Assignment-7

The due date for submitting this assignment has passed.

Due on 2021-03-10, 23:59 IST.

As per our records you have not submitted this assignment.

1) Singular value decomposition (SVD) is defined for *1 point*

- Only square matrices
- Only wide matrices
- Only invertible matrices
- Any matrix

No, the answer is incorrect.
Score: 0

Accepted Answers:
Any matrix

2) In the SVD of matrix $\mathbf{H}$ given as $\mathbf{H} = \mathbf{U}\boldsymbol{\Sigma}\mathbf{V}^H$, $\boldsymbol{\Sigma}$ is *1 point*

- Semi-unitary matrix
- Diagonal matrix of singular values that are real, but not necessarily non-negative
- Diagonal matrix of non-negative singular values
- Unitary matrix

No, the answer is incorrect.
Score: 0

Accepted Answers:
Diagonal matrix of non-negative singular values

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

$$\mathbf{H} = \begin{bmatrix} 1 & 1 \\ 1 & -1 \\ 1 & -1 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} 4 & 0 \\ 0 & 8 \end{bmatrix} \begin{bmatrix} 2 & -2 \\ 2 & 2 \end{bmatrix}$$

Its largest singular value σ_1 is given as

- $4\sqrt{2}$
- $8\sqrt{2}$
- $16\sqrt{2}$
- $32\sqrt{2}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$32\sqrt{2}$

4) Optimal power allocation for a MIMO wireless system to maximize the total transmission rate can obtained via the *1 point*

- Beamforming algorithm
- Water-filling algorithm
- Zero-forcing algorithm
- MMSE algorithm

No, the answer is incorrect.
Score: 0

Accepted Answers:
Water-filling algorithm

5) Consider the singular values of a MIMO channel matrix given as $\sigma_1 = \frac{1}{\sqrt{2}}, \sigma_2 = \frac{1}{2}$, with noise power $\sigma^2 = 2$ and total power $P = 10$. The optimal power allocation to maximize the capacity of the MIMO channel is given as *1 point*

- $7, 3$
- $8, 2$
- $9, 1$
- $6, 4$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$7, 3$

6) The best rank P approximation to a matrix $\mathbf{H}$ can be obtained by *1 point*

- retaining the P smallest singular values of $\mathbf{H}$ and setting the rest to zero in the SVD.
- retaining any P singular values of $\mathbf{H}$ and setting the rest to zero in the SVD.
- retaining the P largest singular values of $\mathbf{H}$ and setting the rest to zero in the SVD.
- retaining P columns of $\mathbf{H}$ with the largest norm and setting the rest of the columns to zero.

No, the answer is incorrect.
Score: 0

Accepted Answers:
retaining the P largest singular values of $\mathbf{H}$ and setting the rest to zero in the SVD.

7) For a uniform linear array (ULA) with antenna spacing d and angle of arrival of plane wave θ with respect to the array, the delay of the signal at each successive antenna element, with respect to the previous antenna, is *1 point*

- $\frac{d \sin\theta}{c}$
- $\frac{d \cos\theta}{c}$
- $\frac{d}{c}$
- $\frac{d(\cos\theta + \sin\theta)}{c}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{d \cos\theta}{c}$

8) Consider the $L \times L$ output covariance matrix $\mathbf{R}_y$ for the MUSIC scheme. Let its eigenvalue decomposition be given $\mathbf{R}_y = \mathbf{U}\boldsymbol{\Lambda}\mathbf{U}^H$, with $\bar{\mathbf{u}}_i,\ i = \{1, 2, \cdots, L\}$, denoting the eigenvectors of $\mathbf{R}_y$ and $\bar{\mathbf{a}}(\theta)$ denoting the array response vector corresponding to angle of arrival θ. Let $L - P$ eigenvalues of $\mathbf{R}_y$, corresponding to $i = \{P+1, P+2, \cdots, L\}$, be small. The MUSIC spectrum as a function of θ plots *1 point*

