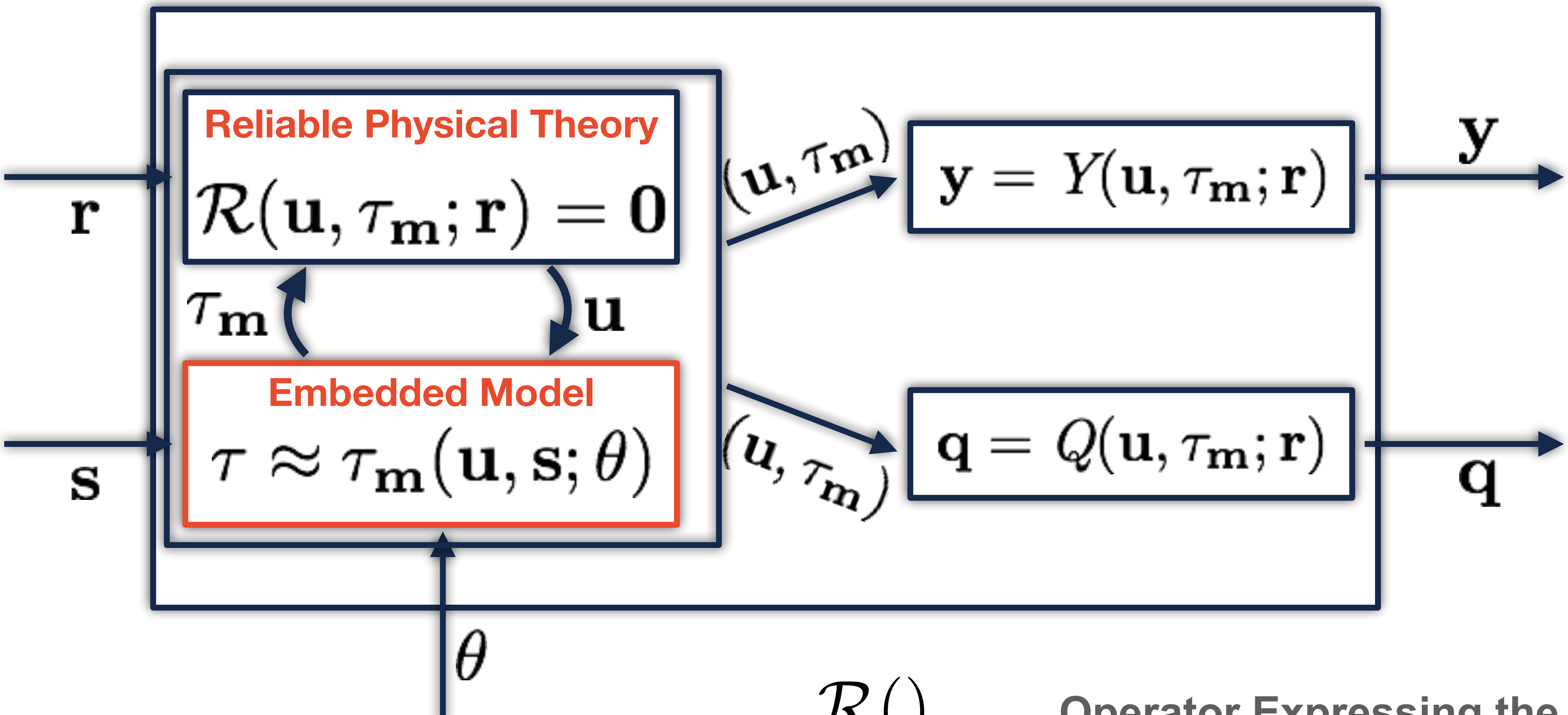
Introduction

If τ where known in terms of $(\mathbf{u}, \mathbf{r})$, the system would be closed. However, it is often the case that the required relationship between τ and $(\mathbf{u}, \mathbf{r})$ is unknown or does not exist.



τ

$\mathcal{R}()$	Operator Expressing the Theory
$\mathbf{u}$	State Variable
$\tau_{\mathbf{m}}$	Closure Variables
θ	Parameters of the Embedded Model
$\mathbf{r} \cup \mathbf{s} = \mathbf{x}$	Input for the Scenario

Introduction

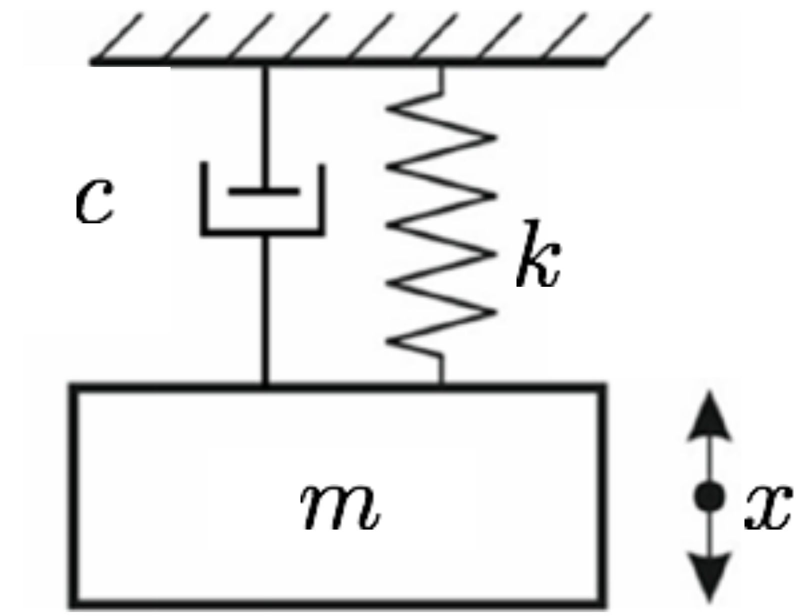
Reliable Physical Theory

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

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

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

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

$$\mathbf{y} = x$$
$$\mathbf{q} = \max(\dot{x})$$