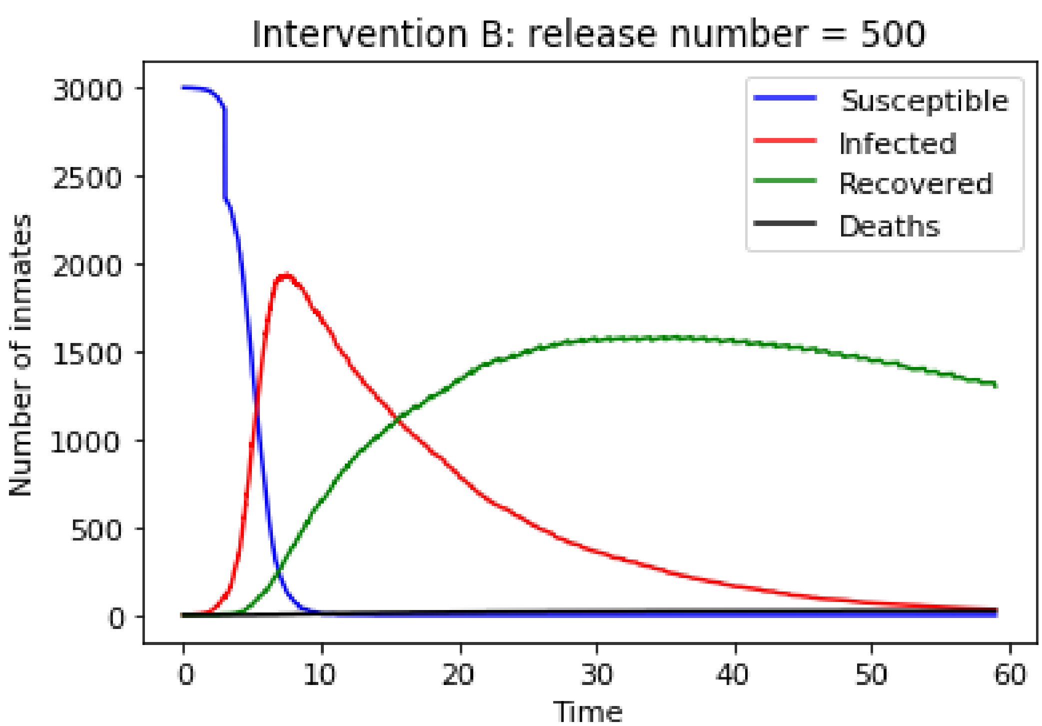

```
Plot saved with filename:
simulation_plot_release_number-0__num_inf_bf_release-100__stp_in_at_int-True__bc
k_turnover-20__rho-0.0003__death_rate-0.012__tau-0.03__gamma-0.07__max_time-60__
N-3000__p-0.02__percent_infected-0.0035__percent_recovered-0.0015__title-
Intervention A_
```

```
<Figure size 432x288 with 0 Axes>
```

2.3 Intervention B: release intervention and stopping of inmate intake

[95]:
```
t, S, I, R, D = (end_to_end(release_number=500,
                            number_infected_before_release=100,
                            stop_inflow_at_intervention=True,
                            save_plot=True,
                            title='Intervention B: release number = 500'))
```

