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Chapter 2

1. We throw a fair six-sided die twice, then add the two numbers. Let E denote the event that getting a number divisible by 5. What is the number of outcomes in E ? + 0.333
- A. 5
B. 6
C. 7
D. 8

Solution

$$E = \{(1, 4), (2, 3), (3, 2), (4, 1), (4, 6), (5, 5), (6, 4)\}$$
$$\Rightarrow |E| = 7$$

Answer: C

2. Which of the following assignments of probabilities to the sample points A, B, and C is valid if A, B, and C are the only sample points in the experiment?
- A. $P(A) = -\frac{1}{4}, P(B) = \frac{1}{2}, P(C) = \frac{3}{4}$
B. $P(A) = \frac{1}{9}, P(B) = \frac{1}{4}, P(C) = \frac{1}{2}$
C. $P(A) = 0, P(B) = \frac{1}{14}, P(C) = \frac{13}{14}$
D. $P(A) = \frac{1}{5}, P(B) = \frac{1}{5}, P(C) = \frac{1}{5}$
E. None of the other choices is correct

Solution

Option A: $P(A) = -\frac{1}{4} < 0 \Rightarrow$ invalid

Option B: $P(A) + P(B) + P(C) = \frac{1}{9} + \frac{1}{4} + \frac{1}{2} \approx 0.861 < 1 \Rightarrow$ invalid

Option D: $P(A) + P(B) + P(C) = \frac{1}{5} + \frac{1}{5} + \frac{1}{5} = 0.6 < 1 \Rightarrow$ invalid

Answer: C

3. If $P(A) = 0.5$, $P(B) = 0.4$ and $P(A \cap B) = 0.3$. Determine $P(A' \cap B)$

Solution

$$P(A' \cap B) = P(B) - P(A \cap B) = 0.4 - 0.3 = 0.1$$

4. Let's say that 50% of 10,000 women who take pregnancy tests are actually pregnant. Suppose there is a new pregnancy test and we know the following information: 92% of women who are pregnant will correctly get a positive result; and 6% of women who are not pregnant will also get a positive result. Given that a woman is not pregnant, what's the chance she'll get a negative result?
- A. 94%
B. 93.88%
C. 95%
D. 93%

Solution

Let A denote the event that a woman is pregnant and B denote the event that the test return positive result.

From the hypothesis:

- $P(A) = 0.5$
- $P(B | A) = 0.92$
- $P(B | \bar{A}) = 0.06$

$$\Rightarrow P(\overline{B} \mid \overline{A}) = 1 - P(B \mid \overline{A}) = 1 - 0.06 = 0.94$$

Answer: A

Chapter 3

1. Assume that male and female births are equally likely and that the birth of any child does not affect the probability of any other children. Find the probability of at most three boys in ten births.
A. 0.333
B. 0.172
C. 0.003
D. 0.300
E. None of the other choices is correct

Solution

X is the number of boys in ten births

$$X \sim B(n = 10, p = 0.5)$$

$$P(X < 3) = \sum_{x=0}^3 \binom{n}{x} 0.5^x 0.5^{n-x} \approx 0.172$$

Answer: B

2. In a certain manufacturing process it is known that, on the average, 1 in every 100 items is defective. What is the probability that the fifth item inspected is the first defective item found?
A. 0.0099
B. 0.8879
C. 0.6879
D. 0.0096
E. None of the other choices is correct

Solution

X is the number of items inspected until the first defective item found

$$X \sim G(p = 0.01)$$

$$P(X = 5) = (1 - p)^4 \cdot p \approx 0.0096$$

Answer: D

3. There are calculation errors in 3 out of a package of 12 invoices. An auditor checks a random sample of 7 invoices from the package. What are the probabilities of finding all 3 errors in the sample?
A. 0.1591
B. 0.1996
C. 0.8327
D. 0.0031
E. None of the other choices is correct

Solution

X is the number of errors in the sample

$$X \sim \text{HG}(N = 12, K = 3, n = 7)$$

$$P(X = 3) = \frac{\binom{K}{3} \cdot \binom{N-K}{n-3}}{\binom{N}{n}} \approx 0.1591$$

