

Course outline

How does an NPTEL online course work?

Week-0

Week-1

Week-2

Week-3

Week-4

Week-5

Week-6

Week-7

Week-8

Lec 37- LMMSE estimation in linear systems

Lec 38- LMMSE application: Wireless channel estimation and example

Lec 39- Time-series prediction via auto-regressive (AR) model

Lec 40- Recommender system: design and rating prediction

Lec 41- Recommender system: Illustration via movie rating prediction example

Quiz : Assignment-8

Feedback For Week 8

Solution-8

Week-9

Week-10

Week-11

Week-12

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Text transcripts

Assignment-8

The due date for submitting this assignment has passed.

Due on 2021-03-17, 23:59 IST.

As per our records you have not submitted this assignment.

 1) Consider the linear model $\bar{\mathbf{y}} = \mathbf{H}\bar{\mathbf{x}} + \bar{\mathbf{n}}$, where $E\{\bar{\mathbf{x}}\bar{\mathbf{x}}^T\} = \mathbf{R}_{xx} = \gamma\mathbf{I}$ and noise covariance $E\{\bar{\mathbf{n}}\bar{\mathbf{n}}^T\} = \epsilon\mathbf{I}$. The SNR is $\frac{\gamma}{\epsilon}$. The Linear Minimum Mean Square Error (LMMSE) estimate of $\bar{\mathbf{x}}$ for this system is given as **1 point**

- $(\mathbf{H}\mathbf{H}^T + \frac{1}{SNR}\mathbf{I})^{-1}\mathbf{H}^T\bar{\mathbf{y}}$
 $(\frac{1}{SNR}\mathbf{H}\mathbf{H}^T + \mathbf{I})^{-1}\mathbf{H}\bar{\mathbf{y}}$
 $(\frac{1}{SNR}\mathbf{H}^T\mathbf{H} + \mathbf{I})^{-1}\mathbf{H}\bar{\mathbf{y}}$
 $(\mathbf{H}^T\mathbf{H} + \frac{1}{SNR}\mathbf{I})^{-1}\mathbf{H}^T\bar{\mathbf{y}}$

No, the answer is incorrect. Score: 0

Accepted Answers:

 $(\mathbf{H}^T\mathbf{H} + \frac{1}{SNR}\mathbf{I})^{-1}\mathbf{H}^T\bar{\mathbf{y}}$

 2) Consider the linear model $\bar{\mathbf{y}} = \mathbf{H}\bar{\mathbf{x}} + \bar{\mathbf{n}}$, where $E\{\bar{\mathbf{x}}\bar{\mathbf{x}}^T\} = \mathbf{R}_{xx} = \gamma\mathbf{I}$ and noise covariance $E\{\bar{\mathbf{n}}\bar{\mathbf{n}}^T\} = \epsilon\mathbf{I}$. Consider the SNR $\frac{\gamma}{\epsilon} \rightarrow \infty$. The Linear Minimum Mean Square Error (LMMSE) estimate of $\bar{\mathbf{x}}$ for this system becomes **1 point**

- $(\mathbf{H}\mathbf{H}^T)^{-1}\mathbf{H}^T\bar{\mathbf{y}}$
 $(\mathbf{H}\mathbf{H}^T + \mathbf{I})^{-1}\mathbf{H}\bar{\mathbf{y}}$
 $(\mathbf{H}^T\mathbf{H})^{-1}\mathbf{H}^T\bar{\mathbf{y}}$
 $(\mathbf{H}^T\mathbf{H} + \mathbf{I})^{-1}\mathbf{H}^T\bar{\mathbf{y}}$

No, the answer is incorrect. Score: 0

Accepted Answers:

 $(\mathbf{H}^T\mathbf{H})^{-1}\mathbf{H}^T\bar{\mathbf{y}}$

 3) Consider the linear model $\bar{\mathbf{y}} = \mathbf{H}\bar{\mathbf{x}} + \bar{\mathbf{n}}$, where $E\{\bar{\mathbf{x}}\bar{\mathbf{x}}^T\} = \mathbf{R}_{xx} = \gamma\mathbf{I}$ and noise covariance $E\{\bar{\mathbf{n}}\bar{\mathbf{n}}^T\} = \epsilon\mathbf{I}$. The SNR is $\frac{\gamma}{\epsilon}$. The error covariance of the Linear Minimum Mean Square Error (LMMSE) estimate of $\bar{\mathbf{x}}$ for this system is given as **1 point**

- $(\frac{1}{\gamma}\mathbf{H}^T\mathbf{H} + \frac{1}{\epsilon}\mathbf{I})^{-1}$
 $(\frac{1}{\epsilon}\mathbf{H}^T\mathbf{H} + \frac{1}{\gamma}\mathbf{I})^{-1}$
 $(\mathbf{H}^T\mathbf{H} + \frac{1}{SNR}\mathbf{I})^{-1}$
 $(\frac{1}{SNR}\mathbf{H}^T\mathbf{H} + \mathbf{I})^{-1}$

No, the answer is incorrect. Score: 0

Accepted Answers:

