#1 Statistics Team Round
February Statewide 2022

Any good statistics team round needs to start with one of these!

Given the following data set of 25 values:

{67, 42, 25, 25, 27, 34, 76, 42, 82, 95, 2, 96, 28, 64, 71, 24, 16, 54, 21, 7, 83, 18, 65, 36, 96}

A) Let A equal the mean of the data set as an exact value in decimal form.

B) Let B equal the standard deviation of the data set as a decimal rounded to the thousandths place.

C) Let C equal the first quartile of the data set as an exact value in decimal form.

D) Let D equal the number of outliers present in this data set according to the 1.5(IQR) rule.

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February Statewide 2022

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B) Let B equal the standard deviation of the data set as a decimal rounded to the thousandths place.

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D) Let D equal the number of outliers present in this data set according to the 1.5(IQR) rule.

#2 Statistics Team Round
February Statewide 2022

For parts A and B only: Given the function $f(x) = ax + b$ that is only defined when $f(x) \geq 0$ and $0 \leq x \leq \left|\frac{3}{2a}\right|$.

A) Let A equal the exact value of $a < 0$ that will make this function a valid probability density function if $b = \frac{13}{4}$.

B) Let B equal the exact value of b that will make this function a valid probability density function if $a = -3$.

C) The mean of a data set consisting of 6 positive integers is 5 and the median is 6. Let C = the largest possible integer value the mode could be, given that the mode of the data set is unique. NOTE: the six positive integers in the data set are not necessarily all distinct and so some values may appear more than once.

D) Three fair six-sided dice are rolled. The probability that the sum of the 3 resulting numbers is 9 is $\frac{D}{216}$. What is D?

#2 Statistics Team Round
February Statewide 2022

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D) Three fair six-sided dice are rolled. The probability that the sum of the 3 resulting numbers is 9 is $\frac{D}{216}$. What is D?

#3 Statistics Team Round
February Statewide 2022

Jack's strange deck consists of 10 strange cards. Three of the cards are red on both sides, 6 of the cards are red on one side and green on the other, and the last card is green on both sides. Being a statistician, Jack wants to calculate some probabilities with his deck. He shuffles the cards, puts them in a stack behind his back and starts drawing cards without replacement and without looking at the deck. Give all answers as simplified fractions.

A) Let A equal the probability that the first card he draws is red on both sides.

B) Let B equal the probability that the last card he draws is red on both sides after drawing all 10 cards.

Use the following information for Parts C and D: Jack now puts all the cards into an opaque bag and begins drawing out cards randomly and without replacement. He then places the drawn cards on a table, without looking at the other side.

C) Jack draws out a card and sees that the side facing up is red. Let C equal the probability that the card is red on both sides.

D) Jack puts the card from part C back into the bag, mixes them up, and now draws three cards at random, one at a time and without replacement. He sees that all three of the sides facing up are red on one side. Let D equal the probability that all three are red on both sides.

#3 Statistics Team Round
February Statewide 2022

Jack's strange deck consists of 10 strange cards. Three of the cards are red on both sides, 6 of the cards are red on one side and green on the other, and the last card is green on both sides. Being a statistician, Jack wants to calculate some probabilities with his deck. He shuffles the cards, puts them in a stack behind his back and starts drawing cards without replacement and without looking at the deck. Give all answers as simplified fractions.

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D) Jack puts the card from part C back into the bag, mixes them up, and now draws three cards at random, one at a time and without replacement. He sees that all three of the sides facing up are red on one side. Let D equal the probability that all three are red on both sides.

#4 Statistics Team Round
February Statewide 2022

Kira has two random variables which she calls X and Y. She knows that $\mu_X = 5$, $\sigma_X = 2$, $\mu_Y = 7$, and $\sigma_Y{}^2 = 9$. Kira wants to combine her random variables; however, she is unsure about whether they are correlated or independent. So, she instead decides to make calculations for both cases.

For parts A and B, assume X and Y are independent.

A) Let A equal the mean of the random variable $3X - 2Y$ as an exact value.

B) Let B equal the standard deviation of the random variable $3X - 2Y$ rounded to the thousandths place.

For parts C and D, assume X and Y are correlated with $\rho = 0.56$. NOTE: The Greek letter "ρ" or "rho" denotes the population correlation between two random variables and the general formula for calculating the variance of linearly transformed and combined random variables is $Var(aX + bY) = (a\sigma_X)^2 + (b\sigma_Y)^2 + 2\rho(a\sigma_X)(b\sigma_Y)$.

C) Let C equal the mean of the random variable $3X - 2Y$ as an exact value.

D) Let D equal the standard deviation of the random variable $3X - 2Y$ rounded to the thousandths place.

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February Statewide 2022

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For parts A and B, assume X and Y are independent.