Answer: A

4. Let X and Y be two discrete uniform distributions with $E(X) = 1$ and $E(Y) = 10$. Find the value of $E(10X + Y)$.

Solution

$$E(10X - Y) = 10E(X) + E(Y) = 0$$

5. The number of times that Cuong stops at traffic lights follows a Poisson distribution with a mean of one stop per kilometer. Find the probability that he only stops at at most two traffic lights during a 5-kilometer ride.
- A. 0.125
B. 0.098
C. 0.134
D. 0.212
E. none of the other choices is correct

Solution

X is the number of times that Cuong stops at traffic lights

$$X \sim P(\lambda = 5)$$

$$P(X < 2) = \sum_{x=0}^2 \frac{e^{-\lambda} \lambda^x}{x!} \approx 0.125$$

Answer: A

6. A batch of 500 machined parts contains 15 that do not conform to customer requirements. The random variable is the number of parts in a sample of ten parts that do not conform to customer requirements. What is the range of the random variable?
- A. Integers from 0 to 10
B. Integers from 0 to 15
C. Integers from 10 to 500
D. Real numbers from 0 to 10
E. Real numbers from 0 to 15

Solution

X is the number of parts in a sample of ten parts that do not conform to customer requirements

$$X \sim \text{HG}(N = 500, K = 15, n = 10)$$

$$\max\{0, n + K - N\} < X < \min\{n, K\} \Rightarrow 0 < X < 10$$

Answer: A

7. A batch contains 52 bacteria cells. Assume that 13 of cells are not good. Five cells are selected at random without replacement. What is the probability that all five cells of selected cells are not good?
- A. None of the others
B. 0.945
C. 0.0002215
D. 0.257
E. 0.0004952

Solution

X is the number of not good cells in the sample

$$X \sim \text{HG}(N = 52, K = 13, n = 5)$$

$$P(X = 5) = \frac{\binom{K}{5} \cdot \binom{N-K}{0}}{\binom{N}{n}} \approx 0.0004952$$

Answer: E

8. A single six-sided die is rolled. Find the probability of rolling a number at most 5.
- A. 0.333
 - B. 0.667
 - C. 0.833
 - D. 0.5
 - E. None of the others choices is correct

Solution

X is the number rolled

$$X \sim U\{1, 6\}$$

$$P(X < 5) = \frac{5}{6}$$

Answer: C

9. Let X be a continuous random variable with $E(X) = 10$ and $E(X^2) = 100$. Find $V(X)$.

Solution

$$V(X) = E(X^2) - E(X)^2 = 0$$

10. Assume that each of your calls to a popular radio station has a probability of 0.02 of connecting, that is, of not obtaining a busy signal. Assume that your calls are independent. What is the probability that your first call that connects is your tenth call?
- A. 0.0167
 - B. 0.1670
 - C. 0.8320
 - D. 0.9833

Solution

X is the number of call until the first connected call

$$X \sim G(p = 0.02)$$

$$P(X = 10) = (1 - p)^9 \cdot p \approx 0.0167$$

Answer: A

11. A statistics professor finds that when he schedules an office hour at the 10:30 a.m. time slot, an average of three students arrive. Use the Poisson distribution to find the probability that in a randomly selected office hour in the 10:30 a.m. time slot exactly five students will arrive.
- A. 0.0070
 - B. 0.1008
 - C. 0.519

- D. 0.0137
E. none of the other choices is correct

Solution

X is the number of students whom will arrive

$$X \sim P(\lambda = 3)$$

$$P(X = 5) = \frac{e^{-\lambda} \lambda^5}{5!} \approx 0.1008$$

Answer: B

12. Suppose that a random variable X has the discrete uniform distribution on the integers 10,...,20. Find $P(X = 7)$.

Solution

$$X \sim U\{10, 20\}$$

$$P(X = 7) = \frac{1}{b - a + 1} = 0.1$$

13. Messages arrive at a switchboard in a Poisson manner at an average rate of five per hour. Find the probability for each of the following event: "At least three messages arrive within one hour"
- A. 0.0380
B. 0.9976
C. None of the other choices is correct
D. 0.0620
E. 0.875

Solution

X is the number of message arrived within one hour

$$X \sim P(\lambda = 5)$$

$$P(X > 3) = 1 - P(X < 2) = 1 - \sum_{x=0}^2 \frac{e^{-\lambda} \lambda^x}{x!} \approx 0.875$$

