Midterm

Task 1 (25p)

Load the data set $Task\_1.csv$ containing samples of a time series. It is assumed that the underlying process has the following form

$$y(k+1) = \theta_1 y(k-1) + \theta_2 y(k-2) + \theta_3 y(k-3)$$

and we know that the parameters of the system to be determined are not necessary constant over time.

Implement an algorithm identifying the system's parameters. Use the following function signature: ***TASK_1_NEPTUNCODE(data)*** where the input is the provided data set. This function makes two plots that depict

1. The input and simulated time series (using the determined parameter values)
2. The parameters over time

so that for the two plots/subplots the time scale is the same.

Task 2 (20p)

Load the data set $Task\_2.csv$ containing samples from a time series of the following form

$$y(k) = \theta_1 y(k-1) + \theta_2 y(k-2) + \theta_3 y(k-3)$$

Assuming that $y(i)$ is not independent of the previous components of the measurement noise $e(i-1), \ldots, e(i-l)$ for some l, implement an algorithm capable of determining the unbiased system parameters. The function signature to be used is ***TASK_2_NEPTUNCODE(data)*** where the input is the provided data set.

Task 3 (25p)

Load the data set $Task\_3.csv$. The obtained samples are from an $AR(2)$ system, i.e.

$$y(k) = \theta_1 y(k-1) + \theta_2 y(k-2)$$

We can assume that the additive noise has the form $e(k) \sim \mathcal{N}(0, \sigma_e)$ where $\sigma_e \simeq 0.3$. You need to implement a function – of signature ***TASK_3_NEPTUNCODE(data)*** – plotting the posterior density function of the parameters without the normalizing constant of the denominator, i.e.:

$$p(\theta | y(k), D^{k-1}) \quad \propto \quad p(y(k)|\theta, D^{k-1}) p(\theta | D^{k-1}).$$

and assume that the prior density $p^0(\theta)$ is Gaussian.