A) Let A equal the mean of the random variable $3X - 2Y$ as an exact value.

B) Let B equal the standard deviation of the random variable $3X - 2Y$ rounded to the thousandths place.

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C) Let C equal the mean of the random variable $3X - 2Y$ as an exact value.

D) Let D equal the standard deviation of the random variable $3X - 2Y$ rounded to the thousandths place.

#5 Statistics Team Round
February Statewide 2022

Eric wants to know how many grapes people eat daily. A previous study showed that the average number of grapes eaten per person per day was 10 grapes. Being the skeptic that he is, Eric believes that, μ, the true mean number of grapes eaten per person per day is higher than 10 grapes. Thus, Eric wishes to test the hypotheses $H_0: \mu = 10$ versus $H_A: \mu > 10$. Eric decides to take an SRS of 100 people to collect data from and because Eric also likes being confident in his results, he performs his test at the 1% significance level. Finally, suppose it is known that the population standard deviation of the number of grapes eaten per person per day is $\sigma = 4$ grapes per person per day. You may assume all inference assumptions and conditions are met.

A) Let A equal the p-value of Eric's test assuming he found a sample mean of 11 grapes eaten per person per day. Round only your final answer to four decimal places.

B) Let B equal the power of Eric's test if the true population mean is $\mu = 11.5$ grapes per person per day. Round only your final answer to four decimal places.

C) Let C equal the probability that Eric rejects $H_0: \mu = 10$ when in fact the true population mean is $\mu = 10$ grapes per person per day. Report your final answer as a decimal rounded to the hundredths place.

D) Let D equal the probability that Eric fails to reject $H_0: \mu = 10$ when the true population mean is $\mu = 11.5$ grapes per person per day. Round only your final answer to four decimal places.

#5 Statistics Team Round
February Statewide 2022

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A) Let A equal the p-value of Eric's test assuming he found a sample mean of 11 grapes eaten per person per day. Round only your final answer to four decimal places.

B) Let B equal the power of Eric's test if the true population mean is $\mu = 11.5$ grapes per person per day. Round only your final answer to four decimal places.

C) Let C equal the probability that Eric rejects $H_0: \mu = 10$ when in fact the true population mean is $\mu = 10$ grapes per person per day. Report your final answer as a decimal rounded to the hundredths place.

D) Let D equal the probability that Eric fails to reject $H_0: \mu = 10$ when the true population mean is $\mu = 11.5$ grapes per person per day. Round only your final answer to four decimal places.

#6 Statistics Team Round
February Statewide 2022

Helena runs a boba shop and wants to know how many people like boba tea or some other type of tea. She surveys 280 people and asks them if they prefer boba tea, milk tea, or iced tea. She found out that 160 people like boba tea, 50 people like milk tea, 100 people like iced tea, and 30 people don't like any of these three types of tea at all. She also found out that 25 people like both boba and milk tea, 30 people like both boba tea and iced tea, and 15 people like both milk tea and iced tea. Assume that each person Helena surveyed can only either like or dislike each one of the three types of tea.

A) Let A equal the number of people who like all three types of tea.

For parts B, C, and D, Helena now wants to randomly select an individual from her survey group to receive a tea prize. Provide each answer as a simplified fraction.

B) Let B equal the probability that Helena selects someone who doesn't like any of the three types of tea.

C) Let C equal the probability that Helena selects someone who likes boba tea given that they do not like iced tea or milk tea.

D) Let D equal the probability that Helena selects someone who likes boba tea and milk tea, but dislikes iced tea.

#6 Statistics Team Round
February Statewide 2022

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For parts B, C, and D, Helena now wants to randomly select an individual from her survey group to receive a tea prize. Provide each answer as a simplified fraction.

B) Let B equal the probability that Helena selects someone who doesn't like any of the three types of tea.

C) Let C equal the probability that Helena selects someone who likes boba tea given that they do not like iced tea or milk tea.

D) Let D equal the probability that Helena selects someone who likes boba tea and milk tea, but dislikes iced tea.

#7 Statistics Team Round
February Statewide 2022

Eddie is practicing his backflipping skills. He is not very good yet, so the probability that he lands a backflip on any given attempt is only 0.23. Eddie decides to keep backflipping until he lands one. Assume every attempt is independent of each another attempt and that the probability that Eddie lands a successful backflip remains constant on each attempt.

A) Let A equal the expected value of the number of backflips Eddie must attempt in order to successfully land his first backflip in this scenario as an exact value in the form of a simplified fraction.

B) Let B equal the variance of the number of backflips Eddie must attempt in order to successfully land his first backflip in this scenario as an exact value in the form of a simplified fraction.

Use the following for parts C and D: Now that Eddie has landed one, he gets more ambitious. He will now keep attempting backflips until he lands three backflips! Ignore the one he landed in parts A and B.

