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NPTEL

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Unit 13 - Week 11 : Application: Radar for target detection, Array Processing, MUSIC, MIMO-Radar Schemes for Enhanced Target Detection

Course outline

How to access the portal

Week 1 : Introduction to properties of Vectors, Norms, Positive Semi-Definite matrices and Gaussian Random Vectors

DOWNLOAD VIDEOS

Week 2: Introduction to Convex Optimization – Convex sets, Hyperplanes/ Half-spaces etc. Application: Power constraints in Wireless Systems

Week 3 : Convex/ Concave Functions, Examples, Conditions for

Assignment-11

The due date for submitting this assignment has passed.

As per our records you have not submitted this assignment.

Due on 2018-10-17, 23:59 IST.

1) Consider the matrix $\mathbf{A}$ given below *1 point*

$$\mathbf{A} = \begin{bmatrix} 1 & 1 & 1 \\ -1 & 2 & 0 \\ 1 & 1 & -1 \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ 0 & 0 & 5 \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & 2 & 1 \\ 1 & 0 & -1 \end{bmatrix}$$

The solution to the problem $\max \bar{\mathbf{v}}^T \mathbf{A} \bar{\mathbf{v}}, \text{ s.t. } ||\bar{\mathbf{v}}|| \leq 1$ is

- 18
- 10
- 15
- 5

No, the answer is incorrect.
Score: 0

Accepted Answers:
18

2) Consider the MIMO channel with channel matrix *1 point*

$$\mathbf{A} = \begin{bmatrix} 1 & 1 & 1 \\ -1 & 2 & 0 \\ \ldots \end{bmatrix} \begin{bmatrix} 2 & 0 & 0 \\ 0 & 3 & 0 \\ \ldots \end{bmatrix} \begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 0 \\ \ldots \end{bmatrix}$$

Cognitive Radio Systems

Week 4 : Convex Optimization problems, Linear Program, Application: Power allocation in Multi-cell cooperative OFDM

Week 5: Jensen's Inequality, Operations that preserve Convexity, Examples,Beamforming in Multi-antenna Wireless Communication

Week-6: Maximal Ratio Combiner (MRC), Multi-antenna Beamforming with Interfering User, Zero-Forcing (ZF) beamforming,Robust beamformer Design

Week-7:Optimization for signal estimation, LS, WLS, Regularization. Application: Wireless channel estimation, Image Reconstruction-Deblurring,Representatic of Convex Optimization problem

Week 8 : Application: Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines

Week 9- Application: Compressive Sensing, Sparse

$\begin{bmatrix} \frac{1}{\sqrt{6}} \\ \frac{2}{\sqrt{6}} \\ \frac{1}{\sqrt{6}} \end{bmatrix}, \begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \\ 0 \end{bmatrix}$

$\begin{bmatrix} \frac{1}{\sqrt{2}} \\ 0 \\ -\frac{1}{\sqrt{2}} \end{bmatrix}, \begin{bmatrix} -\frac{1}{\sqrt{6}} \\ \frac{1}{\sqrt{6}} \\ \sqrt{\frac{2}{3}} \end{bmatrix}$

$\begin{bmatrix} \frac{1}{\sqrt{3}} \\ -\frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} \end{bmatrix}, \begin{bmatrix} \frac{1}{\sqrt{3}} \\ -\frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} \end{bmatrix}$

$\begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 \\ -1 \\ 1 \end{bmatrix}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\begin{bmatrix} \frac{1}{\sqrt{2}} \\ 0 \\ -\frac{1}{\sqrt{2}} \end{bmatrix}, \begin{bmatrix} -\frac{1}{\sqrt{6}} \\ \frac{1}{\sqrt{6}} \\ \sqrt{\frac{2}{3}} \end{bmatrix}$

3) Consider a cooperative communication system with average gains of the source-destination, source-relay and relay-destination gains given by δ_{sd}^2, δ_{sr}^2, and δ_{rd}^2, respectively. Let P_1, P_2 denote source and relay powers, respectively, with noise power equal to σ^2. Let ϕ denote the event of error at relay. Then, $\Pr(\phi)\Pr(e|\phi)$ is *1 point*

$\frac{3\sigma^4}{4P_1P_2\delta_{sd}^2\delta_{rd}^2}$

$\frac{\sigma^4}{4P_1P_2\delta_{sr}^2\delta_{rd}^2}$

$\frac{\sigma^4}{4P_1^2\delta_{sd}^2\delta_{sr}^2}$

Signal Processing, OMP (Orthogonal Matching Pursuit), LASSO (Least Absolute Shrinkage and Selection Operator) for signal estimation,SVM

Week 10- Application: Compressive Sensing, Sparse Signal Processing, OMP (Orthogonal Matching Pursuit), LASSO (Least Absolute Shrinkage and Selection Operator) for signal estimation

