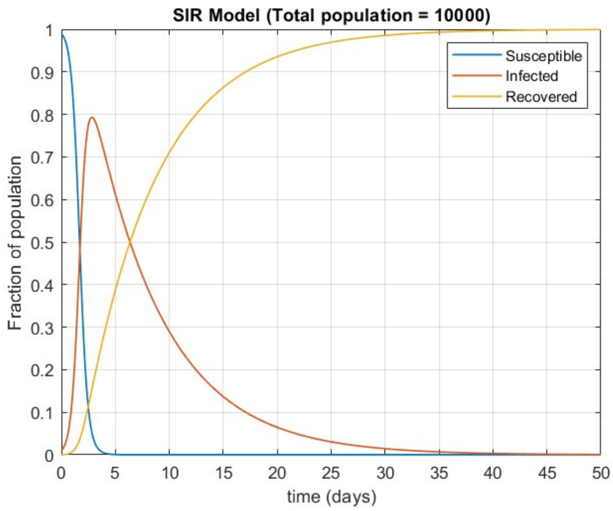
EPIDEMIOLOGICAL MODELLING

[1] Base SIR Model (Suspect, Infected, Recovered)

$$\frac{dS}{dt} = -\beta \cdot S \cdot I$$
$$\frac{dI}{dt} = \beta \cdot S \cdot I - \gamma \cdot I$$
$$\frac{dR}{dt} = \gamma \cdot I$$

$S =$ Susceptible population
$I =$ Infected population
$R =$ Recovered population
$\beta =$ Infection rate
$\gamma =$ Recovery rate

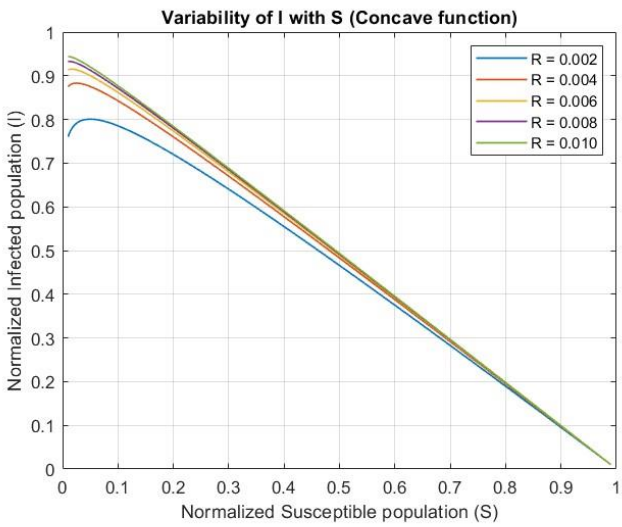


[2] Variation of susceptibility with infection rate in SIR model

$$\frac{dI}{dS} = \frac{\beta \cdot S \cdot I - \gamma \cdot I}{-\beta \cdot S \cdot I} = -1 + \frac{\gamma}{\beta \cdot S}$$
$$\int_{I(0)}^{I(t)} dI = \int_{S(0)}^{S(t)} \left[-1 + \frac{\gamma}{\beta \cdot S} \right] \cdot dS$$

$\Re_o = \dfrac{\beta}{\gamma}$; Reproduction number

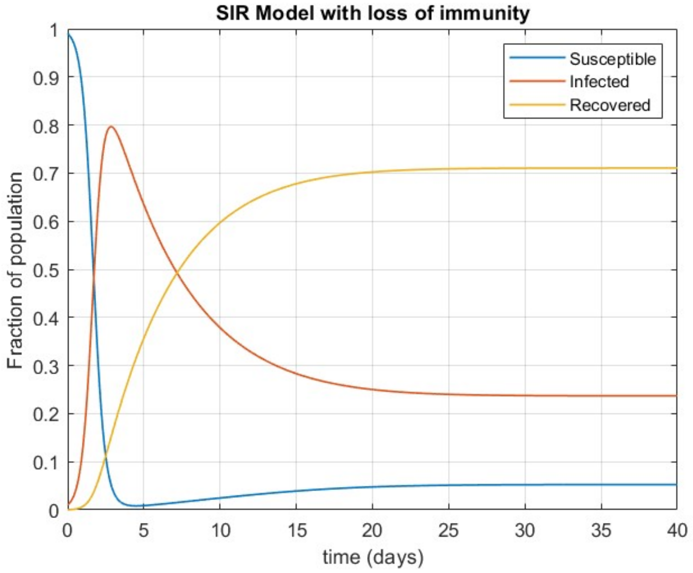
$$\int_{I(0)}^{I(t)} dI = \int_{S(0)}^{S(t)} \left[-1 + \frac{1}{\Re_o \cdot S} \right] \cdot dS$$



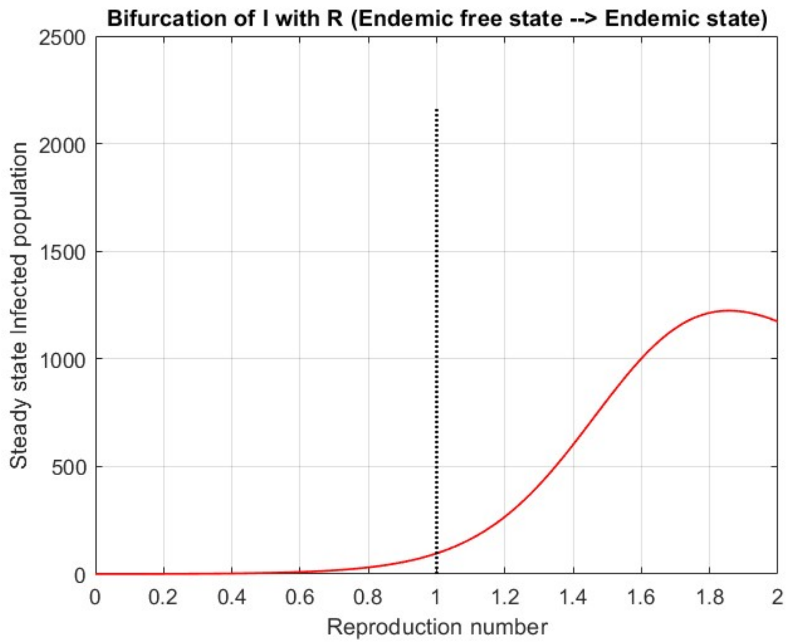
[3] SIR model with loss of immunity

$$\frac{dS}{dt} = -\beta \cdot S \cdot I + \alpha \cdot R$$
$$\frac{dI}{dt} = \beta \cdot S \cdot I - \gamma \cdot I$$
$$\frac{dR}{dt} = \gamma \cdot I - \alpha \cdot R$$

S = Susceptible population
I = Infected population
R = Recovered population
β = Infection rate
γ = Recovery rate
α = Rate of loss of immunity



[4] How the infection becomes endemic with changing reproduction number



[5] SIR model with vital dynamics (generic death)

$$\frac{dS}{dt} = -\beta \cdot S \cdot I + \alpha \cdot R + B - \mu \cdot S$$
$$\frac{dI}{dt} = \beta \cdot S \cdot I - \gamma \cdot I - \mu \cdot I$$
$$\frac{dR}{dt} = \gamma \cdot I - \alpha \cdot R - \mu \cdot R$$
$$B = \mu \cdot S + \mu \cdot I + \mu \cdot R = \mu \cdot N$$

β = Infection rate
γ = Recovery rate
α = Rate of loss of immunity
μ = Generic death rate