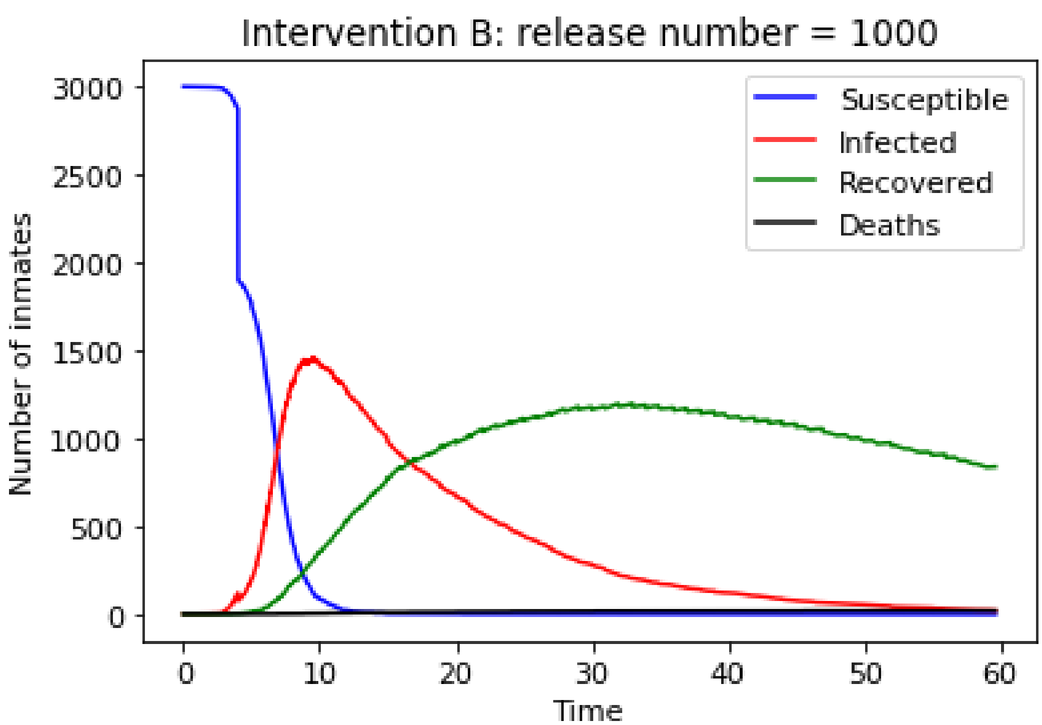
```
Starting simulation...
Release intervention condition met.
        Time: 3
        # of infected: 114
Stopping inmate inflow.
Simulation completed.

##################### Parameters #####################
{'release_number': 500, 'number_infected_before_release': 100,
'stop_inflow_at_intervention': True, 'background_inmate_turnover': 20, 'rho':
0.0003, 'death_rate': 0.012, 'tau': 0.03, 'gamma': 0.07, 'max_time': 60, 'N':
3000, 'p': 0.02, 'percent_infected': 0.0035, 'percent_recovered': 0.0015,
'save_plot': True, 'title': 'Intervention B: release number = 500'}

##################### Results #####################
Total # of infections:  2457
Total # of deaths:  26.0
```



```
Plot saved with filename:
simulation_plot_release_number-500__num_inf_bf_release-100__stp_in_at_int-True__
bck_turnover-20__rho-0.0003__death_rate-0.012__tau-0.03__gamma-0.07__max_time-60
__N-3000__p-0.02__percent_infected-0.0035__percent_recovered-0.0015__title-
Intervention B: release number = 500_

<Figure size 432x288 with 0 Axes>
```

[96]:
```
t, S, I, R, D = (end_to_end(release_number=1000,
                            number_infected_before_release=100,
                            stop_inflow_at_intervention=True,
                            save_plot=True,
                            title='Intervention B: release number = 1000'))
```

```
Starting simulation...
Release intervention condition met.
        Time: 4
        # of infected: 121
Stopping inmate inflow.
Simulation completed.

##################### Parameters #####################
{'release_number': 1000, 'number_infected_before_release': 100,
'stop_inflow_at_intervention': True, 'background_inmate_turnover': 20, 'rho':
0.0003, 'death_rate': 0.012, 'tau': 0.03, 'gamma': 0.07, 'max_time': 60, 'N':
3000, 'p': 0.02, 'percent_infected': 0.0035, 'percent_recovered': 0.0015,
'save_plot': True, 'title': 'Intervention B: release number = 1000'}

##################### Results #####################
Total # of infections:  1977
Total # of deaths:  20.0
```

