

# ECE 826: Quiz 0

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Name:  
Dept:

Email:  
Year:

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**Question 1.** If  $A$  is an  $n \times n$  matrix with rank  $r < n$ , how can one compute its null space?

Answer:

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**Question 2.** Give an example of a function  $f : \mathbb{R}^d \rightarrow \mathbb{R}$  that is negative everywhere and is also concave.

Answer:

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**Question 3.** Let  $X_1, \dots, X_n$  be independent, mean 1, Gaussian random variables with variance 10, and  $Z = \sum_{i=1}^n X_i$ . Please compute: i)  $\mathbb{E}\{Z\}$ , ii)  $\text{var}\{Z\}$ , and iii)  $\mathbb{E}\{Z|X_2, \dots, X_n\}$ .

Answer:

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**Question 4.** Let a coin with 1/4 probability of turning heads (H), and 3/4 tails (T). What is the most likely sequence of events after 5 random tosses?

Answer:

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**Question 5.** You wish to build a classifier that works well on images of cats and dogs. You decide to use a neural network because your friend says they are cool. You are given a data set ( $\mathcal{S}$ ) that consists of 50K test examples ( $\mathcal{S}_{test} \subset \mathcal{S}$ ) and 50K training examples ( $\mathcal{S}_{train} \subset \mathcal{S}$ ). Before using on real data, you want to tune the architecture of the model, and try a few different ones with the goal of maximizing accuracy on real (unseen) data. On what part of the data set will you optimize the network's architecture, and why?

Answer:

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**Question 6.** Let  $c_i \in \mathbb{R}$ . Can you solve either of the following problems in polynomial time in  $n$ ? If so, how? If not, why?

$$\mathcal{A} : \max_{x_i \in \{-1,1\}} \left| \sum_{i=1}^n c_i \cdot x_i \right| \qquad \mathcal{B} : \min_{x_i \in \{-1,1\}} \left| \sum_{i=1}^n c_i \cdot x_i \right|$$

Answer:

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**Question 7.** Construct a neural network that performs  $y = \max(x_1, x_2)$  without using max pool, using ReLU activations (e.g.,  $\sigma(x) = \mathbf{1}_{x>0} \cdot x$ )

Answer: