Some plots I made to fix/answer some of the problems in my draft

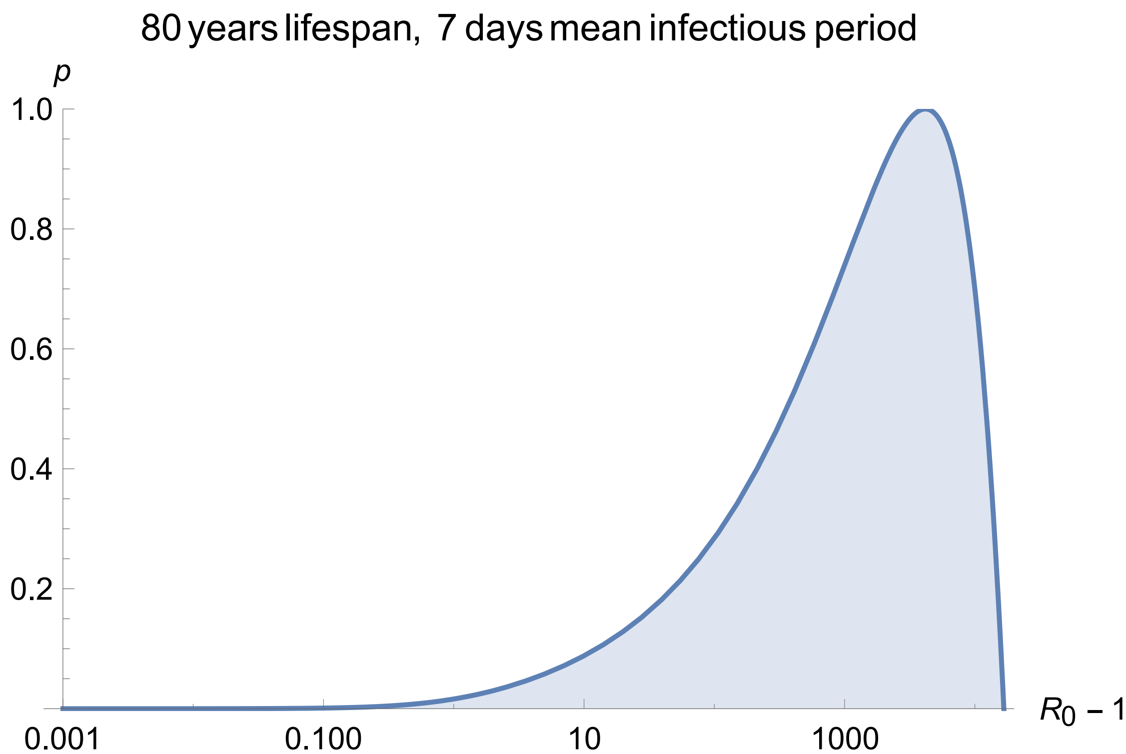
Roger Zhang

July 2nd 2018

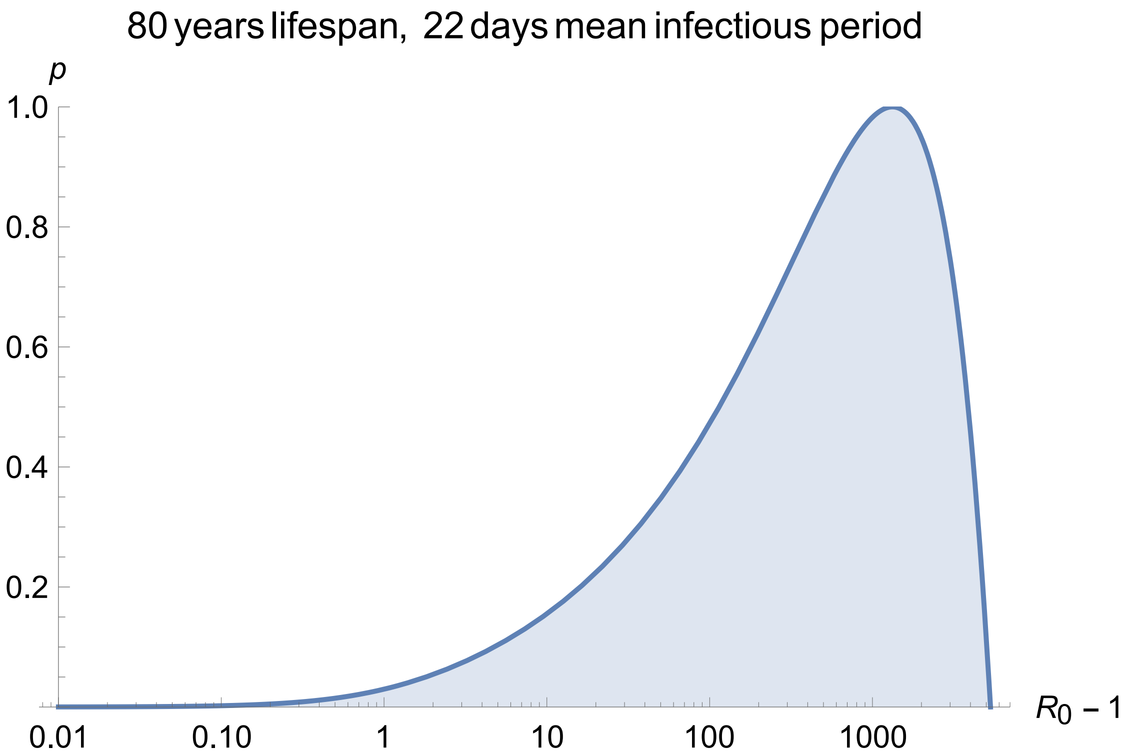
1 Dependence of discriminant on proportion of intentional infection (p) and basic reproduction number ($\mathcal{R}_0$)

Here I show several plot with different ϵ in increasing order.

