Introduction

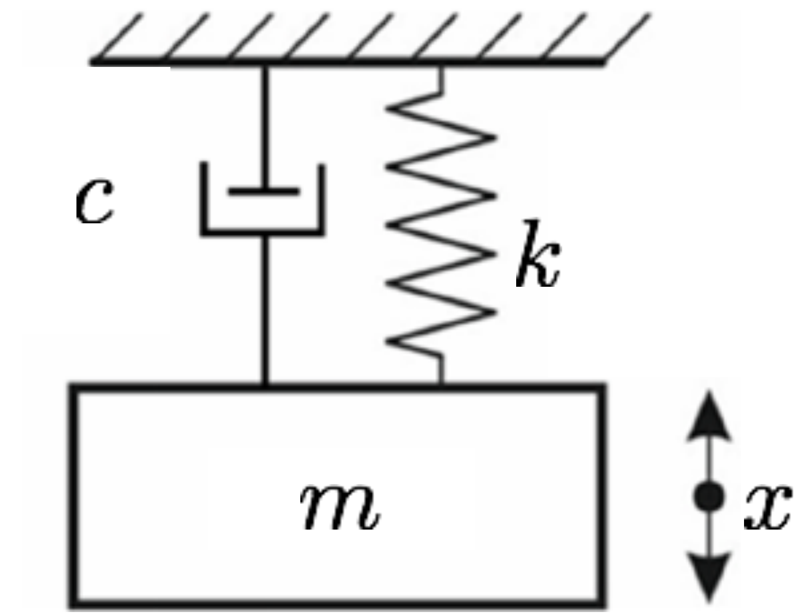
Reliable Physical Theory

Example: Mass-Spring-Damper, Approximated System

$$\mathcal{R}(\mathbf{u}, \tau_{\mathbf{m}}; \mathbf{r}) = \mathbf{0}$$

$$\boxed{m\ddot{x} + c\dot{x} + kx = 0}$$

$$\mathbf{u} = \begin{bmatrix} x \\ \dot{x} \end{bmatrix} \qquad \tau = \begin{bmatrix} c \\ k \end{bmatrix} \qquad \mathbf{r} = \begin{bmatrix} m \\ x(0) \\ \dot{x}(0) \end{bmatrix}$$



Approximated Embedded Model

The true physics of the damper are not well-understood by the modeler

$$\tau_m = (\cancel{\mathbf{u}}, \cancel{\mathbf{v}}, \cancel{\mathbf{s}}, \theta)$$

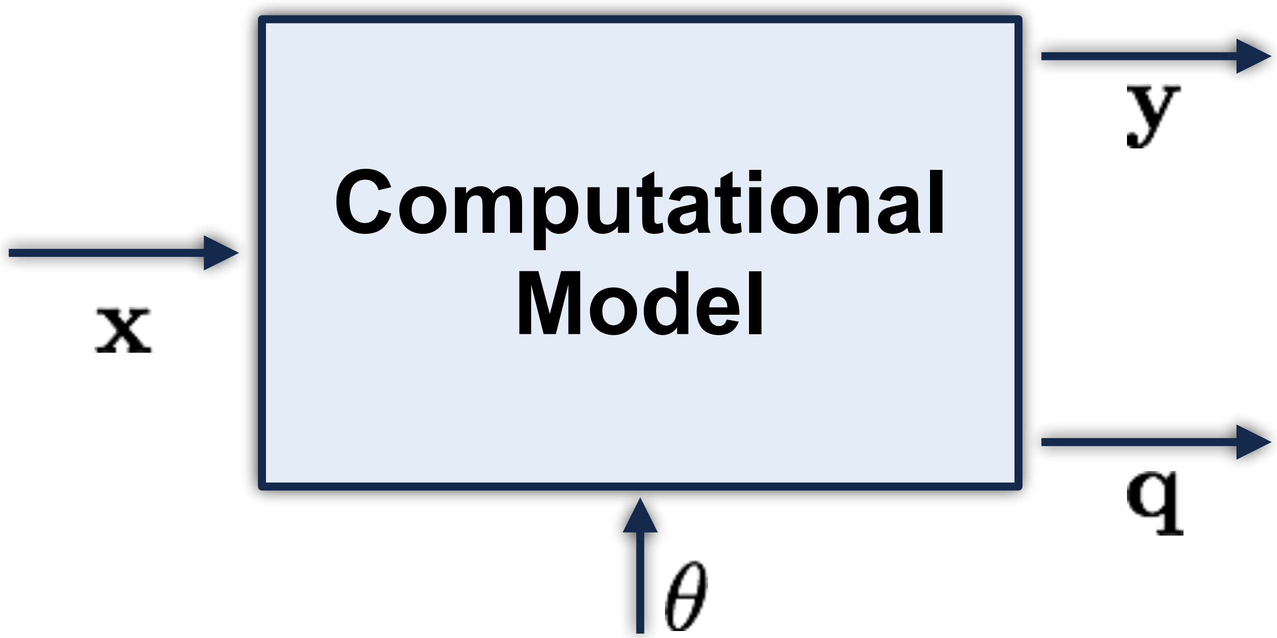
$$\boxed{\begin{aligned} k &= \text{const} \\ c &= \text{const} \end{aligned}}$$

