MODEL

$$\begin{aligned}
\mathbf{z} &= [X, Y, W, Z, V] \text{ Model Compartments} \\
\mathbf{q} &= [\lambda, d, \beta, a, p, c, q, b, h, k, \mu, f] \text{ Parameters} \\
\log \hat{\mathbf{z}}_{\mathbf{i}} &= \log \mathbf{z}_{\mathbf{i}} + \eta * N[0,1] \text{ Simulated Data} \\
C &= \text{ Observation matrix}
\end{aligned}$$

INVERSE PROBLEM

$$\min_{q \in Q_{ad}} J(q) = \frac{\sum_i |\log(C * \mathbf{z}(t_i, \mathbf{q})) - \log(C * \hat{\mathbf{z}}_{\mathbf{i}})|^2}{\sigma_i^2} \text{ Cost Function}$$

SENSITIVITY

$$\begin{aligned}
\frac{\partial J}{\partial \mathbf{q}}(\mathbf{q_0}) &= \sum_i 2 \frac{\log(C * \mathbf{z}(t_i, \mathbf{q_0})) - \log(C * \hat{\mathbf{z}}_{\mathbf{i}})}{\sigma_i^2} \cdot \frac{C^T}{C * \mathbf{z}(t_i, \mathbf{q_0})} \left(\frac{\partial \mathbf{z}}{\partial \mathbf{q}}(t_i, \mathbf{q_0}) \right) \\
\frac{\partial \mathbf{z}}{\partial \mathbf{q}} &= \text{Sensitivity Matrix}
\end{aligned}$$