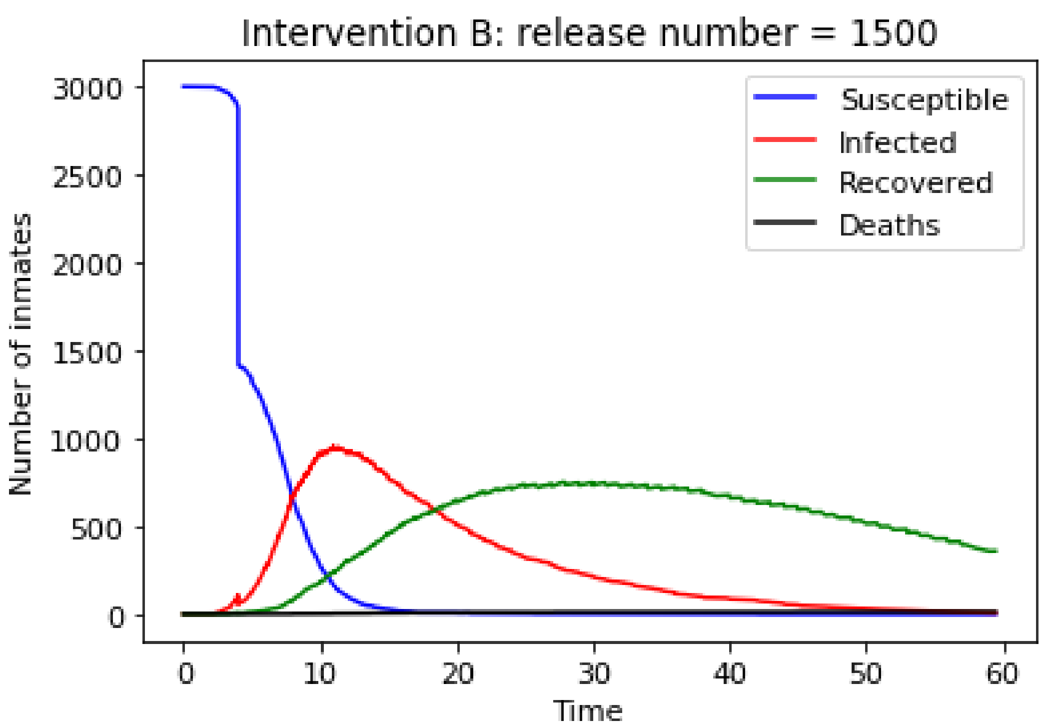


```
Plot saved with filename:
simulation_plot_release_number-1000__num_inf_bf_release-100__stp_in_at_int-True_
_bck_turnover-20__rho-0.0003__death_rate-0.012__tau-0.03__gamma-0.07__max_time-6
0__N-3000__p-0.02__percent_infected-0.0035__percent_recovered-0.0015__title-
Intervention B: release number = 1000_
```

```
<Figure size 432x288 with 0 Axes>
```

[117]:
```python
t, S, I, R, D = (end_to_end(release_number=1500,
                            number_infected_before_release=100,
                            stop_inflow_at_intervention=True,
                            save_plot=True,
                            title='Intervention B: release number = 1500'))
```

```
Starting simulation...
Release intervention condition met.
        Time: 4
        # of infected: 110
Stopping inmate inflow.
Simulation completed.

##################### Parameters #####################
{'release_number': 1500, 'number_infected_before_release': 100,
'stop_inflow_at_intervention': True, 'background_inmate_turnover': 20, 'rho':
0.0003, 'death_rate': 0.012, 'tau': 0.03, 'gamma': 0.07, 'max_time': 60, 'N':
3000, 'p': 0.02, 'percent_infected': 0.0035, 'percent_recovered': 0.0015,
'save_plot': True, 'title': 'Intervention B: release number = 1500'}

##################### Results #####################
Total # of infections:  1471
Total # of deaths:  14.0
```



```
Plot saved with filename:
simulation_plot_release_number-1500__num_inf_bf_release-100__stp_in_at_int-True_
_bck_turnover-20__rho-0.0003__death_rate-0.012__tau-0.03__gamma-0.07__max_time-6
0__N-3000__p-0.02__percent_infected-0.0035__percent_recovered-0.0015__title-
Intervention B: release number = 1500_
```

```
<Figure size 432x288 with 0 Axes>
```