CS 361 Sample Midterm 2

NAME:

NETID:

CIRCLE YOUR DISCUSSION:

Thu 2-3 Thu 4-5 Fri 10-11 Fri 11-12

- Be sure that your exam booklet has 6 pages including this cover page
- Make sure to write your name exactly as it appears on your i-card
- Write your netid and circle your discussion section on this page
- **Show your work**
- This is a closed book exam
- You are allowed one handwritten 8.5 x 11-inch sheet of notes (both sides)
- You may **not** use a calculator or any other electronic device
- Turn off your phone and store it in your backpack
- Store away any other electronic devices including earphones and smartwatches
- Absolutely no interaction between students is allowed
- Use backs of pages for scratch work if needed
- Show your i-card when handing in your exam

Problem	1	2	3	4	5	Total
Possible	30	30	30	30	30	150
Score						

Problem 1 (30 pts)

1. (15 points) The Career Center wants to estimate the mean monthly salary of U of I students who go out on summer internships. The staff surveys 100 students and finds a sample mean of $5000 and a sample (unbiased) standard deviation of $1200. Provide a 95% confidence interval for the population mean monthly salary. Draw a box around your answer.

2. (15 points) You are trying to estimate the mean time that students wait in the CS 225 office hours queue. After 50 samples, you have calculated a standard error of 3 minutes. How many **additional** samples will you need to reduce the standard error to 1 minute? Draw a box around your answer.

Problem 2 (30 pts)

1. (15 points) You ask your CS 361 classmates whether they have started the next homework. Out of 10 students in the sample, 9 have not started yet. Calculate the sample (unbiased) standard deviation of the fraction of students who have started the homework. Draw a box around your answer.

2. (15 points) Your instructor grades 5 midterms out of a much larger stack in order to estimate the median score. The grades of the exams in the sample are 125, 135, 140, 140 and 150. For a bootstrap replicate of this sample, what is the probability that the median score is 150? You may use choose and summation notation in your answer. Draw a box around your answer.

Problem 3 (30 pts)

1. (15 points) You hypothesize that the average mass of apples in the cafeteria is 8 ounces. You weigh an apple every day for 9 days and find that the sample mean is 7.5 ounces and the standard error is 0.25 ounces. Complete the following formula for the two-tailed p-value of this experiment by providing values for a, b and n, where $f_n(x)$ is the probability density function of Student's t-distribution with n degrees of freedom. Draw a box around your answer.

$$\text{p-value} = 1 - \int_a^b f_n(x)dx$$

2. (15 points) A roulette wheel has 36 nonzero slots and an unknown number of zero slots. You observe that in N spins of the wheel, the ball lands in a zero slot k times. Write down the likelihood function $L(\theta)$ for the number of zero slots on the wheel. Draw a box around your answer.

Problem 4 (30 pts)

1. (15 points) You flip a coin 10 times and observe 3 heads. Use the prior distribution $P(\theta)$ below to calculate the maximum a posteriori (MAP) estimate $\hat{\theta}$ of the probability of heads. Draw a box around your answer.

$$P(\theta) = \binom{5}{2}\theta^2(1-\theta)^3$$

2. (15 points) You begin with a belief that your upstairs neighbor has gone away for the weekend with probability 0.1. When she is home, she stomps on your ceiling according to a Poisson process at an intensity of 1 stomp per hour. Between 9 am and noon on Saturday morning, you don't hear any stomps. What is the posterior probability that your neighbor is away? Assume that she is either at home or away. Draw a box around your answer.

Problem 5 (30 pts)

1. (15 points) Can the matrix shown below be a covariance matrix? Justify your answer in one sentence.

$$\begin{bmatrix} 7 & 1 & -0.5 \\ 0.5 & 3 & 0.1 \\ -0.7 & 0.2 & 0.9 \end{bmatrix}$$

2. (15 points) Suppose dataset $\{\mathbf{x}\}$ has the covariance matrix shown below. What is the mean square error incurred by projecting $\{\mathbf{x}\}$ on to its first principal component? Draw a box around your answer.

$$\text{Covmat}(\{\mathbf{x}\}) = \begin{bmatrix} 9 & 4 \\ 4 & 3 \end{bmatrix}$$