SEIcIscR Model

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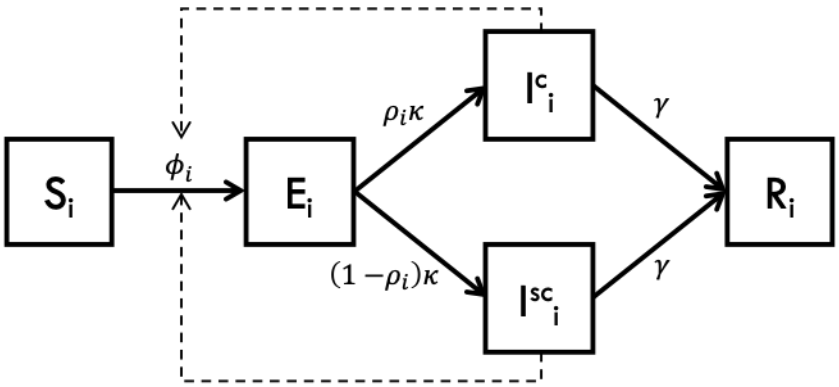
SEIcIscR Model is a cutting-aged model and simulates the COVID-19 spread in Wuhan.

It's an age-structured SEIR model with the assumption that all demographic changes in the population (i.e., births, deaths, and aging) are ignored. We divided all the people's ages into 16 groups and 5-year bands until age 70 years and a single category aged 75 and older.

The age-specific mixing patterns of individuals in age groups i alter their likelihood of being exposed to the virus given a certain number of infectious people in the population.

The model incorporated contributions of asymptomatic and sub-clinical cases which separated I Compartment into Ic and Isc Compartment and assumed that younger individuals are more likely to be asymptomatic (or sub-clinical) and less infectious than older individuals.

Model Description



For a given age group , epidemic transitions can be described by:

$$S_{i,t+1} = S_{i,t} - \beta S_{i,t} \sum_{j=1}^{n} C_{i,j} I^c_{j,t} - \alpha\beta S_{i,t} \sum_{j=1}^{n} C_{i,j} I^{SC}_{j,t}$$

$$E_{i,t+1} = \beta \sum_{j=1}^{n} C_{i,j} I^C_{j,t} + \alpha\beta S_{i,t} \sum_{j=1}^{n} C_{i,j} I^{SC}_{j,t} - (1-\kappa) E_{i,t}$$

$$I^C_{i,t+1} = \rho_i \kappa E_{i,t} + (1-\gamma) I^C_{j,t}$$

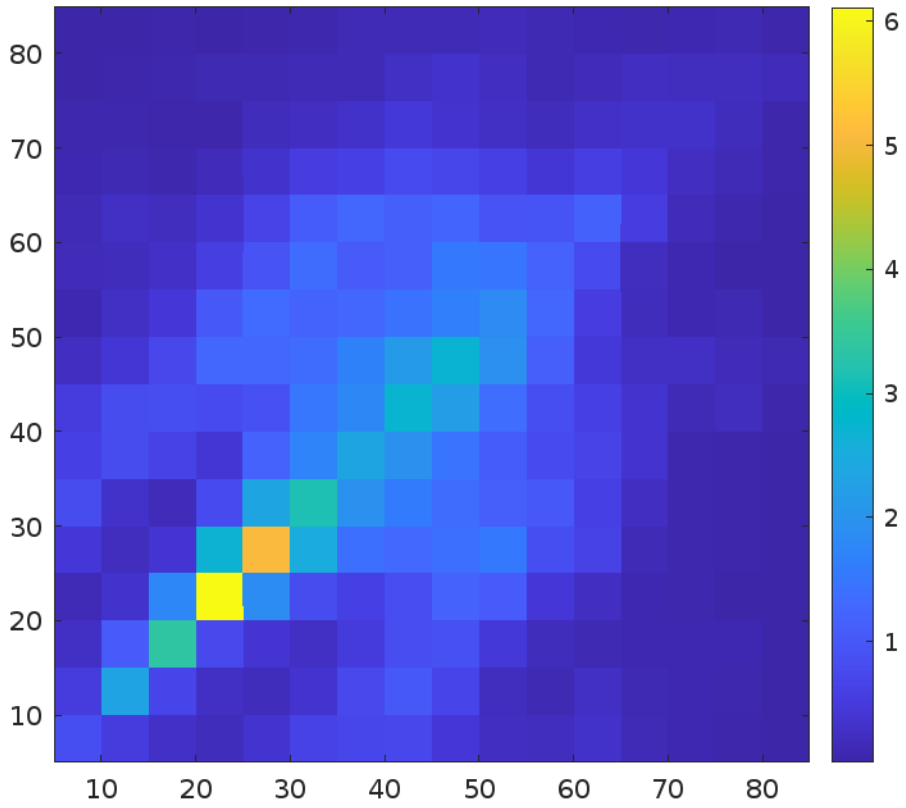
$$I^{SC}_{j,t+1} = (1-\rho_i)\kappa E_{i,t} + (1-\gamma) I^C_{j,t}$$

$$R_{i,t+1} = R_{i,t} + \gamma I^C_{j,t+1} + \gamma I^{SC}_{j,t+1}$$

Meaning of Parameters in the model:

$$
\begin{aligned}
\text{Basic reproduction number} &= R_o = 2.2 \\
\text{transmission rate} &= \beta = 0.025 \\
\text{number of age group} &= n = 16 \\
\text{Average incubation period} &= d_L = 6.4(\kappa = 1 - \exp(\frac{1}{d_L})) \\
\text{Average duration of infection} &= d_I = 7(\gamma = 1 - \exp(\frac{1}{d_I})) \\
\Pr(\text{infected case is clinical}) &= \rho_i = 0.4(i \leq 4), 0.8(i > 4) \\
\Pr(\text{infection acquired from subclinical}) &= \alpha = 0.25 \\
\text{Average duration of infection} &= d_I = 7
\end{aligned}
$$

$C_{i,j}$ describe the contacts of age group j made by age group i $(0 \leq i, j \leq n)$, the heat map is:



Reference

Prem K, Liu Y, Russell T W, et al. The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study[J]. The lancet public health, 2020, 5(5): e261-e270.

Ortega-Quijano D, Ortega-Quijano N. Impact of age-selective vs non-selective physical-distancing measures against coronavirus disease 2019: a mathematical modelling study[J]. International Journal of Epidemiology, 2021, 50(4): 1114-1123.