**I and E equations in matrix form**

$$\begin{pmatrix} -\frac{1}{\tau_{inf}} & \frac{1}{\tau_{inc}} \\ \frac{R}{\tau_{inf}} & -\frac{1}{\tau_{inc}} \end{pmatrix} = S^{-1}DS \tag{1}$$

$$\begin{pmatrix} I \\ E \end{pmatrix}_t = S^{-1}DS \begin{pmatrix} I \\ E \end{pmatrix} \tag{2}$$

The exponential times are the eigenvalues ( diagonal entries in D ). There is one positive and one negative eigenvalue. Early in the epidemic all compartments ( S, E, I and R ) grow with the same exponential rate given by the positive eigenvalue Given the $\tau$ values for COVID-19 even at a later stage the single exponential rate ( though slowly variable ) is still a good approximation as the negative e-value is much larger in absolute value ( -0.63 vs 0.044 for LA ). The exponential rate is taken from the observed positive case growth as it too would have the same exponent as pure S, E, I and R compartments. Then the R value can be calculated region by region

**Initial Conditions**

$$R(t_0) = I_0 \frac{\tau}{\tau_{inf}}(\exp(\frac{t_0}{\tau}) - 1) \approx K\frac{\tau}{\tau_{inf}} \tag{3}$$

$$I(t_0) = K \tag{4}$$

$$E(t_0) = \frac{E_0}{I_0}K, \ \frac{E_0}{I_0} = \tau_{inc}(\frac{1}{\tau} + \frac{1}{\tau_{inf}}) \tag{5}$$