Week 11 : Application: Radar for target detection, Array Processing, MUSIC, MIMO-Radar Schemes for Enhanced Target Detection

- Lec 68- Optimal MIMO Power allocation(Waterfilling)-II
- Lec 69- Example problem on Optimal MIMO Power allocation(Waterfilling)
- Lec 70- Linear objective with box constraints, Linear Programming
- Lec 71- Example Problems II
- Lec 72- Examples on Quadratic Optimization
- Lec 73- Examples on Duality: Dual Norm, Dual of Linear

$$\frac{4\sigma^4}{3P_2^2\delta_{sd}^2\delta_{rd}^2}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\frac{\sigma^4}{4P_1^2\delta_{sd}^2\delta_{sr}^2}$$

4) Consider a cooperative communication system with average gains of the source-destination, source-relay and relay-destination gains given by δ_{sd}^2, δ_{sr}^2, and δ_{rd}^2, respectively. Let P_1, P_2 denote source and relay powers, respectively, with noise power equal to σ^2. Let ϕ denote the event of error at relay. Then, $\Pr(e|\bar{\phi})$ is **1 point**

$$\frac{3\sigma^4}{4P_1P_2\delta_{sd}^2\delta_{rd}^2}$$

$$\frac{\sigma^4}{4P_1P_2\delta_{sr}^2\delta_{rd}^2}$$

$$\frac{\sigma^4}{4P_1^2\delta_{sd}^2\delta_{sr}^2}$$

$$\frac{4\sigma^4}{3P_2^2\delta_{sd}^2\delta_{rd}^2}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\frac{3\sigma^4}{4P_1P_2\delta_{sd}^2\delta_{rd}^2}$$

5) Consider a cooperative communication system with average gains of the source-destination, source-relay and relay-destination gains given by δ_{sd}^2, δ_{sr}^2 and δ_{rd}^2, respectively. Let P_1, P_2 denote source and relay powers, respectively, with noise power equal to σ^2. The optimal power allocation factor alpha where $P_1 = \alpha P,\ P_2 = (1-\alpha)P$ is given as **1 point**

$$\frac{\left(\frac{4}{3}\delta_{sr}^2 - \delta_{rd}^2\right) + \delta_{sr}\sqrt{\frac{8}{3}\delta_{sr}^2 + \delta_{rd}^2}}{4(\delta_{sr}^2 - \delta_{rd}^2)}$$

$$\frac{\left(\delta_{sd}^2 + \frac{1}{3}\delta_{sr}^2\right) + \delta_{rd}\sqrt{\delta_{rd}^2 + \frac{2}{3}\delta_{sd}^2}}{2\left(\frac{1}{3}\delta_{sd}^2 - \delta_{rd}^2\right)}$$

Program(LP)

Quiz : Assignment-11

Assignment-11 Solution

Week 12: Application: Convex optimization for Big Data Analytics, Recommender systems, User Rating Prediction and Optimization for Finance

Transcripts

$$\frac{\left(\delta_{rd}^2 + \frac{1}{2}\,\delta_{sr}^2\right) + \delta_{sd}\sqrt{\delta_{sd}^2 + \frac{1}{4}\,\delta_{sr}^2}}{3\left(\delta_{rd}^2 - \frac{1}{2}\,\delta_{sd}^2\right)}$$

$$\frac{\left(\delta_{sr}^2 - \frac{4}{3}\,\delta_{rd}^2\right) + \delta_{sr}\sqrt{\delta_{sr}^2 + \frac{8}{3}\,\delta_{rd}^2}}{4(\delta_{sr}^2 - \frac{1}{3}\,\delta_{rd}^2)}$$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$$\frac{\left(\delta_{sr}^2 - \frac{4}{3}\,\delta_{rd}^2\right) + \delta_{sr}\sqrt{\delta_{sr}^2 + \frac{8}{3}\,\delta_{rd}^2}}{4(\delta_{sr}^2 - \frac{1}{3}\,\delta_{rd}^2)}$$

6) The compressive sensing problem can be formulated as *1 point*

$\min \|\bar{\mathbf{x}}\|_2$ subject to $\bar{\mathbf{y}} = \Phi\bar{\mathbf{x}}$

$\min \|\bar{\mathbf{x}}\|_0$ subject to $\bar{\mathbf{y}} = \Phi\bar{\mathbf{x}}$

$\min \|\bar{\mathbf{y}} - \Phi\bar{\mathbf{x}}\|^2$

$\min \|\bar{\mathbf{x}}\|_2$ subject to $\bar{\mathbf{y}} \preccurlyeq \Phi\bar{\mathbf{x}}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\min \|\bar{\mathbf{x}}\|_0$ subject to $\bar{\mathbf{y}} = \Phi\bar{\mathbf{x}}$