Answer: E

14. Suppose X has a hypergeometric distribution with $N=20$, $n = 4$, and $K = 4$. Find $P(X=3)$ and $P(X < 3)$
- A. None of the other choices is correct
B. 0.9866 and 0.0134
C. 0.9866 and 0.00012
D. 0.0132 and 0.99998
E. 0.00021 and 0.99979

Solution

$$P(X = 3) = \frac{\binom{K}{3} \binom{N-K}{n-3}}{\binom{N}{n}} \approx 0.0132$$

$$P(X < 3) = \sum_{\{x=0\}} \{3\} \frac{\binom{K}{x} \binom{N-K}{n-x}}{\binom{N}{n}} \approx 0.99979$$

Answer: B

15. The probability of a successful optical alignment in the assembly of an optical data storage products is 0.8. Assume the trials are independent. What is the probability that the first successful alignment requires exactly four trials?
- A. 0.0064
 - B. 0.1262
 - C. 0.4332
 - D. 0.6756

Solution

X is the number trials until the first successful

$$X \sim G(p = 0.8)$$

$$P(X = 4) = (1 - p)^3 p = 0.0064$$

Answer: A

16. The random variable X has a binomial distribution with $n = 10$ and $p = 0.5$. Which in the following statements is TRUE?
- A. $P(X > 9) = 0.0107$
 - B. $P(X < 2) = 0.0547$
 - C. All of the others.
 - D. $P(X = 5) = 0.2461$

Solution

$$X \sim B(n = 10, p = 0.5)$$

$$P(X > 9) = 1 - P(x < 8) = 1 - \sum_{x=0}^8 \binom{n}{x} p^{10} \approx 0.0107$$

$$P(x < 2) = \sum_{x=0}^2 \binom{n}{x} p^{10} \approx 0.0547$$

$$P(X = 5) = \binom{n}{5} p^{10} \approx 0.2461$$

Answer: C

17. Let the random variable X have a discrete uniform distribution on the integer $0 < x < 100$. Find the mean and variance of X .
- A. None of the others
 - B. 50 and 861.6667
 - C. 50 and 816.6667
 - D. 50 and 850
 - E. 49.5 and 850

Solution

$$X \sim U\{1, 99\}$$

$$\mu = \frac{a+b}{2} = 50$$

$$\sigma^2 = \frac{(b-a+1)^2 - 1}{12} \approx 816.6667$$

Answer: C

18. A batch contains 52 bacteria cells. Assume that 13 of cells are not good. Five cells are selected at random, without replacement. What is the probability that all five cells of selected cells are not good?
- A. None of the other choices is correct
 - B. $4.952 \cdot 10^{-4}$
 - C. 0.495
 - D. 0.221
 - E. 0.221

Solution

X is the number of not good cells in the sample

$$X \sim \text{HG}(N = 52, K = 13, n = 5)$$

$$P(X = 5) = \frac{\binom{K}{5} \cdot \binom{N-K}{0}}{\binom{N}{n}} \approx 4.952 \cdot 10^{-4}$$

Answer: B

19. Messages arrive at a switchboard in a Poisson manner at an average rate of five per hour. Find the probability for each of the following event: "No message arrives within one hour"
- A. 0.4046
 - B. 0.0067
 - C. 0.4460
 - D. None of the other choices is correct
 - E. 0.4406

Solution

X is the number of message arrived per hour

$$X \sim P(\lambda = 5)$$

$$P(X = 0) = \frac{e^{-\lambda} \lambda^0}{0!} \approx 0.0067$$

Answer: B

20. Suppose the probability that item produced by a certain machine will be defective is 0.2. Find the probability that 10 items will contain at most one defective item. Assume that the quality of successive items is independent.
- A. 0.27
 - B. None of these
 - C. 0.73
 - D. 0.38
 - E. 0.63

Solution

X is the number of defective item

$$X \sim B(n = 10, p = 0.2)$$

$$P(X < 1) = \sum_{x=0}^1 \binom{n}{x} p^x (1-p)^{n-x} \approx 0.38$$

Answer: D

21. Let the random variable X have a discrete uniform distribution on the integers $1 < x < 35$. Determine the mean and variance of X .
- A. 17.5 and 102
 - B. None of the others
 - C. 17 and 102
 - D. 18 and 102

