SIR vs SEIRD: Disease Transmission

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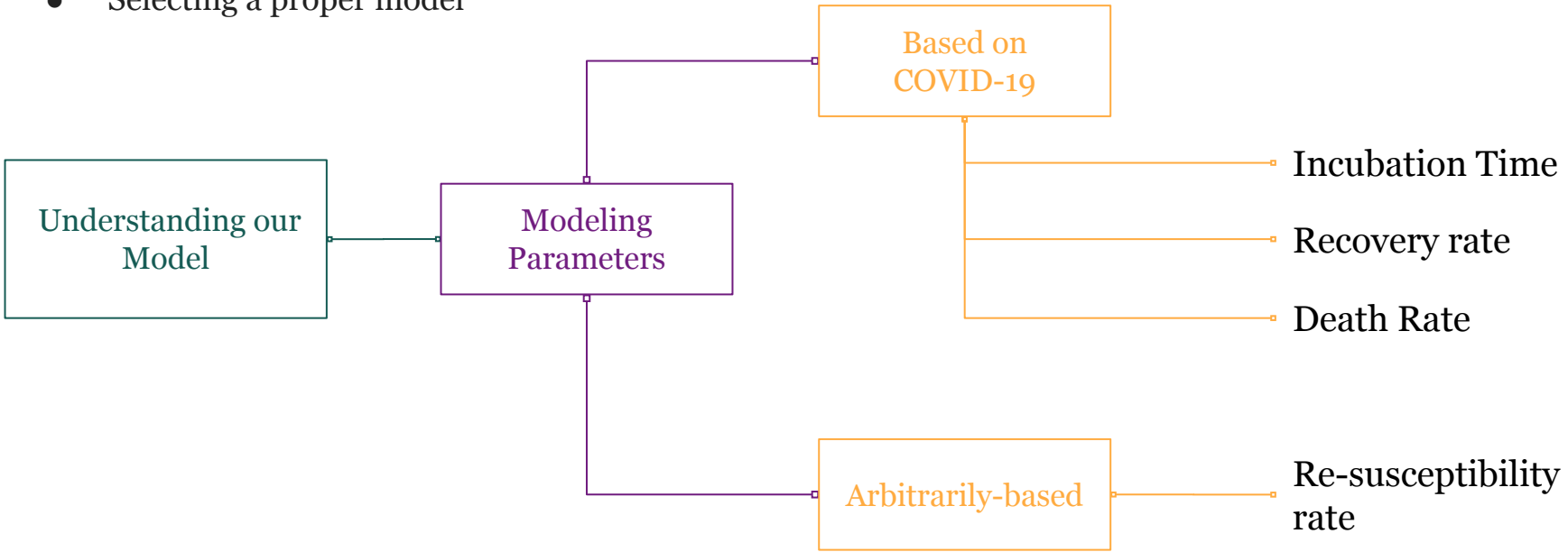
What are the key differences between the SIR and SEIRD models for disease transmission, particularly in how they differ in predicting the time and intensity of a secondary wave, when fit to the same first wave, across a range of infectivity values?

