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Courses » Applied Optimization for Wireless, Machine Learning, Big-Data

Announcements Course Ask a Question Progress Mentor FAQ

# Unit 10 - Week 8 : Application: Convex optimization for Machine Learning, Principal Component Analysis (PCA), Support Vector Machines

**Course outline**

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How to access the portal

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

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**DOWNLOAD VIDEOS**

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

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

## Assignment-8

The due date for submitting this assignment has passed. As per our records you have not submitted this assignment. **Due on 2018-09-26, 23:59 IST.**

1) Which of the following statements is true regarding beamforming with weight vector  $\bar{w}$  **1 point**

- i. It is termed electronic steering
- ii. It is termed mechanical steering
- iii. It is time consuming & expensive
- iv. It has low complexity and high precision

- i and iii
- ii and iv
- i and iv
- ii and iii

**No, the answer is incorrect.**  
**Score: 0**

**Accepted Answers:**  
*i and iv*

2) Consider the multi-antenna system  $\bar{y} = \bar{h}x + \bar{n}$ , with the noise samples in  $\bar{n}$  i.i.d. zero-mean of variance  $\sigma^2$ . The noise power at the output of the beamformer denoted by  $\bar{w}$  is **1 point**

$\sigma^2$

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ce De

$$\sigma^2 \bar{\mathbf{w}} \bar{\mathbf{w}}^T$$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\sigma^2 \|\bar{\mathbf{w}}\|^2$

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

3) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{n}}$ , with the noise samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ . The optimization problem for the optimal beamformer  $\bar{\mathbf{w}}$  can be formulated as 1 point

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

$\min \sigma^2 \|\bar{\mathbf{w}}\|^2$   
s.t.  $\bar{\mathbf{w}}^T \bar{\mathbf{h}} = 1$

$\min \bar{\mathbf{w}}^T \bar{\mathbf{h}}$   
s.t.  $\|\bar{\mathbf{w}}\|^2 = 1$

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

$\max \sigma^2 \|\bar{\mathbf{w}}\|^2$   
s.t.  $\bar{\mathbf{w}}^T \bar{\mathbf{h}} = 1$

$\max \|\bar{\mathbf{w}}\|_1$   
s.t.  $\bar{\mathbf{w}}^T \bar{\mathbf{h}} \leq 1$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\min \sigma^2 \|\bar{\mathbf{w}}\|^2$   
s.t.  $\bar{\mathbf{w}}^T \bar{\mathbf{h}} = 1$

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

4) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{n}}$ , with the noise samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ . The optimization problem for the optimal beamformer is a 1 point

- Linear Program
- Quadratic Program
- Second Order Cone Program
- Semi-Definite Program

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
Quadratic Program

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

5) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{n}}$ , with the noise samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ . The optimal beamformer  $\bar{\mathbf{w}}$  that ensures unity signal gain while minimizing the noise variance is 1 point

$\frac{\bar{\mathbf{h}}}{\|\bar{\mathbf{h}}\|}$

Lec 48-Linear Program Practical Application: Base Station

Co-operation

Lec 49-  
Stochastic  
Linear  
Program,Gaussian  
Uncertainty

Lec 50-  
Practical  
Application:  
Multiple Input  
Multiple Output  
(MIMO)  
Beamforming

Lec 51-  
Practical  
Application:  
Multiple Input  
Multiple Output  
(MIMO)  
Beamformer  
Design

Lec  
52-Practical  
Application:  
Co-operative  
Communication,  
Overview and  
various  
Protocols used

Lec 53-  
Practical  
Application:  
Probability of  
Error  
Computation  
for  
Co-operative  
Communication

Lec 54-  
Practical  
Application:Optimal  
power  
allocation factor  
determination  
for  
Co-operative  
Communication

Quiz :  
Assignment-8

Assignment -8  
Solution

**Week 9-  
Application:  
Compressive  
Sensing, Sparse  
Signal  
Processing,  
OMP  
(Orthogonal  
Matching  
Pursuit), LASSO  
(Least Absolute  
Shrinkage and  
Selection**

 $\bar{\mathbf{h}}$  $\bar{\mathbf{h}}^H$  $\frac{\bar{\mathbf{h}}}{\|\bar{\mathbf{h}}\|^2}$ 

No, the answer is incorrect.

Score: 0

Accepted Answers:

 $\frac{\bar{\mathbf{h}}}{\|\bar{\mathbf{h}}\|^2}$ 

6) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{n}}$ , with the noise **1 point** samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ . The optimal beamformer  $\bar{\mathbf{w}}$  is also termed



Orthogonal Beamformer



Maximal Ratio Combiner



Generalized Optimal Beamformer



Zero-Forcing Combiner

No, the answer is incorrect.

Score: 0

Accepted Answers:

Maximal Ratio Combiner

7) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{g}}x_i + \bar{\mathbf{n}}$ , with the noise **1 point** samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ , and interference symbols  $x_i$  of power  $\sigma_i^2$ . The vectors  $\bar{\mathbf{h}}$  and  $\bar{\mathbf{g}}$  denote the channel vectors of the desired and interfering user, respectively. The noise plus interference covariance is given as

 $(\sigma_i^2 + \sigma^2)\mathbf{I}$  $\sigma_i^2 \|\bar{\mathbf{g}}\|^2 + \sigma^2$  $\sigma_i^2 \bar{\mathbf{g}}\bar{\mathbf{g}}^T + \sigma^2 \mathbf{I}$  $\sigma_i \bar{\mathbf{g}} + \sigma$ 

No, the answer is incorrect.

