

Experimental Modelling

Model identification for a water heater (real data).

The system to be modeled is a water heater, where:

- Input: resistor voltage (measured in percentage).
- Output: water temperature (measured in Celsius degree).

Problem:

- 1) Identify ARX, OE, NARX and NOE models of different orders using experimental data.
- 2) Compare the identified models on a set of data not used for identification. To assess the model quality, consider the following criteria:

- $RMSE = \|\tilde{y} - \hat{y}\| / \sqrt{L}$ or $FIT = 100 \left(1 - \frac{\|\tilde{y} - \hat{y}\|}{\|\tilde{y} - \text{mean}(\tilde{y})\|}\right)$, where \tilde{y} = measured output signal, $\hat{y}(t)$ = simulated (or predicted) output signal, $L = \text{length}(\tilde{y})$.

- Model order.

Procedure:

Data organization:

- 1) Load the data from the file “heater.mat”. The complete data set is composed of two subsets:

- Identification data set (IS):

- ue: 2000 input measurements.
- ye: 2000 output measurements.

- Validation data set (VS):

- uv: 1000 input measurements.
- yv: 1000 output measurements.

The measurements have been collected with a sampling time of 3 s.

- 2) Remove the mean from all the measured signals.

Model identification (data set IS)

- 3) Identify several ARX(na,nb,nk) and OE(nb,nf,nk) models considering different values of na, nf, nb and nk.

- 4) Identify several NARX(na,nb,nk) and NOE(na,nb,nk) models considering different values of na, nb and nk, and different values of the number of basis functions (neurons) r in the interval $[1, 20]$.

Model validation (data set VS)

- 5) Compare the identified models in one-step ahead prediction and in simulation, considering the plot of simulated (or predicted) and measured data, the RMSE error (or the FIT index), and the model order.