Solution

$$X \sim U\{1, 35\}$$

$$\mu = \frac{a+b}{2} = 18$$

$$\sigma^2 = \frac{(b-a+1)^2 - 1}{12} = 102$$

Answer: D

22. Let X be a binomial random variable with $p = 0.1$ and $n = 10$. Calculate the following probability: $P(X > 2)$ and $P(X < 8)$
- A. 0.702 and 0.999
 - B. None of others.
 - C. 0.9892 and 1
 - D. 0.702 and 1
 - E. 0.0702 and 0

Solution

$$X \sim B(n = 10, p = 0.1)$$

$$P(X > 2) = 1 - P(X < 2) = 1 - \sum_{x=0}^2 \binom{n}{x} p^x (1-p)^{n-x} \approx 0.0702$$

$$P(X < 8) = \sum_{x=0}^8 \binom{n}{x} p^x (1-p)^{n-x} \approx 1$$

Answer: A

23. Let the random variable X be as Poisson distribution with mean of 0.604. Find the probability that $X = 1$.
- A. 0.41270
 - B. 0.33016
 - C. 1.10497
 - D. None of the other choices is correct

E. 0.05503

Solution

$$X \sim P(\lambda = 0.604)$$

$$P(X = 1) = \frac{e^{-\lambda} \lambda}{1!} \approx 0.33016$$

Answer: B

24. Let the discrete uniform random variable X has the values 0, 1, 3, 5, 6. What is $P(X=4)$

A. 0.25

B. 0.33

C. No determined

D. 0.2

E. None of the other choices is correct

Solution

$$P(X = 5) = 0.25$$

Answer: A

25. Given that the probability the target of a sniper is 0.7. What is the expected number of until the first hit?

A. 7

B. 3.33

C. 1.43

D. 3

E. None of the other choices is correct

Solution

X is the number of hit until hitting the target

$$X \sim G(p = 0.7)$$

$$\mu = \frac{1}{p} = 7$$

Answer: A

26. Of 800 students who took the MAS291 course last semester, exactly 75% has passed. Random group of 10 from these 800 students. What is the probability that only one of them has failed?

A. 0.187

B. 0.222

C. 0.145

D. 0.25

E. None of the other choices is correct

Solution

X is the number of failed students in the sample

$$X \sim \text{HG}(N = 800, K = 200, n = 10)$$

$$P(X = 1) = \frac{\binom{K}{1} \binom{N-K}{n-1}}{\binom{N}{n}} \approx 0.187$$

Answer: A

Chapter 4

1. Suppose that contamination particle size X (in micrometers) can be modeled as a continuous random variable with probability density function $f(x) = \frac{3}{x^4}$ for $x > 1$. Determine the variance of X .
- A. 0.5
B. 0.25
C. 3
D. 0.75
E. 1

Solution

$$V(X) = \int_1^{+\infty} x^2 f(x) - \left(\int_1^{+\infty} \right)^2 = \int_1^{+\infty} x^2 \frac{3}{x^4} - \left(\int_1^{+\infty} \frac{3}{x^4} \right)^2 = 0.75$$

Answer: D

2. A certain baseball player hits a home run in 3% of his at-bats. Consider at-bats as independent events. Use normal distribution to approximate the probability that this baseball player hit 5 home runs in 60 at-bats?

$$P(Z < 2.80) = 0.9974, \quad P(Z < 2.04) = 0.9793, \quad P(Z < 0.8) = 0.7881$$

- A. 0.0181
B. 0.1093
C. 0.1912
D. 0.3923
E. None of the other choices is correct

Solution

X is the number of home run in 60 at-bats for this baseball player

$$X \sim B(n = 60, p = 0.03)$$

$$\begin{aligned} P(X = 5) &= P(4.5 \leq X \leq 5.5) \\ &= P\left(\frac{4.5 - np}{\sqrt{np(1-p)}} \leq \frac{X - np}{\sqrt{np(1-p)}} \leq \frac{5.5 - np}{\sqrt{np(1-p)}}\right) \\ &\approx P\left(\frac{4.5 - 60 \cdot 0.03}{\sqrt{60 \cdot 0.03 \cdot (1 - 0.03)}} \leq Z \leq \frac{5.5 - 60 \cdot 0.03}{\sqrt{60 \cdot 0.03(1 - 0.03)}}\right) \\ &\approx P(2.04 \leq Z \leq 2.80) \\ &\approx P(Z \leq 2.80) - P(Z \leq 2.04) \\ &\approx 0.9974 - 0.9793 \\ &\approx 0.0181 \end{aligned}$$