- $\frac{1}{\sum_{j=1}^{L} |\bar{\mathbf{a}}^H(\theta)\bar{\mathbf{u}}_j|^2}$
- $\frac{1}{\sum_{j=1}^{P} |\bar{\mathbf{a}}^H(\theta)\bar{\mathbf{u}}_j|^2}$
- $\frac{1}{\sum_{j=P+1}^{L} |\bar{\mathbf{a}}^H(\theta)\bar{\mathbf{u}}_j|^2}$
- $\sum_{j=1}^{P} |\bar{\mathbf{a}}^H(\theta)\bar{\mathbf{u}}_j|^2$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{1}{\sum_{j=P+1}^{L} |\bar{\mathbf{a}}^H(\theta)\bar{\mathbf{u}}_j|^2}$

9) Consider vectors $\bar{\mathbf{x}}, \bar{\mathbf{y}}$ with respective means $\bar{\boldsymbol{\mu}}_x, \bar{\boldsymbol{\mu}}_y$ and covariance matrices $\mathbf{R}_{xx}, \mathbf{R}_{yy}$. Let the cross-covariance matrix be given as $E\{\bar{\mathbf{x}}\bar{\mathbf{y}}^H\} = \mathbf{R}_{xy}$. The Linear Minimum Mean Square Error (LMMSE) estimate of $\bar{\mathbf{x}}$, denoted by $\hat{\mathbf{x}}$, is given as *1 point*

- $\mathbf{R}_{xy}\mathbf{R}_{yy}(\bar{\mathbf{y}} - \bar{\boldsymbol{\mu}}_y) + \bar{\boldsymbol{\mu}}_x$
- $\mathbf{R}_{yy}^{-1}\mathbf{R}_{xy}(\bar{\mathbf{y}} - \bar{\boldsymbol{\mu}}_y) + \bar{\boldsymbol{\mu}}_x$
- $\mathbf{R}_{yy}\mathbf{R}_{xy}^{-1}(\bar{\mathbf{y}} - \bar{\boldsymbol{\mu}}_y) + \bar{\boldsymbol{\mu}}_x$
- $\mathbf{R}_{xy}\mathbf{R}_{yy}^{-1}(\bar{\mathbf{y}} - \bar{\boldsymbol{\mu}}_y) + \bar{\boldsymbol{\mu}}_x$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\mathbf{R}_{xy}\mathbf{R}_{yy}^{-1}(\bar{\mathbf{y}} - \bar{\boldsymbol{\mu}}_y) + \bar{\boldsymbol{\mu}}_x$

10) Consider vectors $\bar{\mathbf{x}}, \bar{\mathbf{y}}$ with respective means $\bar{\boldsymbol{\mu}}_x, \bar{\boldsymbol{\mu}}_y$ and covariance matrices $\mathbf{R}_{xx}, \mathbf{R}_{yy}$. Let the cross-covariance matrix be given as $E\{\bar{\mathbf{x}}\bar{\mathbf{y}}^H\} = \mathbf{R}_{xy}$. The minimum mean square error (MSE) corresponding to the Linear Minimum Mean Square Error (LMMSE) estimate of $\bar{\mathbf{x}}$, is given as *1 point*

- $\mathrm{Tr}(\mathbf{R}_{yy} - \mathbf{R}_{yx}\mathbf{R}_{xx}^{-1}\mathbf{R}_{xy})$
- $\mathrm{Tr}(\mathbf{R}_{xx} - \mathbf{R}_{xy}\mathbf{R}_{yy}^{-1}\mathbf{R}_{yx})$
- $\mathrm{Tr}(\mathbf{R}_{xx} - \mathbf{R}_{xy}\mathbf{R}_{yy}\mathbf{R}_{yx})$
- $\mathrm{Tr}(\mathbf{R}_{xx}^{-1} - \mathbf{R}_{xy}\mathbf{R}_{yy}^{-1}\mathbf{R}_{yx})$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\mathrm{Tr}(\mathbf{R}_{xx} - \mathbf{R}_{xy}\mathbf{R}_{yy}^{-1}\mathbf{R}_{yx})$