Unit 12 - Week 10- Application: Compressive Sensing, Sparse Signal Processing, OMP (Orthogonal Matching Pursuit), LASSO (Least Absolute Shrinkage and Selection Operator) for signal estimation

Assignment-10

The due date for submitting this assignment has passed.

As per our records you have not submitted this assignment.

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

1) Consider a multi-channel estimation problem with pilot matrix $\mathbf{X}$ and received vector $\bar{\mathbf{y}}$ as given below. *1 point*

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

The estimate of the channel vector $\mathbf{h}$ is

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

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2) Consider a multi-channel estimation problem with pilot matrix $\mathbf{X}$ as given below. *1 point*

$$\mathbf{X} = \begin{bmatrix} 1 & 1 \\ 1 & -1 \\ 1 & -1 \\ 1 & 1 \end{bmatrix}$$

The pseudo-inverse of $\mathbf{X}$ is

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

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{1}{4}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -1 & -1 & 1 \end{bmatrix}$

3) Consider a multi-channel estimation problem with pilot matrix $\mathbf{X}$ and received vector $\bar{\mathbf{y}}$ as given below. *1 point*

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

Let the regularization parameter be $\lambda = 2$. The estimate of the channel vector $\bar{\mathbf{h}}$ is

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

No, the answer is incorrect.

Score: 0

Accepted Answers:

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

4) The standard form of a convex optimization problem is *1 point*

- $\min g_0(\bar{\mathbf{x}})$ where $g_0(\bar{\mathbf{x}})$ is any function
- $\min g_0(\bar{\mathbf{x}})$
  s.t. $g_i(\bar{\mathbf{x}}) \leq 0,\ i = 1, 2, \cdots, l$
  $\tilde{g}_j(\bar{\mathbf{x}}) = 0,\ j = 1, 2, \cdots, m$
  where $g_i(\bar{\mathbf{x}})$ are convex and $\tilde{g}_j(\bar{\mathbf{x}})$ are affine
- $\min g_0(\bar{\mathbf{x}})$
  s.t. $g_i(\bar{\mathbf{x}}) \leq 0,\ i = 1, 2, \cdots, l$
  $\tilde{g}_j(\bar{\mathbf{x}}) = 0,\ j = 1, 2, \cdots, m$
  where $g_i(\bar{\mathbf{x}}), \tilde{g}_j(\bar{\mathbf{x}})$ are any convex functions
- $\min g_0(\bar{\mathbf{x}})$
  s.t. $g_i(\bar{\mathbf{x}}) = 0,\ i = 1, 2, \cdots, l$
  where $g_i(\bar{\mathbf{x}})$ are any convex functions

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\min g_0(\bar{\mathbf{x}})$
s.t. $g_i(\bar{\mathbf{x}}) \leq 0,\ i = 1, 2, \cdots, l$
$\tilde{g}_j(\bar{\mathbf{x}}) = 0,\ j = 1, 2, \cdots, m$
where $g_i(\bar{\mathbf{x}})$ are convex and $\tilde{g}_j(\bar{\mathbf{x}})$ are affine

5) The convex optimization problem below can be equivalently recast as *1 point*

$$\min \|\bar{\mathbf{x}}\|_\infty$$
$$\text{s.t. } \bar{\mathbf{x}} \in \mathcal{S}$$

- $\min \bar{\mathbf{1}}^T \bar{\mathbf{t}}$
  s.t. $-\bar{\mathbf{t}} \leq \bar{\mathbf{x}} \leq \bar{\mathbf{t}}$
  $\bar{\mathbf{x}} \in \mathcal{S}$
- $\min \|\bar{\mathbf{x}}\|_1$
  $\bar{\mathbf{x}} \in \mathcal{S}$
- $\min t$
  s.t. $-t\bar{\mathbf{1}} \leq \bar{\mathbf{x}} \leq t\bar{\mathbf{1}}$
  $\bar{\mathbf{x}} \in \mathcal{S}$
- $\min t$
  s.t. $-t \leq \bar{\mathbf{1}}^T \bar{\mathbf{x}} \leq t$
  $\bar{\mathbf{x}} \in \mathcal{S}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\min t$

$\text{s.t.} \; -t\bar{\mathbf{1}} \leq \bar{\mathbf{x}} \leq t\bar{\mathbf{1}}$

$\bar{\mathbf{x}} \in \mathcal{S}$

6) Consider the multi base station cooperation problem in a wireless communication system with P_{ij}, g_{ij} denoting the transmit power and power gain from base station i to user j. Total number of base stations is M and number of users is K.The optimization problem to minimize the sum transmit power while ensuring minimum received power $\tilde{P}$ at all users is ***1 point***

- $\min t$
  $\text{s.t.} \; \sum_{i=1}^{M}\sum_{j=1}^{K} P_{ij} \leq t$
  $\sum_{i=1}^{M} P_{ij}g_{ij} \geq \tilde{P}, j = 1, 2, \cdots, K$
- $\min t$
  $\text{s.t.} \; \sum_{i=1}^{M} P_{ij}g_{ij} < t, j = 1, 2, \cdots, K$
  $\sum_{i=1}^{M}\sum_{j=1}^{K} P_{ij} \geq \tilde{P}$
- $\min t$
  $\text{s.t.} \; \sum_{j=1}^{K} P_{ij}g_{ij} \geq \tilde{P}, j = i = 1, 2, \cdots, M$
  $\sum_{i=1}^{M}\sum_{j=1}^{K} P_{ij} = t$
- $\min t$
  $\text{s.t.} \; \sum_{j=1}^{K} P_{ij}g_{ij} = t, i = 1, 2, \cdots, M$
  $\sum_{i=1}^{M}\sum_{j=1}^{K} P_{ij} \geq \tilde{P}$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\min t$

