BE 218 Computational Epidemiology January 2023

Assignment 1

Due: 23:59 hrs on 25/01/2023

1. Implement the SEIR model in a population of N individuals.

   - The discrete-time dynamics are as follows:

$$
\begin{aligned}
\Delta S(t) &= -\beta(t) S(t) \frac{I(t)}{N-1}, \\
\Delta E(t) &= \beta(t) S(t) \frac{I(t)}{N-1} - \alpha E(t), \\
\Delta I(t) &= \alpha E(t) - \gamma I(t), \\
\Delta R(t) &= \gamma I(t).
\end{aligned}
$$

   - Use the mean incubation period $\alpha^{-1} = 5.8$ days, mean recovery period $\gamma^{-1} = 5$ days, and the total population $N = 70$ million. You are simulating the evolution in Karnataka.
   - Use a cases to infections ratio (CIR) to report the number of 'reported cases'. The number of reported cases on day t is $\alpha E(t)/\mathsf{CIR}$.

2. Assume that $\beta(t) = \beta$ throughout. Seed an infection of 700 over 7 days by placing 100 in the exposed state for the first seven days. Take the $\mathsf{CIR} = 40$. This was the estimate from the serosurvey data of September 2020. Karnataka had a peak of about 10,000 cases in October 2020. By trial and error, identify the β that gets us to this peak. What is the duration from day 0 when you seeded the first 100 infections? What is the duration of the wave, from the time it first crossed 1000 cases to the time it went below 1000 cases?

Print them in the following standardised format:

```
>beta_trial_and_error: ##.##

>num_days_to_peak: ###

>num_days_greater_than_1000_cases: ###
```

3. Summarise your implementation and findings in the form of a pdf report of two pages (with plots). If you feel there is something interesting about your implementation or finding, describe it. Structure your report into three sections – implementation details, numerical results, discussion of the results.

Submit your code and report as a single firstname-lastname-assignment1.zip file that contains a single .py file (code) and a single .pdf file (report). The code should run and generate the plot(s) matching the peak in your report.