Answer: A

3. If a random variable has a normal distribution with mean $\mu = 30$ and standard deviation $\sigma = 5$, find the probability that it will take on the value less than 32.
- A. 0.3446
B. 0.4207
C. 0.6554

D. 0.5793

E. None of the other choices is correct

Solution

$$X \sim \mathcal{N}(\mu = 30, \sigma = 5)$$

$$P(X < 32) = P\left(\frac{X - \mu}{\sigma} < \frac{32 - \mu}{\sigma}\right) = P\left(Z < \frac{32 - 30}{5}\right) = P(Z < 0.4) = 0.6554$$

Answer: C

4. The volumes of soda in quart soda bottles are normally distributed with a mean of 32.3 oz and a standard deviation of 1.2 oz. What is the probability that the volume of soda in a randomly selected bottle will be less than 32 oz?

$$P(Z < -0.3) = 0.3821 \quad , \quad P(Z < -0.25) = 0.4013$$

$$P(Z < 0.6) = 0.5987 \quad , \quad P(Z < 0.85) = 0.8026$$

A. 0.4013

B. 0.8026

C. 0.3821

D. 0.5987

E. None of the other choices is correct

Solution

$$X \sim \mathcal{N}(\mu = 32.3, \sigma = 1.2)$$

$$P(X < 32) = P\left(\frac{X - \mu}{\sigma} < \frac{32 - \mu}{\sigma}\right) = P\left(Z < \frac{32 - 32.3}{1.2}\right) = P(Z < -0.25) = 0.4013$$

Answer: A

Chapter 8

1. A researcher at a major hospital wishes to estimate the proportion of the adult population of the United States that has high blood pressure. How large a sample is needed in order to be 98% confident that the sample proportion will not differ from the true proportion by more than 6%?

Let $z_{0.01} = 2.33$.

- A. 10
- B. 755
- C. 378
- D. None of the other choices is correct
- E. 267

Solution

$$\alpha = 1 - 0.98 = 0.02$$

$$E = z_{\frac{\alpha}{2}} \sqrt{\frac{f(1-f)}{n}} = 0.06$$

$$\Rightarrow n = f(1-f) \left(\frac{z_{0.01}}{0.06} \right)^2 = 0.5(1-0.5) \left(\frac{2.33}{0.06} \right)^2 \approx 377.007 \Rightarrow n = 378$$

Answer: C

2. In a sample of 10 randomly selected women, it was found that their mean height was 63.4 inches. From previous studies, it is assumed that the standard deviation of the population is 2.4 inches. Construct the 95% confidence interval for the population mean.

Let $z_{0.025} = 1.96$, $z_{0.05} = 1.65$, $t_{0.025,9} = 2.26$

- A. None of the other choices is correct
- B. (61.9, 64.9)
- C. (58.1, 67.3)
- D. (59.7, 66.5)
- E. (60.8, 65.4)

Solution

Given:

- $n = 10$
- $\bar{x} = 63.4$
- $\sigma = 2.4$
- $\alpha = 0.05$

$\Rightarrow \sigma$ known

\Rightarrow Case 1

$$\begin{aligned} \text{CI} &= \left(\bar{x} - z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}}, \bar{x} + z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} \right) \\ &= \left(63.4 - z_{0.025} \frac{2.4}{\sqrt{10}}, 63.4 + z_{0.025} \frac{2.4}{\sqrt{10}} \right) \\ &= (61.9, 64.9) \end{aligned}$$

Answer: B

3. In an application to estimate the mean number of miles that downtown employees commute to work roundtrip each day, the following information is given: $n = 20$, $\bar{x} = 4.33$, $s = 3.50$. Based on this information, what is the upper limit for a 95 percent two-sided confidence interval

estimate for the true population mean?

