Week 1 Quiz

10 questions

1 point

1.
A New York City cab was involved in a hit-and-run accident last night. Five witnesses reported the incident, four of whom said that the cab was green and one of whom said that the cab was yellow. Assume each witness correctly identifies the color of a cab with probability 2/3. It is known that 85% of registered cabs in New York City are yellow and 15% are green. Based on this information, what is the probability that the cab was green?

- 58.5%
- 88.9%
- 41.5%
- 15.0%

1 point

2.
Suppose ten people are sampled from the population and their heights are recorded. Further suppose their heights are distributed normally, with unknown mean μ and unknown variance σ^2 . Which of the following statements best describes the likelihood of the data Y in this situation?

- The probability of observing the data, given μ, σ^2 .
- The probability of observing the data, given μ , σ^2 , and the prior.
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The probability of observing the data, given the prior beliefs about the distribution of μ and σ^2 .

- The probability of observing heights with a mean at least as extreme as $\bar{Y}$, given μ and σ^2 .

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1 point

3.

Recall the probability distribution of a Poisson random variable X:

$$P(X = x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

where λ is the rate parameter that equals the expected value of X .

John is analyzing traffic patterns on a country road. He believes that the number of cars that come during a given hour follows a Poisson distribution with rate λ. Further, he believes that either λ = 1 , λ = 2 , or λ = 4 and assigns equiprobable beliefs to each of the possible values of λ. He observes traffic for one hour and records a total of three cars passing.

Consider the following hypotheses:

H0: λ < 2

H1: λ = 2

H2: λ > 2

Which of the hypotheses has the greatest posterior probability?

- H_0
- H_1
- H_2

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1 point

4.

The posterior distribution after running two identical experiments is the same as that after running the second experiment with the posterior of the first experiment as the prior.

- (selected) True
- False

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1 point

5.

Which of the following corresponds to a Frequentist interpretation of the statement “the probability of rain tomorrow is 30 percent”?

- (selected) If conditions identical to tomorrow occurred an infinite number of times, we would observe rain on 30 percent of those days.
- If we predicted rain tomorrow, we would be 30% confident in our prediction.
- A degree of belief of 0.3, where 0 means rain is impossible and 1 means rain is certain.
- Under similar conditions, it has rained 30 percent of the time in the past.

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1 point

6.

Sander runs a controlled experiment to test the hypothesis that rats treated with 10 mg of Vitamin A have higher mortality rates than rats not given Vitamin A. After every death, he checks to see whether the p-value under the null hypothesis of no difference is below 0.05. If the p-value is greater than 0.05, he keeps collecting data. Otherwise, he stops collecting data and reports his results. If, after 10,000 deaths, he does not get significant results, he stops. Under a **Bayesian** framework, what is the problem with Sander’s experimental design?

- There is no problem with Sander’s design; the posterior only depends on the entirety of the data and the prior beliefs before the experiment.
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The posterior distribution will be biased, since Sander was intent on getting a specific result before the experiment began

By making a stopping rule that was dependent on his results, he made it more probable that he would get results suggesting Vitamin A increases rat mortality rates.

Sander excluded the possibility of getting a p-value larger than 0.05 by stopping the experiment prematurely

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1 point

7.

Hearing about your brilliant success in working with M&Ms, Mars Inc. transfers you over to the Skittles department. They recently have had complaints about tropical Skittles being mixed in with original Skittles. You decide to conduct a frequentist analysis. Although you are confident that the quality control measures result in less than 1% of all regular Skittles accidentally being tropical Skittles, you understand that things need to change if the complaints are true, so you set the significance level $\alpha = 0.1$. Randomly sampling 300 supposedly original Skittles, you find that five of them are tropical. What are your findings? Hint- $H_0 : p \leq 0.01$ and $H_1 : p > 0.01$.

Reject H_0, since the p-value is equal to 0.027, which is less than $\alpha = 0.1$

Fail to reject H_0, since the p-value is equal to 0.245, which is greater than $\alpha = 0.1$

Fail to reject H_0, since the p-value is equal to 0.101, which is greater than $\alpha = 0.1$

Fail to reject H_0, since the p-value is equal to 0.184, which is greater than $\alpha = 0.1$

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1 point

8.

You decide to conduct a statistical analysis of whether to determine how many

You decide to conduct a statistical analysis of a lottery to determine how many possible lottery combinations there were. If there are N possible lottery combinations, each person has a 1/N chance of winning. Suppose that 413,271,201 people played the lottery and three people won. You are told that the number of lottery combinations is a multiple of 100 million and less than 1 billion, but have no other prior information to go on. What is the posterior probability that there were **fewer** than 600 million lottery combinations?

- 0.269
- 0.390
- 0.511
- 0.894

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1 point

9.

Recall the probability distribution of a Poisson random variable X:

$$P(X = x) = \frac{\lambda^x e^{-\lambda}}{x\,!}$$

where λ is the rate parameter that equals the expected value of X.

You are a professor and assign your TAs to type up a very important homework assignment. You have three TAs: David makes an average of one typo per page, Amy makes an average of two typos per page, and Joe makes an average of three typos per page. A one-page typed homework assignment is turned into your box that has ten typos! Assuming that typos follow a Poisson distribution and you have no prior knowledge about which TA typed the assignment, what is the posterior probability that the TA who typed the homework assignment was Joe?

- 0.334
- 0.547
- 0.866
- 0.954

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1 point

10.

True or False: As long as the prior places non-zero probability on all possible values of a proportion, the posterior of the proportion is guaranteed to converge to the true proportion as the sample size approaches infinity.

- (●) True
- ( ) False

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