
CSE 575: Statistical Machine Learning Self-Evaluation Exam

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First Name:			
Last Name:			
Email:			
ASU ID:			
Q	Topic	Max Score	Score
1	Probability	24	
2	Iterative Algorithms	21	
3	MLE	20	
4	Quadratic Optimization	17	
5	Distance Metric	18	
Total:		100	

- This exam book has **6** pages, including this cover page and a blank page at the end.
- Good luck!

1 Probability (24 points)

(7 points.) If A and B are **DISJOINT** events, and $P(B) > 0$, what is the value of $P(A|B)$?

(7 points.) Suppose that the PDF of a random variable X is as follows:

$$f(x) = \begin{cases} \frac{4}{3}(1 - x^3), & \text{for } 0 \leq x \leq 1 \\ 0, & \text{otherwise} \end{cases}$$

Then what is the value of $P(X < 0)$?

(10 points.) Suppose that X is a random variable for which $E(X) = \mu$ and $Var(X) = \sigma^2$, and let c be an arbitrary constant. What is the value of $E[(X - c)^2]$?

Hint: What is the definition of variance?

2 Iterative Algorithms and Big-O (21 points)

[7 points.] Write a program/function (**Not Pseudocode**) to calculate the following sum (c++ or any of your favorite programming language). Your program takes an integer n ($n \geq 1$) as the input; and returns r defined as $r = \sum_{i=1}^n \sum_{j=1}^i j$.

(7 points.) What is the value r returned by your program? Express your answer as a function of n and use *closed-form* solution.

(7 points.) Using $O()$ notation, give the worst-case running time of your program.

3 Maximum Likelihood Estimation (20 points)

[10 points.] Suppose we flip a coin, and observe either a head or a tail. The probability of observing a head in each trial is p ($0 \leq p \leq 1$). If we flip the coin five times, and observe (*head, head, tail, tail, head*), what is the maximum likelihood estimate of p ? Justify your answer.

[10 points.] Suppose we flip a coin, and observe either a head or a tail. The probability of observing a head in the first trial is p ($0 \leq p \leq 1$). The probability of observing a head in the second trial is $2p$. The probability of observing a head in the third and fourth trials is $3p$, respectively. The probability of observing a head in the fifth trial is $5p$. If we flip the coin five times, and observe (*head, head, tail, tail, head*), what is the maximum likelihood estimate of p ? Justify your answer.

4 Quadratic Optimization (17 points)

[7 points.] Solve the following optimization problem

$$\operatorname{argmin}_x 3x^2 - 12x + 8$$

[10 points.] Solve the following optimization problem

$$\begin{aligned} &\operatorname{argmin}_x 3x^2 - 12x + 8 \\ &\text{subject to } 6 < x < 10 \end{aligned}$$

5 Distance Metric (18 points)

[18 points]. Given two data points $x_1 = (0, 0)'$ and $x_2 = (1, 2)'$ in two-dimensional space, what is the L_2 distance between them? What is the L_1 distance between them? What is the L_∞ distance between them? Justify your answer.