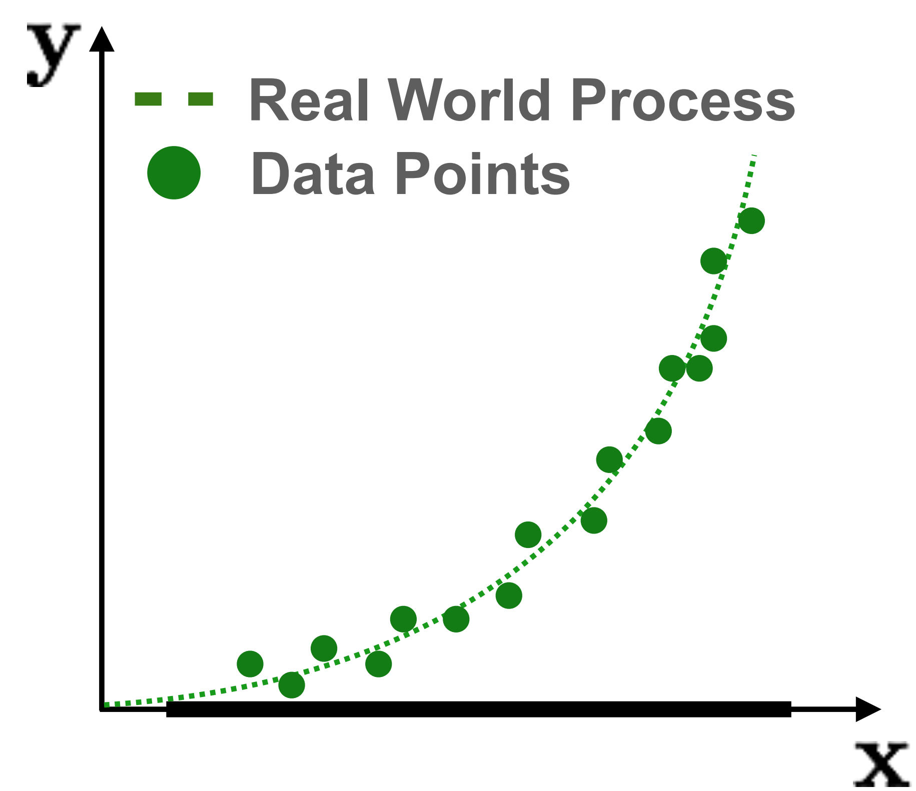
$$\theta = \begin{bmatrix} c \\ k \end{bmatrix}$$

$$\boxed{\begin{aligned} \mathbf{y} &= x \\ \mathbf{q} &= \max(\dot{x}) \end{aligned}}$$

Classic Approach to Validation

One approach [2] for taking into account the uncertainties on the predictions relies on "appending" a statistical model directly to the observable quantities:





[2] Kennedy, M.C. and O'Hagan, A., "*Bayesian Calibration of Computer Models*", Journal of the Royal Statistical Society: Series B, Vol. 63, 2001.