System Identification – Practical Assignment 5
Correlation Analysis

Logistics

Please reread the logistics part of lab 2, the same rules will apply to this lab. The only thing that changes is the dropbox link, which for this lab is:

`https://www.dropbox.com/request/oUELDlZDUKUN1OfnDTRE`

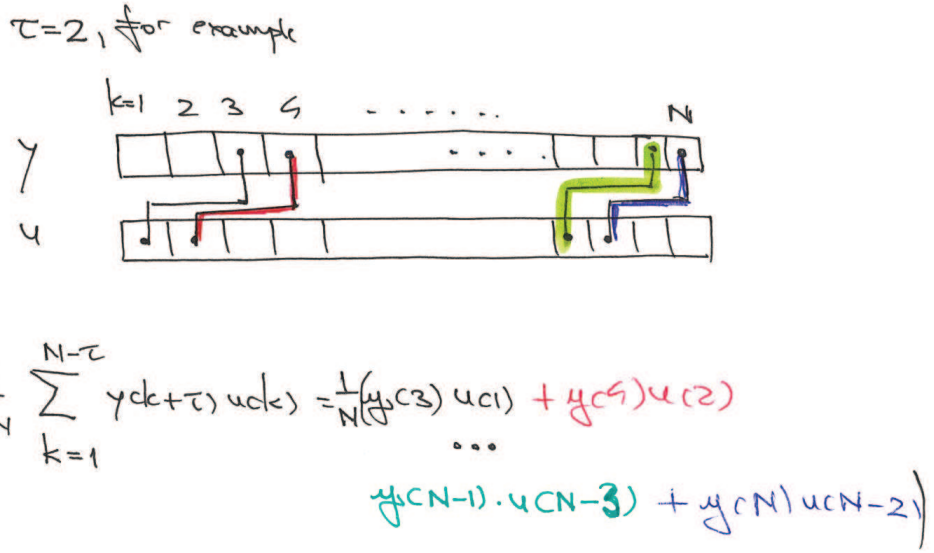
Assignment description

We apply the linear regression method to obtain finite impulse response (FIR) models from input-output data – see the course material, *Correlation Analysis*. This data is more general than just the step or impulse responses we have been seeing so far.

Each student is assigned an index number by the lecturer. Then, the student downloads the data file that forms the basis of the assignment from the course webpage. The file contains the identification data in variable `id`, and separately the validation data in variable `val`. Both these variables are objects of type `iddata` from the system identification toolbox of Matlab, see `doc iddata`. The corresponding time vectors are `tid`, `tval`.

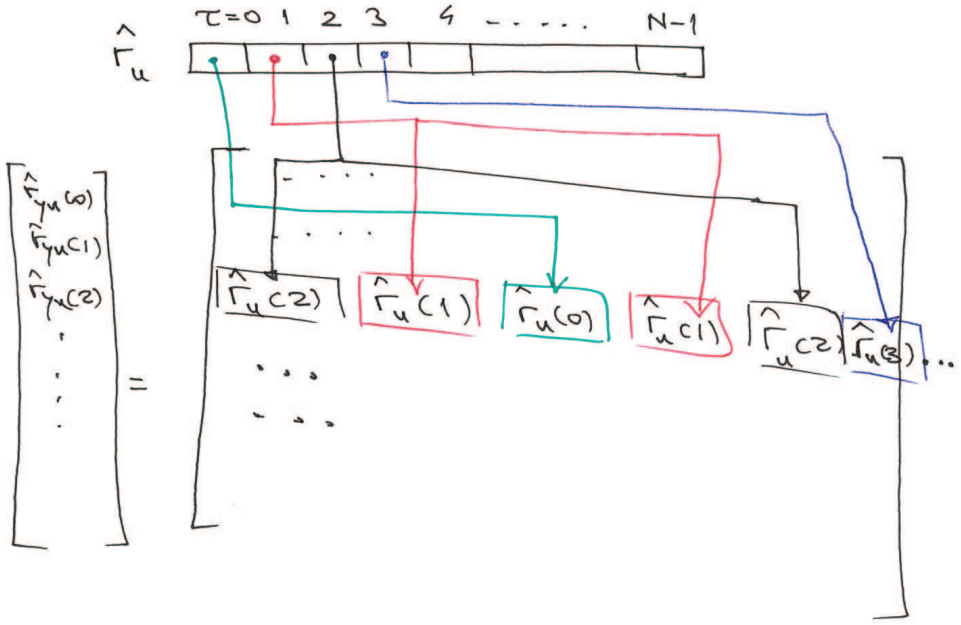
Requirements:

- Plot and examine the data supplied. Determine whether the input and output are zero-mean or not. If the signals are not zero-mean, remove the means, either manually or using e.g. `detrend`.
- After making sure the signals are zero-mean, compute the correlation functions $r_u(\tau)$ and $r_{yu}(\tau)$ from the identification data, using the formulas from the lecture. An illustration is provided below. Check whether the input signal is white noise. Hint: By checking the structure of the linear system, it will become clear that you only need to compute the covariances for positive τ.



- Implement the system of linear equations to obtain the FIR model for an arbitrary value of M supported by the data. Hint: Make sure you understand the structure of the regressor matrix, with

the values of r_u "reflected" around 0, for example:



- Compute the convolutions to simulate the model response to the identification and validation inputs, and compare with the identification and validation outputs.
- Study the influence of the length M of the FIR model on the accuracy of the model. A rule of thumb for selecting a good M is as follows: preferably the entire transient regime of the impulse response must be modeled (until it reaches steady state), but without estimating too many parameters because this would introduce overfitting. These requirements may be conflicting so you may need to deviate one way or the other to get a good fit.

To allow for more insight, the true impulse response of the system is provided as a vector `imp` in the datafile (note that this true response would not be available in a real identification experiment). Solve each part of the assignment without using the true response, but once you have solved it, you may optionally compare the FIR models obtained with the true impulse response.

This is the first lab where we start using in earnest the System Identification toolbox (`ident`). Relevant functions from this toolbox: `detrend`, `plot`, `compare`, `cra`, `impulseest`; and generic Matlab function `conv`. See also `doc ident` for the full documentation of the toolbox.