C) Let C equal the probability that Eddie accomplishes this amazing feat in at most 5 attempts. Round only your final answer to 3 decimal places.

D) Let D equal 1 if the distribution used to calculate the answer to part C is a normal distribution, 2 if it is a geometric distribution, 3 if it is a binomial distribution, 4 if it is a negative binomial distribution, 5 if it is a hypergeometric distribution, or 6 if it is a Poisson distribution.

#7 Statistics Team Round
February Statewide 2022

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#8 Statistics Team Round
February Statewide 2022

Jeffrey's favorite random variable, X, is a normal distribution that has a mean of 18 and a standard deviation of 3.

A) Let A equal the z-score of the value $x = 6$ in Jeffrey's normal distribution as an exact value.

Use the following for part B only: Jeffrey decides that he is feeling adventurous, so he decides to shift his normal distribution by adding a non-zero real constant, k, such that the mean ends up being equal to the standard deviation.

B) Let B equal the z-score of x = 6 in Jeffrey's new shifted normal distribution as an exact value.

Use the following for parts C and D: Jeffrey isn't satisfied, so he instead decides to add a non-zero real constant, k, to every value in his favorite original normal distribution and then multiply all those values by k as well to get another new normal distribution of the form $k(X + k)$. This time, however, the new mean ends up being equal to the new variance of the new normal distribution.

C) Let C equal the mean of Jeffrey's new normal distribution as an exact value.

D) Let D equal the standard deviation of Jeffrey's new normal distribution as an exact value.

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C) Let C equal the mean of Jeffrey's new normal distribution as an exact value.

D) Let D equal the standard deviation of Jeffrey's new normal distribution as an exact value.

#9 Statistics Team Round
February Statewide 2022

Alice wants to find out what proportion of students at Mu Alpha Theta competitions skip questions on their tests. William claims that he knows the proportion is 40%. However, because William isn't always a reliable source, and because Alice believes the proportion is higher, she takes a simple random sample of Mu Alpha Theta competitors to get her own results. She finds that 55% of the students she asked skipped questions. Sadly, Alice asked so many students that she forgot how many students she asked, so in her calculations she just calls it n. You may assume all inference assumptions and conditions for the appropriate test are met.

A) Let A equal Alice's value of n if the test statistic of her test is 2.7386 when rounded.

B) Using an alpha level of 0.01, let B equal the minimum integral value of n Alice would need to reject William's claim of $p = 0.40$ for the proportion of students who skip questions on their tests assuming she still has a constant sample proportion of 55%. Round the critical value you use to at least 3 decimal places.

Use the following for parts C and D: Alice doesn't know how many people she asked, but still wants to know if William was accurate or not, so she assumes n is 100.

C) Let C equal the p-value Alice gets from this test. Round only your final answer to 4 decimal places.

D) Using an alpha value of 0.05, let D equal 1 if Alice rejects William's claim and let D equal 0 otherwise.

#9 Statistics Team Round
February Statewide 2022

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#10 Statistics Team Round
February Statewide 2022

Recently, there has been an outbreak of chungalitis around the world. Bailey is a leading expert in chungalitis detection research, and he has devised a chungalitis test to see if people have the disease. Even though Bailey is a super genius, he cannot make the test 100% accurate. Out of the 1000 people that he has tested so far, 334 have tested positive for chungalitis, and out of those people who tested negative, $\frac{1}{9}$ of them actually have chungalitis. Finally, 10 people out of those who tested positive actually do not have chungalitis. Give exact answers for all parts.

A) Let A equal the number of people who actually have chungalitis out of those tested by Bailey.

B) Let B equal the number of people who got the wrong result from this test when tested by Bailey.

C) If one person is picked from this group of 1000 people at random, let C equal the probability that he/she is a true negative in the sense that the person both received a negative test result and actually does not have chungalitis.

D) If one person were to be picked from this group of 1000 people at random, let D equal the probability that he/she has chungalitis given that they tested positive.

#10 Statistics Team Round
February Statewide 2022

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C) If one person is picked from this group of 1000 people at random, let C equal the probability that he/she is a true negative in the sense that the person both received a negative test result and actually does not have chungalitis.

D) If one person were to be picked from this group of 1000 people at random, let D equal the probability that he/she has chungalitis given that they tested positive.

#11 Statistics Team Round
February Statewide 2022

Amy wants to know how tall an average man is in the US. According to healthline.com, the average man in the US stands about 69 inches tall. Amy decides to test the accuracy of the healthline.com claim and takes a simple random sample of 100 men from around the US. She ends up with a sample mean of 70.5 inches with a test statistic 2.87 (when rounded) for her hypothesis test. You may assume all inference assumptions and conditions of the test are met.