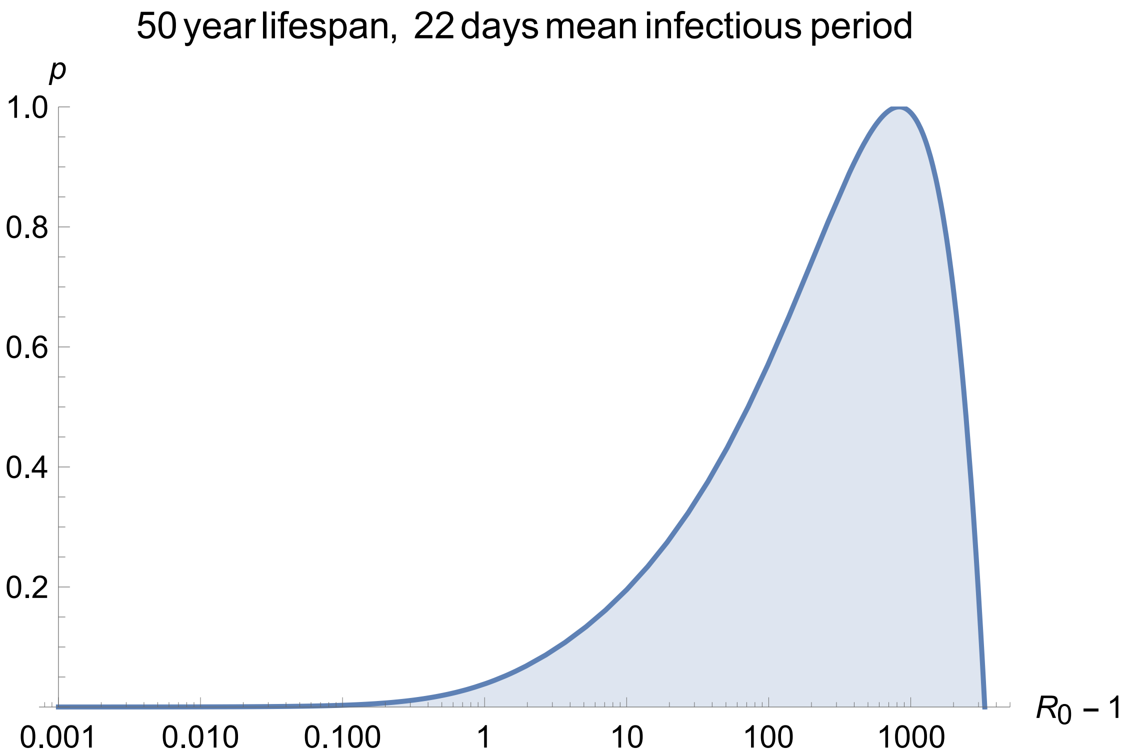
1.1 $\epsilon = \frac{7}{29207}$



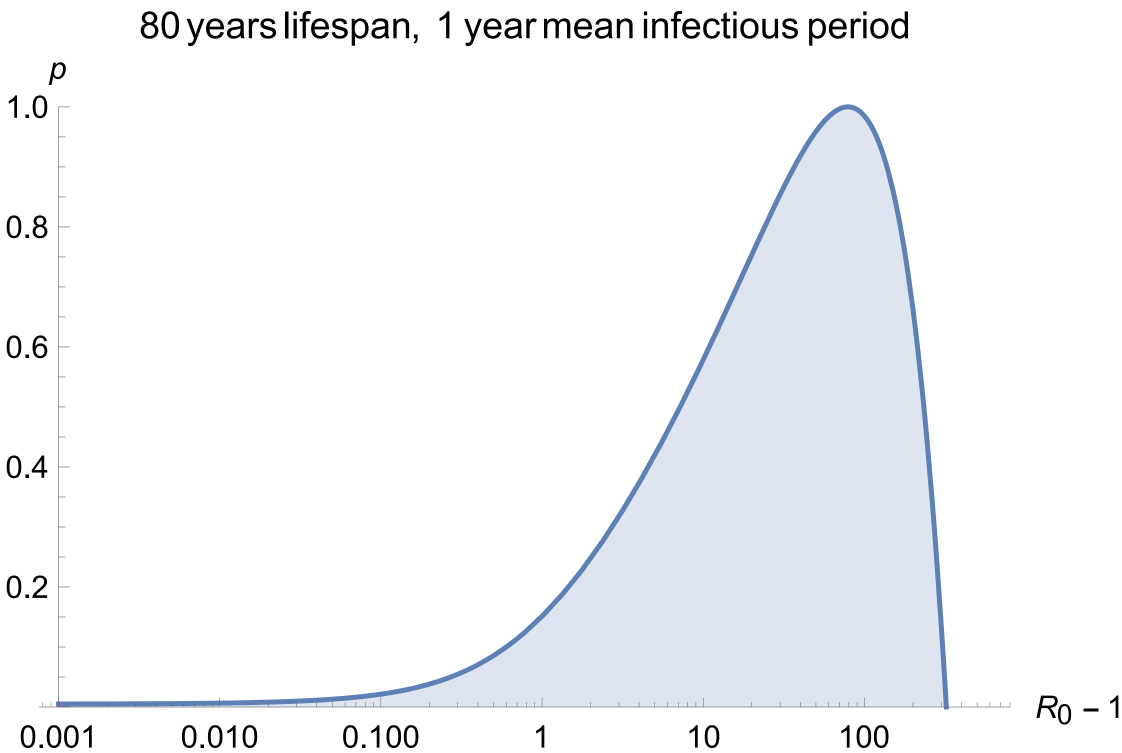