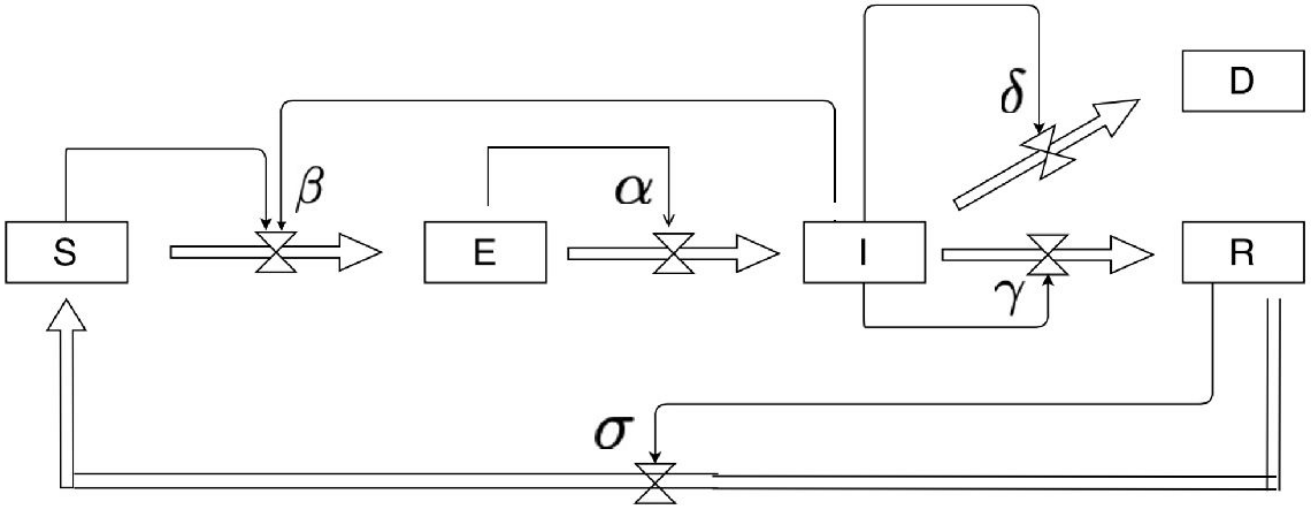
What makes it interesting and important?

Explanatory Question

- Behaviour of different models
- Selecting a proper model



SEIRD Model



Stock and flow diagram

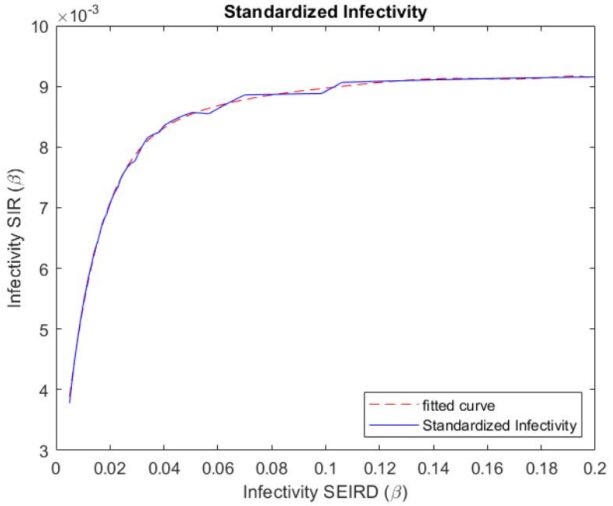
Update state Equations

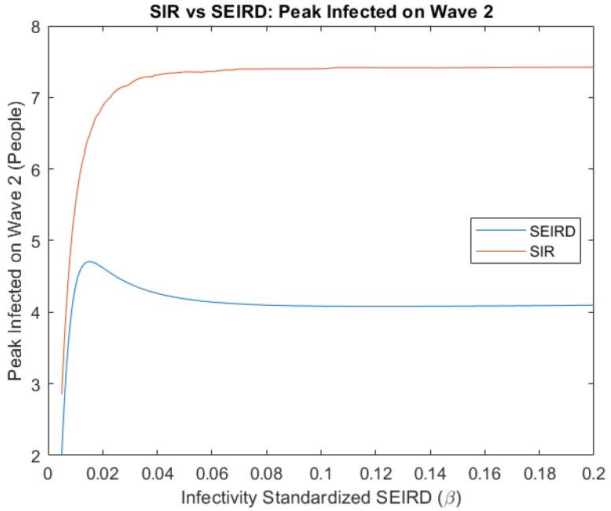
$$S_{n+1} = S_n - \beta IS + \sigma R$$
$$E_{n+1} = E_n - \alpha E + \beta IS$$
$$I_{n+1} = I_n - \gamma I - \delta I + \alpha E$$
$$R_{n+1} = R_n - \sigma R + \gamma I$$
$$D_{n+1} = D_n + \delta I$$