7) Consider the sparse signal estimation problem below *1 point*

$$\begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \end{bmatrix} = \begin{bmatrix} 10 \\ 2 \\ 0 \\ 8 \end{bmatrix}$$

The non-zero signal coefficients in the sparse solution are

x_2, x_5

x_1, x_4

x_3, x_6

x_3, x_5

No, the answer is incorrect.
Score: 0

Accepted Answers:
x_3, x_6

8) Consider the sparse signal estimation problem below *1 point*

$$\begin{bmatrix} 1 & 0 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \end{bmatrix} = \begin{bmatrix} 10 \\ 2 \\ 0 \\ 8 \end{bmatrix}$$

The values of the non-zero signal coefficients in the sparse solution are

- $2, 8$
- $4, 6$
- $3, 5$
- $5, 2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$2, 8$

9) Consider two sets of points $\bar{\mathbf{x}}_i,\ \bar{\mathbf{y}}_i, 1 \leq i \leq N$. The two hyperplanes which separate them with maximum distance of separation between them are given as the solution to the optimization problem *1 point*

- $\max 1$
  s.t. $\bar{\mathbf{a}}^T \bar{\mathbf{x}}_i \geq b, 1 \leq i \leq N$
  $\bar{\mathbf{a}}^T \bar{\mathbf{y}}_i \leq b, 1 \leq i \leq N$
- $\min ||\bar{\mathbf{a}}||$
  s.t. $\bar{\mathbf{a}}^T \bar{\mathbf{x}}_i \geq b, 1 \leq i \leq N$
  $\bar{\mathbf{a}}^T \bar{\mathbf{y}}_i \leq b, 1 \leq i \leq N$
- $\max ||\bar{\mathbf{a}}||$
  s.t. $\bar{\mathbf{a}}^T \bar{\mathbf{x}}_i \geq b, 1 \leq i \leq N$
  $\bar{\mathbf{a}}^T \bar{\mathbf{y}}_i \leq b, 1 \leq i \leq N$
- $\min ||\bar{\mathbf{a}}||$
  s.t. $\bar{\mathbf{a}}^T \bar{\mathbf{x}}_i + b \geq 1, 1 \leq i \leq N$
  $\bar{\mathbf{a}}^T \bar{\mathbf{y}}_i + b \leq -1, 1 \leq i \leq N$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\min ||\bar{\mathbf{a}}||$
s.t. $\bar{\mathbf{a}}^T \bar{\mathbf{x}}_i + b \geq 1, 1 \leq i \leq N$
$\bar{\mathbf{a}}^T \bar{\mathbf{y}}_i + b \leq -1, 1 \leq i \leq N$

10) Consider the standard form of the optimization problem given below *1 point*

$\min g_0(\bar{\mathbf{x}})$
s.t. $g_i(\bar{\mathbf{x}}) \leq 0, i = 1, 2, \ldots, l$
$\tilde{g}_j(\bar{\mathbf{x}}) = 0, j = 1, 2, \ldots, m$
The Lagrangian for the above problem is

- $L(\bar{\mathbf{x}}) = g_0(\bar{\mathbf{x}}) + \sum_{i=0}^{l} g_i(\bar{\mathbf{x}}) + \sum_{j=0}^{m} \tilde{g}_j(\bar{\mathbf{x}})$
- $L(\bar{\mathbf{x}}, \bar{\boldsymbol{\lambda}}) = g_0(\bar{\mathbf{x}}) + \sum_{i=0}^{l} \lambda_i g_i(\bar{\mathbf{x}}) + \sum_{j=0}^{m} \tilde{g}_j(\bar{\mathbf{x}})$
- $L(\bar{\mathbf{x}}, \bar{\boldsymbol{\nu}}) = g_0(\bar{\mathbf{x}}) + \sum_{i=0}^{l} g_i(\bar{\mathbf{x}}) + \sum_{j=0}^{m} \nu_j \tilde{g}_j(\bar{\mathbf{x}})$
- $L(\bar{\mathbf{x}}, \bar{\boldsymbol{\lambda}}, \bar{\boldsymbol{\nu}}) = g_0(\bar{\mathbf{x}}) + \sum_{i=0}^{l} \lambda_i g_i(\bar{\mathbf{x}}) + \sum_{j=0}^{m} \nu_j \tilde{g}_j(\bar{\mathbf{x}})$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$L(\bar{\mathbf{x}}, \bar{\boldsymbol{\lambda}}, \bar{\boldsymbol{\nu}}) = g_0(\bar{\mathbf{x}}) + \sum_{i=0}^{l} \lambda_i g_i(\bar{\mathbf{x}}) + \sum_{j=0}^{m} \nu_j \tilde{g}_j(\bar{\mathbf{x}})$

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