1.2 $\epsilon = \frac{11}{14611}$



1.3 $\epsilon = \frac{11}{9136}$



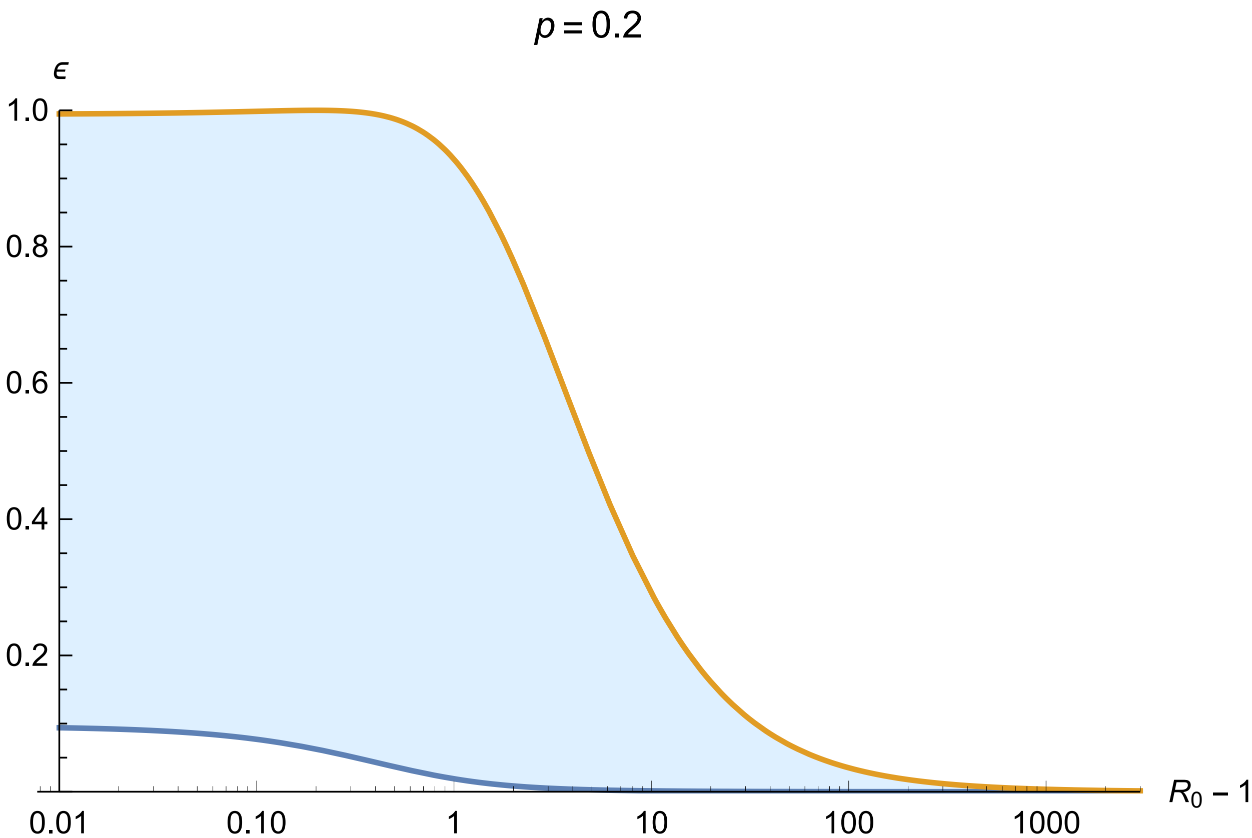
