

INFO 7390

Advances in Data Sciences and Architecture

Assignment 1 – Review Probability & Stats

Professor: Nik Bear Brown
Due: September 21, 2019

Q1 (5 Points)

A certain disease has an incidence rate of 5%. If the false negative rate is 1% and the false positive rate is 3%, compute the probability that a person who tests positive actually has the disease.

Q2 (5 Points)

A box contains 5 red balls and 9 green balls. Two balls are drawn in succession **without** replacement. That is, the first ball is selected and its color is noted but it is not replaced, then a second ball is selected. What is the probability that:

- a. the first ball is green and the second ball is green?
- b. the first ball is green and the second ball is red?
- c. the first ball is red and the second ball is green?
- d. the first ball is red and the second ball is red?

Q3 (5 Points)

How many people must there be before the probability that at least two people have a birthday on October 31 is greater than $1/2$?

Q4 (5 Points)

What is the probability of getting exactly 2 heads after flipping three coins?

Q5 (5 Points)

Consider a six-sided die that gets a 1 with probability $p = 1/6$. How confident are you that you can get a 1 after rolling the die 3 times?

Q6 (5 Points)

Look up the Boolean satisfiability problem (SAT)

https://en.wikipedia.org/wiki/Boolean_satisfiability_problem

Consider a randomized version of SAT called Max-SAT which tries to satisfy as many clauses as possible with a random polynomial-time algorithm. More precisely, we define Max-SAT as follows: Given a set of k clauses $C = \{C_1, C_2 \dots C_k\}$ and n literals $X = \{X_1, X_2 \dots X_n\}$ find a truth assignment satisfying as many clauses as possible. Each clause must have at least one literal in it, and all of the literals within a single clause are distinct.

- A. What is the expected number of satisfied clauses if each clause has just one literal and we randomly assign the truth value by flipping a fair coin?
- B. If each clause has just one literal can we always find a solution that will satisfy all k clauses?

Q7 (5 Points)

Compute the probability of randomly drawing 4 cards from a deck and getting exactly three Queens.

Q8 (5 Points)

A group of people decide to do a Xmas gift exchange. In a bag contains each person's name on a token. Each person selects a token at random. That is the name of the person to give a gift to secretly.

This only works if you get someone else's name, as you would not want to give a gift to yourself.

What is the probability the draw is successful? That is, what is the chance no one selects his or her own name?

Q9 (5 Points)

$P(A) = 0.22$, $P(B) = 0.33$, $P(A \cup B) = 0.55$

What is $P(A|B)$?

Q10 (5 Points)

Assume $P(A)$ and $P(B)$ are independent.

Which of the following are true?

- a) $P(A \text{ and } B) = P(A)P(B)$
- b) $P(A|B) = P(A)$
- c) $P(B|A) = P(B)$

For the following questions create a homework problem with solutions based on the worked problems in the jbststatistics videos. ONLY when a video has no example calculations can you create a conceptual question.

Q11 (5 Points)

Create a novel homework problem with solutions for a Z Test for One Mean. See the example in Z Tests for One Mean: An Example <https://youtu.be/Xi33dGcZCA0>

Q12 (5 Points)

Create a novel homework problem with solutions for creating a Confidence Interval. See the example Inference for One Variance: An Example of a Confidence Interval and a Hy... <https://youtu.be/tsLGbpu>

Q13 (5 Points)

Create a novel homework problem with solutions for Deriving a Confidence Interval for a Variance (Assuming a Normal Distribution). See the example Deriving a Confidence Interval for a Variance (Assuming a Normally Distr... <https://youtu.be/q-CHZyOs5DQ>

Q14 (5 Points)

Create a novel homework problem with solutions for A One-Way ANOVA Example. See the example A One-Way ANOVA Example <https://youtu.be/WUoVftXvjiQ>

Q15 (5 Points)

Create a novel homework problem with solutions for Finding the P-value in One-Way ANOVA. See the example Finding the P-value in One-Way ANOVA <https://youtu.be/XdZ7BRqznSA>

Q16 (5 Points)

Create a novel homework problem with solutions for example Inference for Two Means: Introduction. See the example Inference for Two Means: Introduction <https://youtu.be/86ss6qOTfts>

Q17 (5 Points)

Create a novel homework problem with solutions for Calculating Power and the Probability of a Type II Error. See the example Calculating Power and the Probability of a Type II Error (A One-Tailed E... <https://youtu.be/BJZpx7Mdde4>

Q18 (5 Points)

How does a t Distribution differ from a normal Distribution? See the example Introduction to the t Distribution (non-technical) <https://youtu.be/Uv6nGlgZMVw>

Q19 (5 Points)

Create a novel homework problem with solutions for a Conditional Probability worked problem. See the example Conditional Probability Example Problems <https://youtu.be/ES9HFNDu4Bs>

Q20 (5 Points)

Create a novel homework problem with solutions for calculating the Power of the Test. See the example Type I Errors, Type II Errors, and the Power of the Test https://youtu.be/7mE-K_w1v90