Numerical Method and Simulations

0.1 Isolation-only model with Case Importation

$$\frac{dS}{dt} = -\beta S(I_1 + I_2) \tag{1}$$

$$\frac{dI_1}{dt} = \beta S(I_1 + I_2) - (\mu + u_i)I_1 \tag{2}$$

$$\frac{dI_2}{dt} = \theta - \gamma I_2 \tag{3}$$

$$\frac{dw}{dt} = u_i I_1 \tag{4}$$

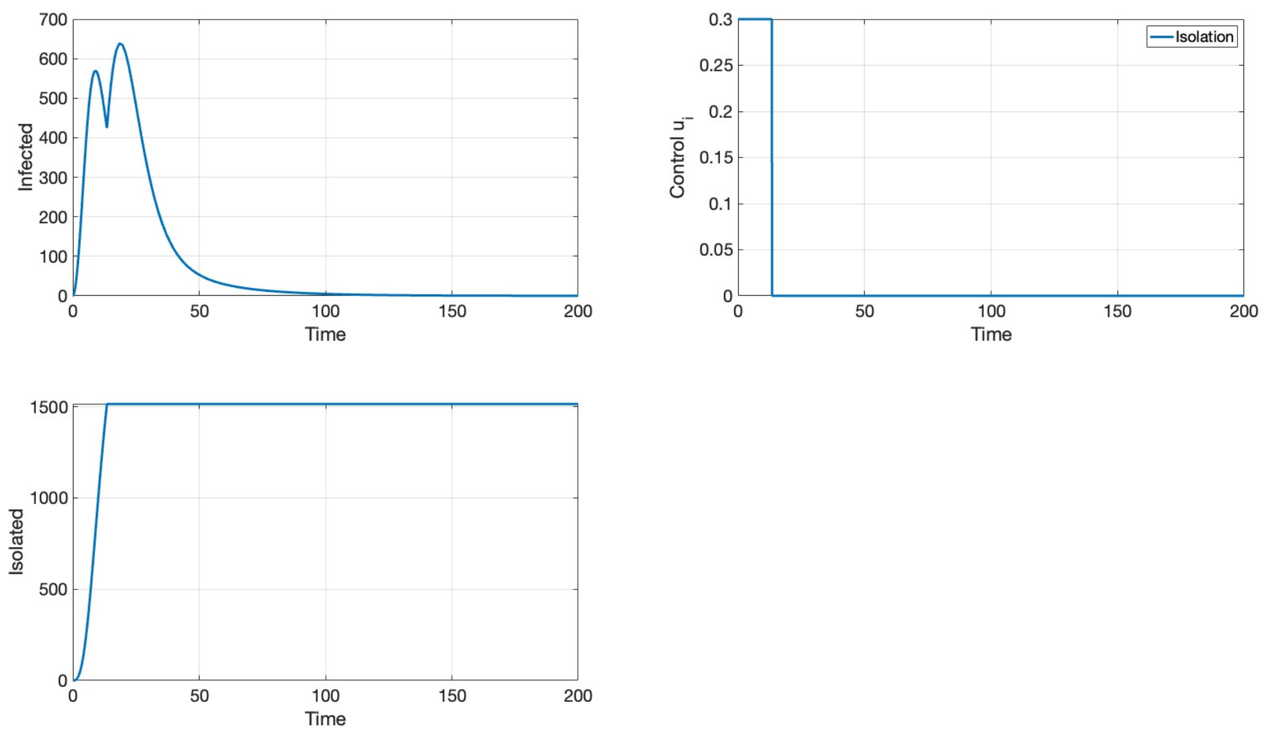


Figure 1: Dynamics of isolation-only model for $w_{max} = 1500,\ t_0 = 0$

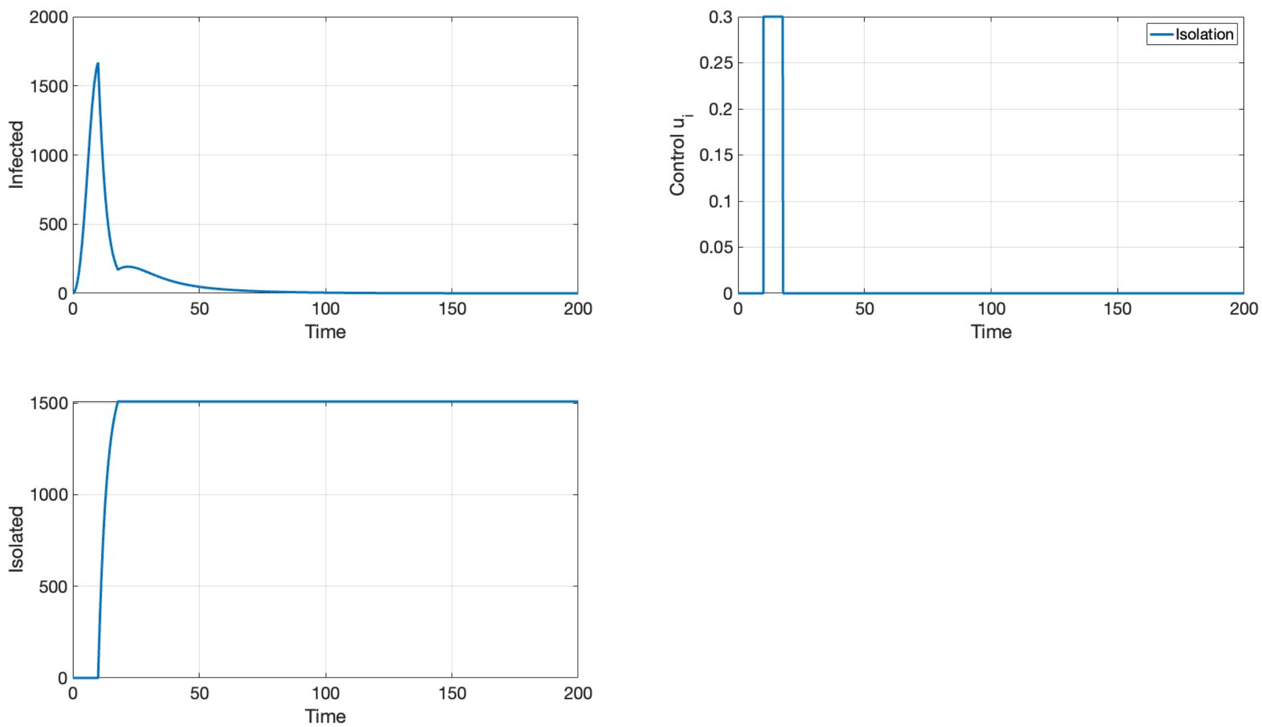


Figure 2: Dynamics of isolation-only model for $w_{max} = 1500,\ t_0 = 10$

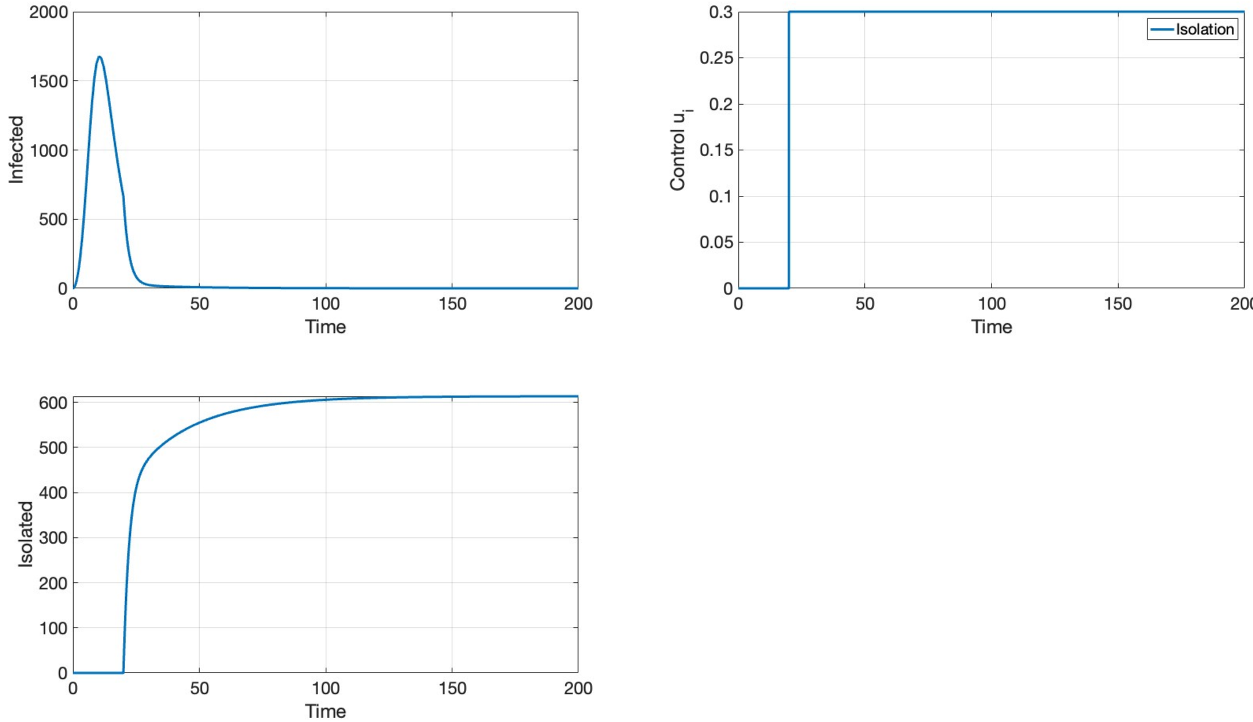
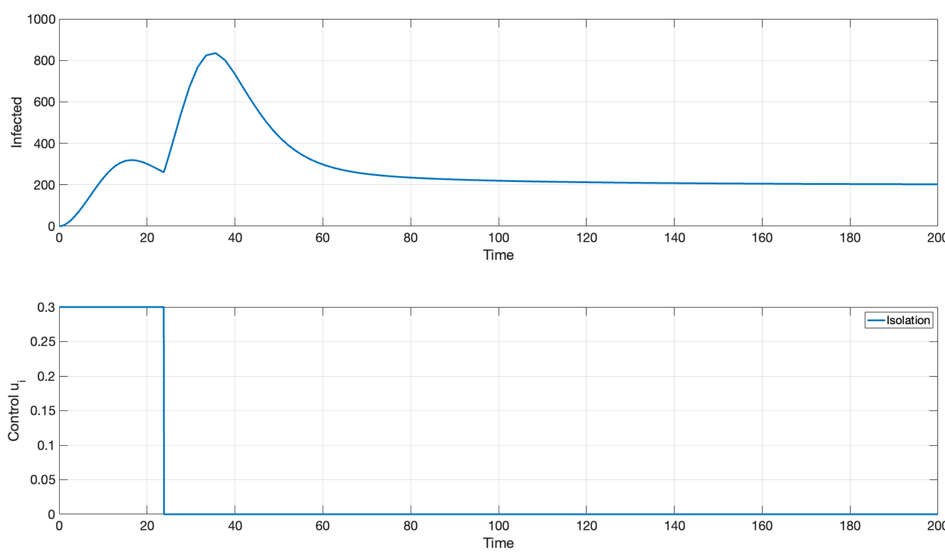


Figure 3: Dynamics of isolation-only model for $w_{max} = 1500,\ t_0 = 20$

Isolation-only	
Timing (t)	Objective Function Value (J)
Start control at $t = 0$	5097.3222
Start control at $t = 10$	4978.3124