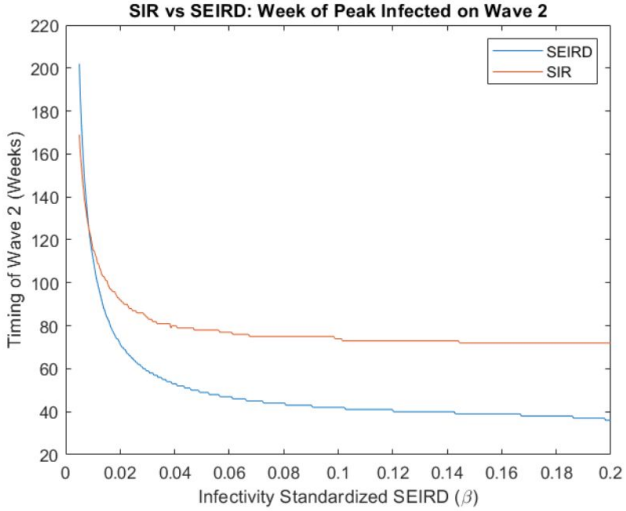
S: Susceptible
E: Exposed
I: Infectious
R: Recovered
D: Dead

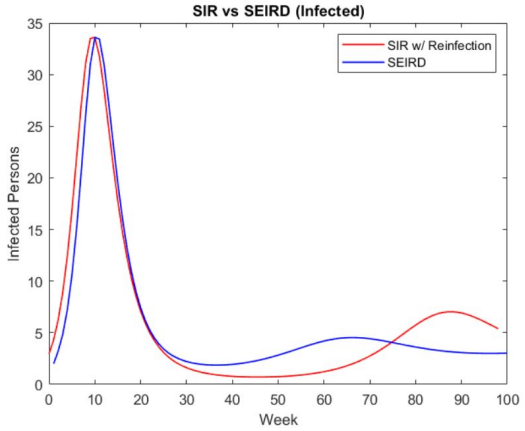
α : Incubation time
β : Infectivity
γ : Recovery
δ : Death
σ : Re-susceptibility

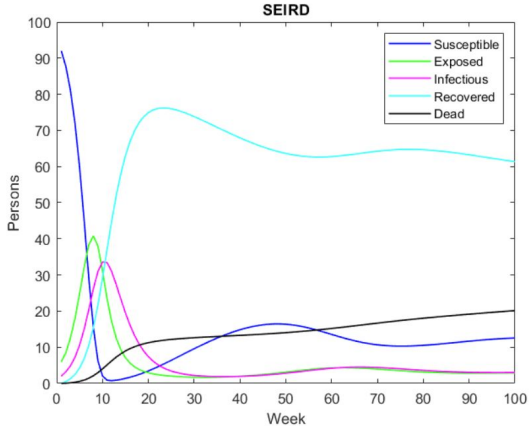
Results


Standardized Infectivity
×10^-3
Infectivity SIR (β)
Infectivity SEIRD (β)
fitted curve
Standardized Infectivity


SIR vs SEIRD: Peak Infected on Wave 2
Peak Infected on Wave 2 (People)
Infectivity Standardized SEIRD (β)
SEIRD
SIR


SIR vs SEIRD: Week of Peak Infected on Wave 2
Timing of Wave 2 (Weeks)
Infectivity Standardized SEIRD (β)
SEIRD
SIR


SIR vs SEIRD (Infected)
Infected Persons
Week
SIR w/ Reinfection
SEIRD


SEIRD
Persons
Week
Susceptible
Exposed
Infectious
Recovered
Dead

Interpretation

Results:

- Divergence in intensity & time of the second wave due to the Exposed stock
- No change in trends without dead stock
- Making alpha larger makes the inclusion of the Exposed stock increasingly negligible

Limitations:

- Inaccuracies in the starting value of Exposed individuals
- The inability to line up the first waves perfectly horizontally

Next steps:

- Standardizing infectivity
- Running the model on a daily-basis