Score: 0

Accepted Answers:

 $\sigma_i^2 \bar{\mathbf{g}}\bar{\mathbf{g}}^T + \sigma^2 \mathbf{I}$ 

8) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{g}}x_i + \bar{\mathbf{n}}$ , with the noise **1 point** samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ , and interference symbols  $x_i$  of power  $\sigma_i^2$ . The noise plus interference covariance is denoted by  $\mathbf{R}$ . The vectors  $\bar{\mathbf{h}}$  and  $\bar{\mathbf{g}}$  denote the channel vectors of the desired and interfering user, respectively. The optimal beamformer  $\bar{\mathbf{w}}$  that ensures unity signal gain while minimizing the noise + interference is

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

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

Transcripts

$$\frac{\mathbf{R}^{-1}\bar{\mathbf{h}}}{\bar{\mathbf{h}}^T \mathbf{R}^{-1} \bar{\mathbf{h}}}$$

$$\mathbf{R}\bar{\mathbf{h}}$$

$$\mathbf{R}^{-1}\bar{\mathbf{h}}$$

$$\frac{\mathbf{R}\bar{\mathbf{h}}}{\bar{\mathbf{h}}^T \mathbf{R} \bar{\mathbf{h}}}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\frac{\mathbf{R}^{-1}\bar{\mathbf{h}}}{\bar{\mathbf{h}}^T \mathbf{R}^{-1} \bar{\mathbf{h}}}$$

9) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{g}}x_i + \bar{\mathbf{n}}$ , with the noise **1 point** samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ , and interference symbols  $x_i$  of power  $\sigma_i^2$ . The noise plus interference covariance is denoted by  $\mathbf{R}$ . The vectors  $\bar{\mathbf{h}}$  and  $\bar{\mathbf{g}}$  denote the channel vectors of the desired and interfering user, respectively, with  $\mathbf{C} = [\bar{\mathbf{h}} \quad \bar{\mathbf{g}}]$ . The optimization problem for the optimal zero-forcing beamformer  $\bar{\mathbf{w}}$  is

$$\begin{aligned} \min \bar{\mathbf{w}}^T \bar{\mathbf{g}} \\ \text{s.t. } \bar{\mathbf{w}}^T \bar{\mathbf{h}} = 1 \end{aligned}$$

$$\begin{aligned} \min \bar{\mathbf{w}}^T \bar{\mathbf{h}} \\ \text{s.t. } \bar{\mathbf{w}}^T \bar{\mathbf{g}} = 0 \\ \|\bar{\mathbf{w}}\|^2 = 1 \end{aligned}$$

$$\begin{aligned} \min \sigma^2 \|\bar{\mathbf{w}}\|^2 \\ \text{s.t. } \bar{\mathbf{w}}^T \bar{\mathbf{h}} = 1 \\ \bar{\mathbf{w}}^T \bar{\mathbf{g}} = 0 \end{aligned}$$

$$\begin{aligned} \min \sigma^2 \|\bar{\mathbf{w}}\|^2 \\ \text{s.t. } \bar{\mathbf{w}}^T \bar{\mathbf{h}} = 0 \\ \bar{\mathbf{w}}^T \bar{\mathbf{g}} = 1 \end{aligned}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\begin{aligned} \min \sigma^2 \|\bar{\mathbf{w}}\|^2 \\ \text{s.t. } \bar{\mathbf{w}}^T \bar{\mathbf{h}} = 1 \\ \bar{\mathbf{w}}^T \bar{\mathbf{g}} = 0 \end{aligned}$$

10) Consider the multi-antenna system  $\bar{\mathbf{y}} = \bar{\mathbf{h}}x + \bar{\mathbf{g}}x_i + \bar{\mathbf{n}}$ , with the noise **1 point** samples in  $\bar{\mathbf{n}}$  i.i.d. zero-mean of variance  $\sigma^2$ , and interference symbols  $x_i$  of power  $\sigma_i^2$ . The noise plus interference covariance is denoted by  $\mathbf{R}$ . The vectors  $\bar{\mathbf{h}}$  and  $\bar{\mathbf{g}}$  denote the channel vectors of the desired and interfering user, respectively, with  $\mathbf{C} = [\bar{\mathbf{h}} \quad \bar{\mathbf{g}}]$ . The optimal zero-forcing

beamformer  $\bar{\mathbf{w}}$  is



$$\mathbf{C}(\mathbf{C}^T \mathbf{C})^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$



$$(\mathbf{C}^T \mathbf{C})^{-1} \mathbf{C} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$



$$\mathbf{C}(\mathbf{C} \mathbf{C}^T)^{-1} \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$



$$\mathbf{C}^{-1} \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$$\mathbf{C}(\mathbf{C}^T \mathbf{C})^{-1} \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

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