

Model Calibration, Uncertainty & Global Sensitivity — Hands-on

Learn how to turn qualitative fits into quantitatively calibrated and stress tested systems models. This module walks through parameter estimation workflows, uncertainty quantification and global sensitivity analysis so that you can defend model predictions and focus on parameters and mechanisms that truly matter.

Model Calibration, Uncertainty & Global Sensitivity

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Session Index

[Session 1 — Parameter Estimation & Calibration Basics](#) [Session 2 — Bayesian Calibration & Identifiability](#) [Session 3 — Uncertainty Quantification & Global Sensitivity](#) [Session 4 — Mini Capstone: Calibrated & Stress Tested Model](#)

Session 1

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Parameter Estimation & Calibration Basics

Error models and objective functions for calibration

[least squares and likelihood views](#) [measurement noise assumptions](#) [cost surfaces and minima intuition](#)

Local optimisation and gradient based methods

[Levenberg Marquardt style ideas](#) [handling bounds](#)

and constraints **practical convergence diagnostics**

Good practices for calibration experiments and data use

separation of training and validation data **scaling**
and normalisation of readouts **simple residual and fit checks**

Session 2

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Bayesian Calibration & Identifiability

Bayesian view of parameter estimation

priors likelihood and posteriors **credible intervals**
for parameters **prediction intervals vs fits**

MCMC and sampling concepts for calibration

random walk and adaptive schemes **burn in mixing**
and diagnostics **posterior summaries and plots**

Structural and practical identifiability basics

non identifiable parameter combinations **profile**
likelihood style thinking **design hints to improve**
identifiability

Session 3

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Uncertainty Quantification & Global Sensitivity

Sources and types of uncertainty in systems models

parameter and structural uncertainty **observation and**
process noise **scenario and input uncertainty**

Sampling based uncertainty propagation

Latin hypercube and Monte Carlo ideas **prediction**

bands and fan plots **communicating uncertainty clearly**

Global sensitivity: screening and variance based methods

Morris screening concepts **Sobol indices intuition**
linking sensitivity to design choices

Session 4

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Mini Capstone: Calibrated & Stress Tested Model

Select a small systems model and data set for calibration

Theory + Practical

Calibrate parameters and map uncertainty and sensitivity

run basic optimisation or sampling **generate prediction intervals** **compute simple global sensitivity indices**

Deliverables: calibrated model, UQ plots and sensitivity summary

SBML or notebook implementation **tables of parameter and sensitivity metrics** **short interpretation and limitations note**