PROBLEM NL1

With reference to the pH neutralization process data:

- ftp://ftp.esat.kuleuven.be/pub/SISTA/data/process_industry/pHdata.dat.gz
- ftp://ftp.esat.kuleuven.be/pub/SISTA/data/process_industry/pHdata.txt
- (see also the process description in the cited paper)

perform a nonlinear model identification using both the FROE method with polynomial NARX models and feedforward neural networks. Divide the dataset in identification and validation data (take care of representing all possible conditions in both datasets). Use the former only for model estimation and the latter for model evaluation, both in terms of prediction and simulation accuracy. Compare the results with different model complexity assumptions.

References:

- T.J. Mc Avoy, E. Hsu and S. Lowenthal, "Dynamics of pH in controlled stirred tank reactor", *Ind. Eng. Chem. Process Des. Develop.*, vol. 11, pp. 68–70, 1972.

PROBLEM NL2

With reference to the heat exchanger data:

- ftp://ftp.esat.kuleuven.be/pub/SISTA/data/process_industry/exchanger.dat.gz
- ftp://ftp.esat.kuleuven.be/pub/SISTA/data/process_industry/exchanger.txt
- (see also the process description in the cited paper)

perform a nonlinear model identification using both the FROE method with polynomial NARX models and feedforward neural networks. Divide the dataset in identification (first 3000 data) and validation data (the remaining 1000 data). Use the former only for model estimation and the latter for model evaluation, both in terms of prediction and simulation accuracy. Compare the results with different model complexity assumptions.

References:

- S. Bittanti and L. Piroddi, "Nonlinear identification and control of a heat exchanger: a neural network approach", Journal of the Franklin Institute, vol. 334B, pp. 135–153, 1997.

PROBLEM NL3

The listed reference compares different old and new nonlinearity tests. Implement the tests and try them on the documented examples.

References:

- T. Knudsen, "Test for Nonlinear Input Output Relations in SISO Systems by Preliminary Data Analysis".

PROBLEM NL4

The listed reference compares two different algorithms for the identification of Wiener-Hammerstein systems. Code the two algorithms in Matlab and test them on the given simulation example.

References:

- M. Schoukens, E.W. Bai, and Y. Rolain, "Identification of Hammerstein-Wiener Systems", *16th IFAC Symposium on System Identification*, pp. 274-279, Brussels, Belgium, July 11-13, 2012.

PROBLEM NL5

With reference to the Coupled Electric Drives data:

- http://www.it.uu.se/research/publications/reports/2010-020/NonlinearData.zip (files DATAPRBS.MAT and DATAUNIF.MAT)
- (see also the description of the example and of the data in Sec.s 2 and 4 of the PDF file, respectively)

perform a nonlinear model identification of the SISO system with the FROE algorithm, using NARX or NARMAX models. Use one data-set for identification and the other for validation. Compare the results on the validation data, both in terms of prediction and simulation accuracy.

PROBLEM NL6

The identification of hybrid systems, where the dynamics may switch from one model to another, is important in several applications. Implement the method described in the listed reference for the identification of piecewise affine (PWA) models and test it on the analytical examples documented there.

References:

- A. Bemporad, A. Garulli, S. Paoletti, and A. Vicino, "A Bounded-Error Approach to Piecewise Affine System Identification", *IEEE Transactions on Automatic Control*, Vol. 50, no. 10, pp. 1567-1580, October 2005.