Start control at $t = 20$	5066.9198

Our disease model assumes that infected travellers are only present for a short stay in the population. Consequently, over time, the count of infections declines to zero. However, when we incorporate into our model the scenario where infected travellers (I_2) add to the local spread of the disease (I_1) throughout the period, we reach a state of non-zero equilibrium.

$$\frac{dS}{dt} = -\beta S I_1 \tag{5}$$
$$\frac{dI_1}{dt} = \beta S I_1 - (\mu + u_i)I_1 + I_2 \tag{6}$$
$$\frac{dI_2}{dt} = \theta - \gamma I_2 \tag{7}$$
$$\frac{dw}{dt} = u_i I_1 \tag{8}$$



Under this condition, the community maintains a persistent level of infection due to the ongoing addition of new cases from infected travellers.

Now, on the issue of travel restrictions from the previous results:

Travel restrictions, when imposed just before or right after the peak of infections, result in a minimum value of the objective function. This is because fewer susceptible individuals remain at the infection's peak. By intensifying control measures during this time, we can significantly decrease the emergence of new infections, aligning with our objective of reducing the incidence of new cases. However, it's crucial to note that implementing these controls too early can lead to premature depletion of our available resources, rendering us unable to sustain isolation or travel restrictions. At this juncture, many individuals would still be vulnerable, and introducing new infections by arriving travellers could raise the number of new cases. This resurgence is primarily due to the steady inflow of infected individuals.