MECHTRON 4AX3, Assignment 3

Handout: Oct 2 Due-Date Oct 20 2021

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This assignment is to prepare for the midterm, these are all hand compute questions.

1) Independent Observations

Two sensors S_1 and S_2 are measuring the same quantity x and are independent. $var(S_1) = \sigma_1^2$ and $var(S_2) = \sigma_2^2$. What is your best estimate for the quantity x given you have the measurements s_1 and s_2 ? Justify your answer.

2) Observer

Show that the Lüneberger observer construct for also works for linear time dependent systems,

$$x(n+1) = A(n)x(n) + B(n)u(n) \quad y(n) = C(n)x(n)$$

By showing that the error of the observation can be controlled to zero.

3) Learning LLS

Construct an iterative learning scheme that estimates the model $y = \lambda_1 x + \lambda_2$ online as samples (x_i, y_i) arrive. So a update process of the form $\lambda(n+1) = \lambda(n) - \mu f(x_n, y_n)$ were you have to give μ and f

4) Reachability

Given some discrete system by A, B, C, and some state x^*. $x(0)$ is zero. Determine if there is a control input $u(0), u(1), \cdots, u(N-1)$ such that $x(N) = x^*$. (Set up the matrix which would solve the problem and determine when a solution exists).

5) Estimation

Given 3 points $(x_1, y_1), (x_2, y_2), (x_3, y_3)$ and the model $y = a * x + b$, what is your best estimate for a, b, justify your answer.

6) Control

Given the system G by its state space equations.

$$A = \begin{bmatrix} 1 & .5 \\ 0 & 1 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad C = \begin{bmatrix} 0 & 1 \end{bmatrix}$$

Define a new system $\tilde{A}, \tilde{B}, \tilde{C}$ that has an integrator in the input path $1/sG(S)$.

7) State space Control

We have the system $x(n+1) = 1.5x(n) + u(n),\ y(n) = x(n)$. Develop a closed loop state space feedback controller that controls the system to the state $x^* = 2$.