The ODE model

The ODE model is implemented in R, the solver is ode45 which is based on an explicit Runge-Kutta (4,5) formula.

SIR - Hard Interventions

$$
\begin{aligned}
N &= S + I + R + V \\
\frac{dS}{dt} &= \frac{-\beta SI}{N} - \nu \\
\frac{dI}{dt} &= \frac{\beta SI}{N} - \gamma I \\
\frac{dR}{dt} &= \gamma I \\
\frac{dV}{dt} &= \nu
\end{aligned} \tag{3}
$$

SEIR - Hard Interventions

$$
\begin{aligned}
N &= S + E + I + R + V \\
\frac{dS}{dt} &= \frac{-\beta SI}{N} - \nu \\
\frac{dE}{dt} &= \frac{\beta SI}{N} - \delta E \\
\frac{dI}{dt} &= \delta E - \gamma I \\
\frac{dR}{dt} &= \gamma I \\
\frac{dV}{dt} &= \nu
\end{aligned} \tag{4}
$$

- β... transmission rate
- δ... latency rate
- γ...recovery rate (drawn from a normal distribution)
- ν... vaccinations per day (constant, albeit only whenever the intervention is activated, set to 0 otherwise)

SIR - Soft Interventions

$$
\begin{aligned}
N &= S + I + R \\
\frac{dS}{dt} &= \frac{-\beta SI}{N}\Theta \\
\frac{dI}{dt} &= \frac{\beta SI}{N}\Theta - \gamma I \\
\frac{dR}{dt} &= \gamma I
\end{aligned} \tag{1}
$$

SEIR - Soft Interventions

$$
\begin{aligned}
N &= S + E + I + R \\
\frac{dS}{dt} &= \frac{-\beta SI}{N}\Theta \\
\frac{dE}{dt} &= \frac{\beta SI}{N}\Theta - \delta E \\
\frac{dI}{dt} &= \delta E - \gamma I \\
\frac{dR}{dt} &= \gamma I
\end{aligned} \tag{2}
$$

- Θ... division factor of contacts (set to 1 when interventions are not active)

SIR - Soft+Hard Interventions

$$
\begin{aligned}
N &= S + I + R + V \\
\frac{dS}{dt} &= \frac{-\beta SI}{N}\Theta - \nu \\
\frac{dI}{dt} &= \frac{\beta SI}{N}\Theta - \gamma I \\
\frac{dR}{dt} &= \gamma I \\
\frac{dV}{dt} &= \nu
\end{aligned} \tag{5}
$$

SEIR - Soft+Hard Interventions

$$
\begin{aligned}
N &= S + E + I + R + V \\
\frac{dS}{dt} &= \frac{-\beta SI}{N}\Theta - \nu \\
\frac{dE}{dt} &= \frac{\beta SI}{N}\Theta - \delta E \\
\frac{dI}{dt} &= \delta E - \gamma I \\
\frac{dR}{dt} &= \gamma I \\
\frac{dV}{dt} &= \nu
\end{aligned} \tag{6}
$$