 $(\frac{1}{\epsilon}\mathbf{H}^T\mathbf{H} + \frac{1}{\gamma}\mathbf{I})^{-1}$

 4) Consider the linear model $\bar{\mathbf{y}} = \mathbf{H}\bar{\mathbf{x}} + \bar{\mathbf{n}}$, where **1 point**

$$\mathbf{H} = \begin{bmatrix} 1 & -1 \\ -1 & -1 \\ -1 & -1 \\ 1 & -1 \end{bmatrix}, \bar{\mathbf{y}} = \begin{bmatrix} 2 \\ -1 \\ -2 \\ 3 \end{bmatrix}$$

 with the covariance $E\{\bar{\mathbf{x}}\bar{\mathbf{x}}^T\} = \mathbf{R}_{xx} = \frac{1}{4}\mathbf{I}$ and noise covariance $E\{\bar{\mathbf{n}}\bar{\mathbf{n}}^T\} = \frac{1}{2}\mathbf{I}$. The Linear Minimum Mean Square Error (LMMSE) estimate of $\bar{\mathbf{x}}$ for this system is given as

- $\frac{1}{3} \begin{bmatrix} 4 \\ -1 \end{bmatrix}$
 $\frac{1}{3} \begin{bmatrix} -2 \\ -3 \end{bmatrix}$
 $\frac{1}{3} \begin{bmatrix} 1 \\ 3 \end{bmatrix}$
 $\frac{1}{3} \begin{bmatrix} -2 \\ 2 \end{bmatrix}$

No, the answer is incorrect. Score: 0

Accepted Answers:

 $\frac{1}{3} \begin{bmatrix} 4 \\ -1 \end{bmatrix}$

 5) Consider the linear model $\bar{\mathbf{y}} = \mathbf{H}\bar{\mathbf{x}} + \bar{\mathbf{n}}$, where **1 point**

$$\mathbf{H} = \begin{bmatrix} 1 & -1 \\ -1 & -1 \\ -1 & -1 \\ 1 & -1 \end{bmatrix}, \bar{\mathbf{y}} = \begin{bmatrix} 2 \\ -1 \\ -2 \\ 3 \end{bmatrix}$$

 with the covariance $E\{\bar{\mathbf{x}}\bar{\mathbf{x}}^T\} = \mathbf{R}_{xx} = \frac{1}{4}\mathbf{I}$ and noise covariance $E\{\bar{\mathbf{n}}\bar{\mathbf{n}}^T\} = \frac{1}{2}\mathbf{I}$. The error covariance of the Linear Minimum Mean Square Error (LMMSE) estimate of $\bar{\mathbf{x}}$ for this system is given as

- $\frac{1}{12} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$
 $\frac{3}{8} \begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$
 $\frac{1}{4} \begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}$
 $\frac{1}{2} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

No, the answer is incorrect. Score: 0

Accepted Answers:

 $\frac{1}{12} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

 6) Autoregression refers to **1 point**

- Regression that is performed automatically
 Auto encoded regression using the principal components
 Regression performed using past samples of the same process
 Regression performed on auto-orthogonal random vectors

No, the answer is incorrect. Score: 0

Accepted Answers:

Regression performed using past samples of the same process

 7) Consider a zero-mean wide sense stationary time-series $x(n)$. For such a process, the auto-correlation $E\{x(i)x(j)\}$ **1 point**

- Depends only on the time-sum $i + j$
 Depends only on the time-product ij
 Is necessarily periodic with respect to i and j
 Depends only on the time-difference $i - j$

No, the answer is incorrect. Score: 0

Accepted Answers:

 Depends only on the time-difference $i - j$

 8) Consider a zero-mean wide sense stationary time-series $x(n)$ with auto-correlation $r_{xx}(n) = 0.8^n$. The best prediction of $x(n)$ based on $x(n-1)$ is given as **1 point**

- $\frac{1}{0.8}x(n-1)$
 $0.8^2x(n-1)$
 $0.8x(n-1)$
 $\frac{1}{0.8^2}x(n-1)$

No, the answer is incorrect. Score: 0

Accepted Answers:

 $0.8x(n-1)$

 9) Consider a zero-mean wide sense stationary time-series $x(n)$ with auto-correlation $r_{xx}(n) = 0.8^n$. The regression error for the best prediction of $x(n)$ based on $x(n-1)$ is given as **1 point**

- 0.8
 0.36
 0.64
 0.2

No, the answer is incorrect. Score: 0

Accepted Answers:

0.36

 10) Consider a zero-mean wide sense stationary time-series $x(n)$ with the vector $\bar{\mathbf{x}}$ defined as **1 point**

$$\bar{\mathbf{x}} = \begin{bmatrix} x(n-1) \\ x(n-2) \\ \vdots \\ x(n-L) \end{bmatrix}$$

 The covariance matrix $E\{\bar{\mathbf{x}}\bar{\mathbf{x}}^T\}$ has the following structure

- Toeplitz
 Circulant
 Diagonal
 Frobenius

No, the answer is incorrect. Score: 0

Accepted Answers:

Toeplitz