1.4 $\epsilon = \frac{1}{81}$



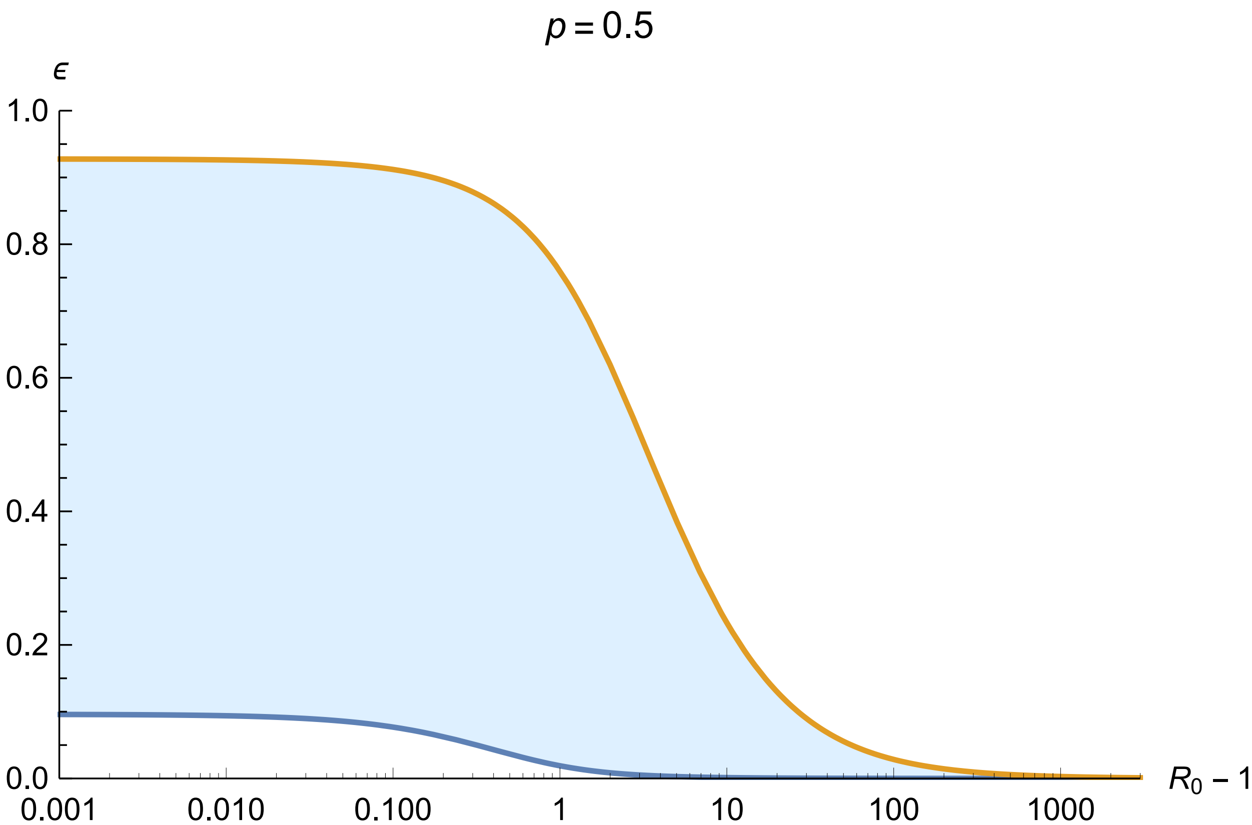
2 Plot ϵ as a function of $\mathcal{R}_0$

