Course outline

How does an NPTEL online course work?

MATLAB

Overview and Pre-Requisites

Week-1: Background and Introduction

- Recap: Linear Algebra
- Recap: Differential and Difference Equations
- Recap: Process Control Basics
- Introduction to Model Predictive Control
- MPC: Salient Features
- MPC: Historical Perspective
- Quiz : Assignment 1
- Week 1 Feedback Form : Model Predictive Control: Theory and Applications
- Assignment 1 solutions

Week-2: Linear Algebra

Week 3: Discrete-Time Step Response Models

Week 4: Discrete-Time Models and Model Conversion

Week 5: Dynamic Matric Control (DMC)

Week 6: DMC Algorithm and Implementation

Week 7: Linear Time Invariant (LTI) Models

Week 8 : Linear Quadratic (LQ) Control

Week 9 : State Estimation

Week 10 : Linear Quadratic Gaussian (LQG) Control

Week 11: State-Space MPC

Week 12: Practical Issues in MPC

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Assignment 1

The due date for submitting this assignment has passed.

Due on 2021-02-03, 23:59 IST.

As per our records you have not submitted this assignment.

Problem 1: Sub-Matrices

Consider the following matrix multiplication:

$$\mathbf{y} = \left[\begin{array}{ccc|c} 2 & 1 & 2 & -1 \\ 1 & 1 & 1 & 3 \\ 0 & 1 & -1 & 2 \end{array}\right] \mathbf{x}$$

The above equation can be written as

$$\begin{bmatrix} \mathbf{y_1} \\ \mathbf{y_2} \end{bmatrix} = \begin{bmatrix} P & Q \\ R & S \end{bmatrix} \begin{bmatrix} \mathbf{x_1} \\ \mathbf{x_2} \end{bmatrix}$$

where, $\mathbf{y_1}$ is a 2×1 vector, $\mathbf{x_1}$ is a 3×1 vector, and so on. The above can also be written as

$$\mathbf{y_1} = P\mathbf{x_1} + Q\mathbf{x_2}, \qquad \mathbf{y_2} = R\mathbf{x_1} + S\mathbf{x_2}$$

Please complete the following tasks in MATLAB:

- For $x = \begin{bmatrix} 1 & 0 & -1 & 3 \end{bmatrix}'$, compute y_1. Return the result in vector `y1Res`.
- What are the matrices P and Q in the above? Store the results in P and Q.
- For $x_1 = \begin{bmatrix} 1 & 0 & -1 \end{bmatrix}'$ and $x_2 = 3$, compute: $y_1 = Px_1 + Qx_2$ Store the results in vector `y1Res`.
- Repeat to compute $y_2 = Rx_1 + Sx_2$ and store the results in `y2Res`.

Please answer the following questions

1) Please report the vector `y1Res` in the spaces below.

The value of `y1Res(1) =` _____

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Numeric) -3
(Type: Numeric) 9

0.25 points

2) Please report the vector `y1Res` in the spaces below.

The value of `y1Res(2) =` _____

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

0.25 points

3) Please report the vector `y2Res`

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

0.5 points

Problem 2: Eigenvalues

```
A = [3, -1.2, 0.4; 1, 1, 0; 1, 0, 1];
```

- Compute the eigenvalues of A using hand-calculations
- Compute the eigenvalues and eigenvectors of A using `eig` command in MATLAB
- Report the eigenvalues of A (from largest to smallest)

4) Please report the largest of the three eigenvalues

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 2.44,2.45

0.3 points

5) Please report the second of the three eigenvalues

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1.5,1.6

0.3 points

6) Please report the smallest of the three eigenvalues

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.99,1.01

0.4 points

Problem 3: Difference Equations

Consider the following difference equation: $x(k+1) = 0.5x(k) + u(k)$
Let $x(0) = 0$ and $u(k) = 1, \forall k \geq 0$. Note that the value of $x(1)$ is calculated as:
$x(1) = x(0) + u(0) = 0.5 \times 0 + 1 = 1.0$. Thus, $x(1) = 1.0$

7) Repeat the above calculations and obtain $x(2)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1.49,1.51

0.25 points

8) Repeat the above calculations once again and report $x(3)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1.74,1.76

0.25 points

9) Repeat the above calculations once again and report $x(4)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1.87,1.88

0.25 points

10) Repeat the above calculations once again and report $x(5)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1.93,1.94

0.25 points

Problem 4: Difference Equations at Steady State

11) Repeat the above calculations ten more times. At what value of $x(k)$ does the equation converge? Please report that value

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 1.99,2.01

1 point

Problem 5: "Unstable" Difference Equations

We will repeat the difference equation from Problem 3, but for the following case:

$x(k+1) = 1.5x(k) + u(k)$
Let $x(0) = 0$ and $u(k) = 1, \forall k \geq 0$.

12) Please report the value of $x(1)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 0.99,1.01

0.2 points

13) Repeat the above calculations and report $x(2)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 2.49,2.51

0.2 points

14) Repeat the above calculations once again and report $x(3)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 4.74,4.76

0.2 points

15) Repeat the above calculations once again and report $x(4)$

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 8.1,8.2

0.2 points

16) Repeat the above calculations once again and report $x(5)$. Notice that for this system, value of $x(k)$ keeps growing!

No, the answer is incorrect.
Score: 0
Accepted Answers:
(Type: Range) 13.1,13.2

0.2 points