$\text{s.t.} \; \sum_{i=1}^{M}\sum_{j=1}^{K} P_{ij} \leq t$

$\sum_{i=1}^{M} P_{ij}g_{ij} \geq \tilde{P}, j = 1, 2, \cdots, K$

7) The constraint $\Pr(\bar{\mathbf{c}}^T\bar{\mathbf{x}} \leq d) \geq \eta$ where $\bar{\mathbf{c}}$ is Gaussian with mean $\bar{\boldsymbol{\mu}}$ and covariance matrix $\Sigma = \tilde{\Sigma}\tilde{\Sigma}^T$ can be equivalently represented as ***1 point***

- $|\bar{\mathbf{x}}^T\bar{\boldsymbol{\mu}}| \leq \frac{1}{\eta}\left(d - \bar{\mathbf{x}}^T\Sigma\bar{\mathbf{x}}\right)$
-

$|\bar{\mathbf{x}}^T\bar{\mathbf{c}}|Q(\eta-1) \leq (d\bar{\mathbf{c}}+\bar{\boldsymbol{\mu}})^T\Sigma(d\bar{\mathbf{c}}+\bar{\boldsymbol{\mu}})$

$\| \tilde{\Sigma}^T\bar{\mathbf{x}} \| \leq \frac{1}{Q^{-1}(1-\eta)}(d-\bar{\mathbf{x}}^T\bar{\boldsymbol{\mu}})$

$\bar{\mathbf{x}}^T\tilde{\Sigma}\bar{\mathbf{x}}+\bar{\mathbf{x}}^T\bar{\boldsymbol{\mu}} \leq dQ^{-1}(1-\eta)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\| \tilde{\Sigma}^T\bar{\mathbf{x}} \| \leq \frac{1}{Q^{-1}(1-\eta)}(d-\bar{\mathbf{x}}^T\bar{\boldsymbol{\mu}})$

8) The robust linear program $\min \bar{\mathbf{c}}^T\bar{\mathbf{x}},$ s.t. $\bar{\mathbf{a}}^T\bar{\mathbf{x}} \leq b$ for all $\bar{\mathbf{a}} \in \{\hat{\mathbf{a}}+\mathbf{P}\bar{\mathbf{u}} | \ \| \bar{\mathbf{u}} \| \leq 1\}$ can be represented equivalently as *1 point*

$\min \bar{\mathbf{c}}^T\bar{\mathbf{x}},$ s.t. $\hat{\mathbf{a}}^T\bar{\mathbf{x}}- \| \mathbf{P}\mathbf{P}^T\bar{\mathbf{x}} \| \leq b$

$\min \bar{\mathbf{c}}^T\bar{\mathbf{x}},$ s.t. $|\hat{\mathbf{a}}^T\bar{\mathbf{x}}|^2+\bar{\mathbf{x}}^T\mathbf{P}\mathbf{P}^T\bar{\mathbf{x}} \leq b$

$\min \bar{\mathbf{c}}^T\bar{\mathbf{x}},$ s.t. $\hat{\mathbf{a}}^T\bar{\mathbf{x}} \leq b$

$\min \bar{\mathbf{c}}^T\bar{\mathbf{x}},$ s.t. $\hat{\mathbf{a}}^T\bar{\mathbf{x}}+ \| \mathbf{P}^T\bar{\mathbf{x}} \| \leq b$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\min \bar{\mathbf{c}}^T\bar{\mathbf{x}},$ s.t. $\hat{\mathbf{a}}^T\bar{\mathbf{x}}+ \| \mathbf{P}^T\bar{\mathbf{x}} \| \leq b$

9) The optimal vector $\bar{\mathbf{v}}$ that is the solution to the optimization problem $\max \ \bar{\mathbf{v}}^T\mathbf{G}\bar{\mathbf{v}}, s.t. \| \bar{\mathbf{v}} \| \leq 1,$ where $\mathbf{G}$ is a PSD matrix, is *0 points*

Any eigenvector of $\mathbf{G}$

Unit-norm eigenvector of $\mathbf{G}$ corresponding to minimum eigenvalue

Unit-norm eigenvector of $\mathbf{G}$ corresponding to minimum eigenvalue

Eigenvector of $\mathbf{G}$ corresponding to eigenvalue = 1

No, the answer is incorrect.
Score: 0

Accepted Answers:
Unit-norm eigenvector of $\mathbf{G}$ *corresponding to minimum eigenvalue*

10) Consider a MIMO channel with channel matrix given as $\mathbf{H}$. The optimal receive and transmit beamformers for this channel are given as *1 point*

Principal eigenvectors of $\mathbf{H}\mathbf{H}^H$ and $\mathbf{H}^H\mathbf{H}$ respectively

Principal eigenvectors of $\mathbf{H}^H\mathbf{H}$ and $\mathbf{H}\mathbf{H}^H$ respectively

Principal eigenvectors of $\mathbf{H}^H$ and $\mathbf{H}$ respectively

Principal eigenvectors of $\mathbf{H}$ and $\mathbf{H}^H$ respectively

No, the answer is incorrect.
Score: 0

Accepted Answers:
Principal eigenvectors of $\mathbf{H}\mathbf{H}^H$ *and* $\mathbf{H}^H\mathbf{H}$ *respectively*

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