A) Let A equal the sample standard deviation of Amy's data set rounded to three decimal places.

B) Using an alpha level of 0.05, let B equal 1 if Amy rejects healthline.com's average and let B equal 0 otherwise.

C) Let C equal the maximum sample standard deviation Amy's data set could have had and still reject healthline.com's claim about the average height of US men assuming all other variables remain constant. Round only your final answer to the hundredths place.

D) Let D equal the p-value of this test rounded to three decimal places.

#11 Statistics Team Round
February Statewide 2022

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D) Let D equal the p-value of this test rounded to three decimal places.

#12 Statistics Team Round
February Statewide 2022

One of the first things you learn in statistics is the Empirical Rule. I hope you still remember it! Given a normal distribution with a mean of 10 and a standard deviation of 2, use the Empirical Rule to evaluate each of the following. Express all answers in decimal from without any rounding.

A) Let A equal the probability that a value in this distribution is greater than 16.

B) Let B equal the probability that a value in this distribution is less than 6.

C) Let C equal the probability that a value in this distribution is between 12 and 16.

D) Let D equal the probability that a value in this distribution is between 6 and 12.

#12 Statistics Team Round
February Statewide 2022

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A) Let A equal the probability that a value in this distribution is greater than 16.

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C) Let C equal the probability that a value in this distribution is between 12 and 16.

D) Let D equal the probability that a value in this distribution is between 6 and 12.

#13 Statistics Team Round
February Statewide 2022

You are invited to try the famous Monty Hall problem but with a little twist. This time, Monty has 5 doors at his disposal, behind four doors are goats and behind the fifth door is a car. Define winning as picking the door with the car behind it. You first pick a door at random. Define "switch" as randomly picking a door that is closed and is not the door you initially picked. Also, Monty knows what is behind each of the doors. Consider each of the following scenarios and give all answers as simplified fractions.

A) Monty opens three of the doors that have goats behind them after you pick a door at random. Let A equal the probability that you win if you switch doors.

B) Monty opens only one of the doors that has a goat behind it after you pick a door at random. Let B equal the probability that you win if you switch doors.

C) You pick a door at random. Now, suppose now that Monty randomly selects a door to open and happens to open a door that has a goat behind it and happens to not be the door you have initially picked. Let C equal the probability that you win if you switch doors.

D) You pick a door at random. Now, Monty first opens one of the doors that he knows has a goat behind it. You then switch your door at random to one of the unopened doors. Monty then selects a second door at random and happens to open a door that has a goat behind it and happens to not be the door you initially picked nor the second one that you have picked now. Let D equal the probability that you win if you switch doors again.

#13 Statistics Team Round
February Statewide 2022

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A) Monty opens three of the doors that have goats behind them after you pick a door at random. Let A equal the probability that you win if you switch doors.

B) Monty opens only one of the doors that has a goat behind it after you pick a door at random. Let B equal the probability that you win if you switch doors.

C) You pick a door at random. Now, suppose now that Monty randomly selects a door to open and happens to open a door that has a goat behind it and happens to not be the door you have initially picked. Let C equal the probability that you win if you switch doors.

D) You pick a door at random. Now, Monty first opens one of the doors that he knows has a goat behind it. You then switch your door at random to one of the unopened doors. Monty then selects a second door at random and happens to open a door that has a goat behind it and happens to not be the door you initially picked nor the second one that you have picked now. Let D equal the probability that you win if you switch doors again.

#14 Statistics Team Round
February Statewide 2022

Consider the following 9 variables:

Height in inches	Foot length in cm	GPA
Age in years	Zip Code	Number of hairs on your head
Weight in ponds	IQ	Dollars earned per month

A) Let *A* equal the number of quantitative variables in the above list.

Let S be a set of data that has a 5-number summary of {3, 7, 18, 29, 33}. For each of the following statements, assign a lettered part a value of 2 is the statement about the set S is absolutely true; assign a value of 1 if the statement is potentially true, but not necessarily absolutely true; and assign a value of 0 if the statement is absolutely false.

B) The mean of set S is 18.
C) Set S has <u>exactly</u> 25% of its data values strictly less than 7.
D) Judging by the 5-number summary alone, the distribution of set S is perfectly symmetric.

#14 Statistics Team Round
February Statewide 2022

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Let S be a set of data that has a 5-number summary of {3, 7, 18, 29, 33}. For each of the following statements, assign a lettered part a value of 2 is the statement about the set S is absolutely true; assign a value of 1 if the statement is potentially true, but not necessarily absolutely true; and assign a value of 0 if the statement is absolutely false.

B) The mean of set S is 18.
C) Set S has <u>exactly</u> 25% of its data values strictly less than 7.
D) Judging by the 5-number summary alone, the distribution of set S is perfectly symmetric.