Again, I made plots with different p in increasing order

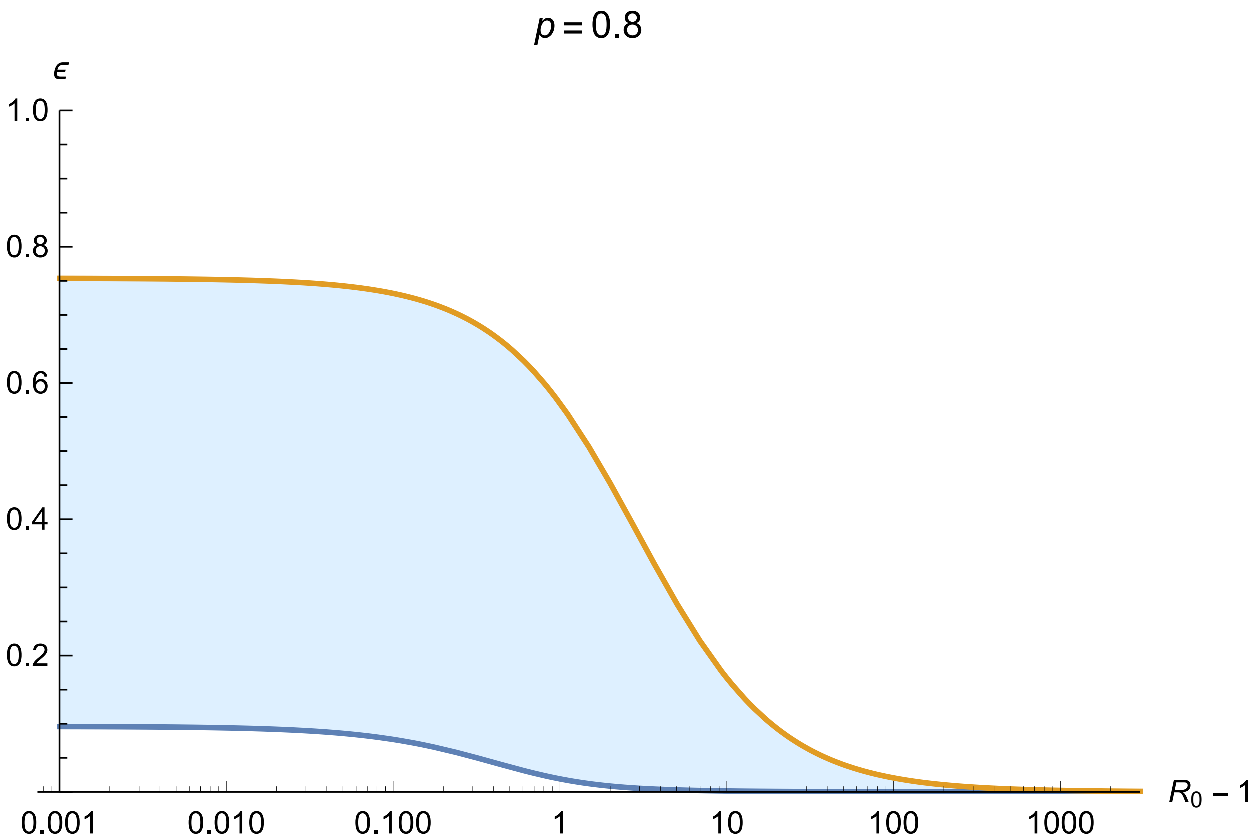
2.1 $p = 0.2$



2.2 $p = 0.5$



2.3 $p = 0.8$



3 Correct formulation for smallpox and variolation

We haven't found any evidence suggesting that, individuals infected variolated cases will have different severity of disease from normally infected cases. Here we assume variolation is not by using different strain, but just a different method of infection.

The correct formulation based on this assumption is shown in the following.

$$\frac{\mathrm{d}S}{\mathrm{d}\tau} = \epsilon(1-p) - \mathcal{R}_0 S(V+I) - \epsilon S\,, \tag{1a}$$
$$\frac{\mathrm{d}V}{\mathrm{d}\tau} = \epsilon p - V\,, \tag{1b}$$
$$\frac{\mathrm{d}I}{\mathrm{d}\tau} = \mathcal{R}_0 SV + \mathcal{R}_0 SI - I\,, \tag{1c}$$
$$\frac{\mathrm{d}M}{\mathrm{d}\tau} = p_V(1-\epsilon)V + p_I(1-\epsilon)I\,, \tag{1d}$$
$$\frac{\mathrm{d}R}{\mathrm{d}\tau} = (1-p_V)(1-\epsilon)V + (1-p_I)(1-\epsilon)I - \epsilon R\,, \tag{1e}$$

3.1 Equilibrium

By solving the system, we obtain one equilibrium,

$$\hat{S} = \frac{1+\mathcal{R}_0+\sqrt{1-2\mathcal{R}_0+\mathcal{R}_0^2+4p\mathcal{R}_0}}{2\mathcal{R}_0}\,, \tag{2a}$$
$$\hat{V} = \epsilon p\,, \tag{2b}$$
$$\hat{I} = \frac{\epsilon}{2}\left(1-2p-\frac{1}{\mathcal{R}_0}-\frac{\sqrt{1-2\mathcal{R}_0+4p\mathcal{R}_0+\mathcal{R}_0^2}}{\mathcal{R}_0}\right) \tag{2c}$$