Course outline

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Assignment 5: Setting up DMC Algorithm

The due date for submitting this assignment has passed.

Due on 2021-02-24, 23:59 IST.

As per our records you have not submitted this assignment.

Description

In this assignment, we will take two types of problems that will help us set outselves for coding the DMC algorithm. First, we will perform *simulations of step-response model* for a series of step inputs. We will also compare them with state space model (state-space model is not graded). Next, we will build S^U and Hessian matrix, in order to setup for DMC.

We will do this for the SISO example:

$$\frac{1.25}{5s+1}e^{-1.4s}$$

as well as the MIMO example:

$$G(s) = \begin{bmatrix} \frac{2}{36s^2+12s+1} & \frac{1.5}{40s^2+16s+1} \\ \frac{2.1}{20s^2+7s+1} & \frac{0.9}{10s^2+5s+1} \end{bmatrix}$$

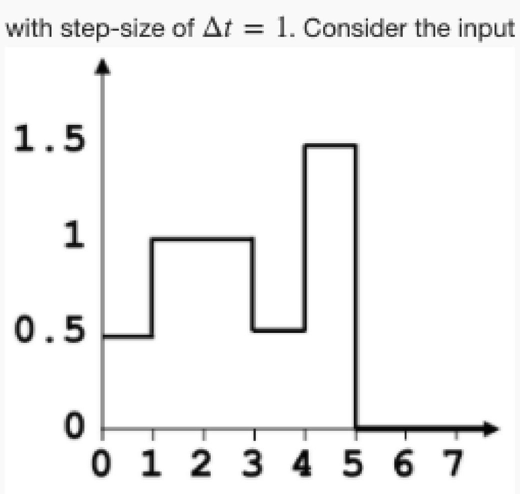
Problem 1: Simulation of SISO Step-Response Model

Although hand-calculations or MATLAB are both acceptable, we recommend you try hand-calculations for this system.

You developed step-response model in Assignment-3 for the following system:

$$\frac{1.25}{5s+1}e^{-1.4s}$$

with step-size of $\Delta t = 1$. Consider the input to be as shown:



Note that the inputs are $U = \{0.5, 1.0, 1.0, 0.5, 1.5, 0, 0, 0, \cdots\}$

The step-response coefficient matrix S^u is uploaded in the file `SISO_StepCoeff.mat`.

Please simulate the finite step response (FSR) model for the above sequence of inputs and report the outputs at the following times:

1) Please report the output `y(1)` :

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) -0.001,0.001

0.2 points

2) Please report the output `y(2)` :

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.070,0.0714

0.2 points

3) Please report the output `y(3)` :

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.240,0.244

0.2 points

4) Please report the output `y(6)` :

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.66,0.67

0.2 points

5) Please report the output `y(9)` :

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.448,0.456

0.2 points

Problem 2: Setting Up DMC Matrices for SISO System

As in the previous problem, you may download and use the MAT file for SISO step response matrix.

For the SISO system of the above problem, we will set up the matrices required for DMC algorithm, with the following parameters.

Let the prediction and control horizons be `p=5` and `m=2` , respectively. With this, develop the S^U matrix.

Next, consider the input and output weights to be `Q=1` and `R=0.25` , respectively. Use these values and S^U from above to compute the Hessian, `Hess` . Please report the Hessian, which is a 2×2 matrix.

6) Please report the first element of Hessian, `Hess(1,1)`

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1,1.1

0.25 points

7) Please report the next element of Hessian, `Hess(1,2)`

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.53,0.56

0.25 points

8) Please report `Hess(2,1)` of the Hessian matrix computed above

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.53,0.56

0.25 points

9) Please report the last element of the Hessian matrix, `Hess(2,2)`

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.634,0.654

0.25 points

Problem-3: Calculation of Hessian for MIMO System

You may download and use MAT file that contains Step-Response Matrix used in this problem.

We recommend using MATLAB for this problem. We will repeat the calculation of Hessian for the MIMO system:

$$G(s) = \begin{bmatrix} \frac{2}{36s^2+12s+1} & \frac{1.5}{40s^2+16s+1} \\ \frac{2.1}{20s^2+7s+1} & \frac{0.9}{10s^2+5s+1} \end{bmatrix}$$

Note that we developed step response matrix in Assignment-3 for the above system with $\Delta t = 2$ and $n = 25$. The `S` matrix was therefore a 50×2 matrix. This matrix can be downloaded in the MIMO_StepCoeff.mat file.

Please generate the Hessian with the following parameters: prediction and control horizons `p=10, m=5` , and output and input weights as respectively:

$$Q = \begin{bmatrix} 1 & 0 \\ 0 & 0.2 \end{bmatrix} \qquad R = 0.25I$$

10) Please report element `Hess(2,2)` of the Hessian matrix.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 6.36,6.56

0.2 points

11) Please report element `Hess(3,2)` of the Hessian matrix.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 9,9.4

0.2 points

12) Please report element `Hess(6,3)` of the Hessian matrix.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 7,7.3

0.2 points

13) Please report element `Hess(7,5)` of the Hessian matrix.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 8.8,9.2

0.2 points

14) Please report element `Hess(10,10)` of the Hessian matrix.

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 2,2.06

0.2 points

Calculation of Gradient and Constraint Matrices (self-study)

We will not be grading the following questions, but it is a good idea to know how to develop them

- With setpoint of $y^{SP} = [0.5 \quad 1]^T$ and assuming one starts from the origin (i.e., $\tilde{Y}(0) = 0$ and $u(-k) = 0$), compute the gradient vector
- If the constraints are $|\Delta u(k)| \leq 0.1$ and $0 \leq u(k) \leq 1$, please compute the LHS (C_{LHS}) of the constraint equation: $C_{LHS}\Delta U(k) \leq c_{RHS}$
- Also compute the RHS of the constraint equation