Calibration of computer models

Introduction

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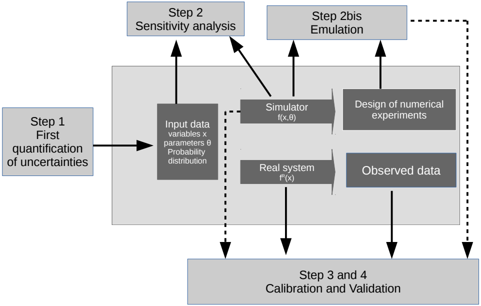
Uncertainty Quantification / Model Uncertainty



In this talk we will focus on calibration and validation.

Ref.: Kennedy and O'Hagan (2001), Hidgon et al. (2005), Bayarri et al. (2007).

Calibration of a computer code

Computer experiments:

Computer model (simulator) $(\mathbf{x}, \boldsymbol{\theta}) \mapsto f(\mathbf{x}, \boldsymbol{\theta}) \in \mathbb{R}^s$ where

- **physical parameters**: $\mathbf{x} \in \mathbb{X} \subset \mathbb{R}^p$ observable and often controllable inputs
- **simulator parameters**: $\boldsymbol{\theta} \in \Theta \subset \mathbb{R}^d$ non-observable parameters, required to run the simulator.

  2 types:
  - "calibration parameters": physical meaning but unknown, necessary to make the code mimic the reality,
  - "tuning parameters": no physical interpretation.

Goal:
Calibrate the code: finding "best" or "true" $\boldsymbol{\theta}$ from real observations / field data (provided by physical experiments):

$$\mathbf{y} = \{y_1 = \zeta(\mathbf{x}_1), \dots, y_n = \zeta(\mathbf{x}_n)\},$$

where ζ is the real physical phenomenon.

Validation

- Validation (rather than verification) is considered,
- Does the computer simulator correspond to field data?

$$\exists \boldsymbol{\theta}^*?, \text{ s.t., } \forall \mathbf{x}, \quad f(\mathbf{x}, \boldsymbol{\theta}^*) \approx y(\mathbf{x})$$

- This question is related with intended use of the simulator: range of **x**, required precision...
- Biased computer model, no setting of calibrated parameters leads to outputs close to field data
  $\Rightarrow$ discrepancy.
- Do we want to validate the computer model itself or the computer model with the bias / discrepancy correction?