SSY 230, System Identification
Project 3: Identification of a Real System

Yuxuan Xia
yuxuan.xia@chalmers.se
Emil Staf
emil.staf@chalmers.se

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1 Flexible Robot Arm

The system we have chosen to identify is a mechanical system, where a flexible robot arm have been installed on an electrcal motor. It is a SISO system where the input $u(t)$ is measured reaction torque and the output $y(t)$ is the acceleration of the flexible robot arm. The experimental set-up was performed using a periodic sinusodial sweep.

1.1 Data

As mentioned previously the input data is a periodic sinusodial sweep (see top plot of Figure 1). Due to the fact that the data was obtained using a periodic sinusodial sweep we split the data in half and use the first part as training data and the second part as validation data.

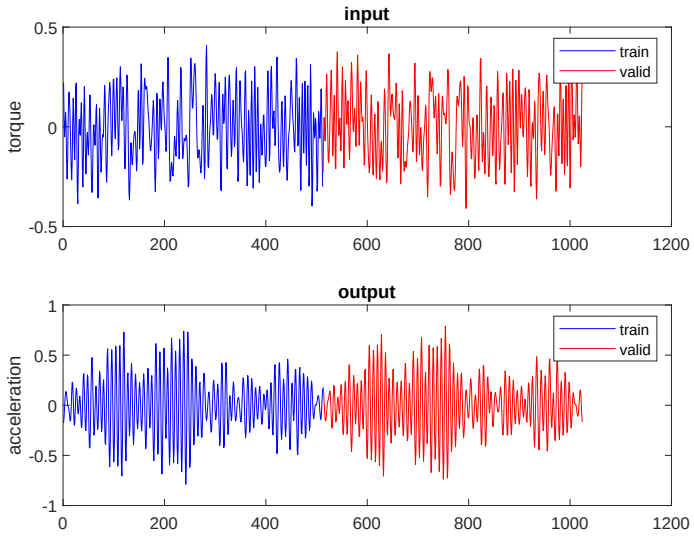
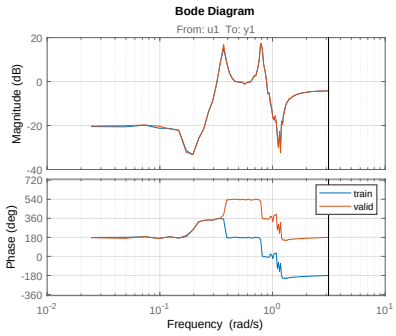
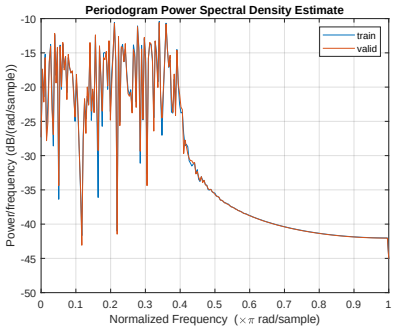


Figure 1: System data, input $u(t)$ (top) and output $y(t)$ (bottom).

To make sure that the frequency content in both the training and validation data are similar we use the *etfe* in MATLAB to find the Empirical Transfer Function Estimate of training- and validation data. The resulting bode-plot is shown in Figure 2a.



(a) Bode-plot of training and validation data.



(b) Periodogram of training and validation data.

Figure 2: Analyzing training/validation split.

From analysing Figure 2a it is clear that the amplitude of the frequency content in both training- and validation data is very similar, while there is a 360 degree phase shift approximately starting from frequencies > 0.35 rad/s. However, it should be noted that a 360 degree phase shift means the validation data and training data are still in phase. Using the MATLAB build-in function *periodogram* it is clear that the frequency content of the training- and validation data is very similar. Also, it can be seen that for frequencies > 0.5 rad/s the power the amount of information for each frequency decreases. The high frequency assymptote amplitude is constant, which means that (for a linear system) there are an equal amount of poles and zeroes.

1.2 Pre-Processing

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1.3 Model Estimation

Due to the conclusion that there should be an equal amount of poles and zeros the search for model order is simplified.

1.3.1 Linear Models

In this section we search over the linear model space for candidate models. A few different linear models are tested and compared: ARX, OE, State Space and Transfer Function Estimation.

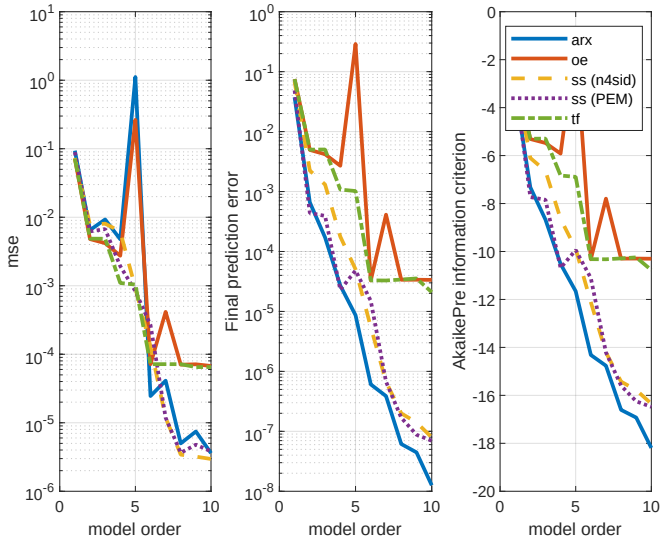

Figure 3: Searching over different model orders n, where the number of parameters p are $p = 2n + 1$.