Let $z_{0.025} = 1.96$, $z_{0.05} = 1.65$, $t_{0.025,9} = 2.09$, $t_{0.05,19} = 1.73$

- A. about 9.02 miles
- B. about 5.97 miles
- C. about 12.0 miles
- D. about 7.83 miles

Solution

Given:

- $n = 20$
- $\bar{x} = 4.33$
- $s = 3.50$
- $\alpha = 0.05$

$\Rightarrow \sigma$ unknown and $n < 30$

\Rightarrow Case 3

$$\begin{aligned} \text{CI} &= \left(\bar{x} - t_{\frac{\alpha}{2}, n-1} \frac{s}{\sqrt{n}}, \bar{x} + t_{\frac{\alpha}{2}, n-1} \frac{s}{\sqrt{n}} \right) \\ &= \left(4.33 - t_{0.025, 19} \frac{3.50}{\sqrt{20}}, 4.33 + t_{0.025, 19} \frac{3.50}{\sqrt{20}} \right) \\ &= (2.69, 5.97) \end{aligned}$$

Answer: B

4. An economist is interested in studying the incomes of consumers in a particular standard deviation is known to be \$1,500. A random sample of 50 individuals resulted in an average income of \$25,000. What is the width of the 95% confidence interval?

Let $z_{0.025} = 1.96$, $t_{0.025,49} = 2.01$, $z_{0.05} = 1.65$, $t_{0.05,49} = 1.68$

- A. 700.04
- B. 415.78
- C. 350.02
- D. None of the other choices is correct
- E. 831.56

Solution

Given:

- $n = 50$
- $\bar{x} = 25000$
- $\sigma = 1500$
- $\alpha = 0.05$

$\Rightarrow \sigma$ known

\Rightarrow Case 1

$$\text{Width} = 2E = 2z_{\frac{\alpha}{2}} \frac{\sigma}{\sqrt{n}} = 2z_{0.025} \frac{1500}{\sqrt{50}} \approx 831.56$$

Answer: E

Chapter 9

1. A manufacturer makes ball bearings that are supposed to have a mean weight of 30g. A retailer suspects that the mean weight is actually less than 30g. The mean weight for a random sample of 16 ball bearings is 28.8g with a standard deviation of 3.8g. At the 0.05 significance level, test the claim that the mean is less than 30g. Assume that the sample has been randomly selected from a population with a normal distribution.

Let $t_{0.05,15} = 1.75$, $t_{0.025,15} = 2.13$

- A. Test statistic $t = -1.463$. There is not sufficient evidence to support the claim that the mean is less than 30g.
B. Test statistic $t = -1.263$. There is not sufficient evidence to support the claim that the mean is less than 30g.
C. Test statistic $t = -1.463$. There is sufficient evidence to support the claim that the mean is less than 30g.
D. Test statistic $t = -1.263$. There is sufficient evidence to support the claim that the mean is less than 30g.
E. None of the other choices is correct.

Solution

Given:

- $n = 16$
- $\bar{x} = 28.8$
- $\sigma = 3.8$
- $\alpha = 0.05$

σ known \Rightarrow Case 1

$$\begin{cases} H_0: \mu = 30 \\ H_1: \mu < 30 \end{cases}$$

$$\omega_\alpha = (-\infty, -t_{\alpha, n-1}) \approx (-\infty, -1.75)$$

$$t_0 = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{28.8 - 30}{\frac{3.8}{\sqrt{16}}} \approx -1.263 \notin \omega_\alpha$$

\Rightarrow Reject H_0

\Rightarrow The mean is less than 30g

Answer: B

2. Medicare would like to test the hypothesis that the average monthly rate for one-bedroom assisted-living facility is equal to \$3,300. A random sample of 12 assisted-living facilities had an average rate of \$3,690 per month and a standard of \$530. It is believed that the monthly rate for one-bedroom assisted-living facility is normally distributed. Use the significance level of 0.05 for this hypothesis test, what is the critical value?

Let $z_{0.05} = 1.645$, $t_{0.025,11} = 2.201$, $t_{0.05,11} = 1.796$

- A. 2.201; -2.201
B. 2.761; -2.761
C. 1.985; -1.985
D. 1.645; -1.645
E. None of the other choices is correct.

Solution

Given:

- $n = 12$
- $\bar{x} = 3690$
- $s = 530$
- $\alpha = 0.05$

σ unknown and $n < 30 \Rightarrow$ Case 3

$$\begin{cases} H_0: \mu = 3300 \\ H_1: \mu \neq 3300 \end{cases}$$

$$t_{\frac{\alpha}{2}, n-1} = t_{0.025, 11} \approx 2.201$$

Answer: A

3. The Department of Mathematics would like to test the hypothesis that the average debt load of graduating students with a Bachelor's degree is equal to \$17,000. A random sample of 34 students had an average debt load of \$18,200. It is believed that the debt load follows a normal distribution with the standard deviation of \$4,200. At the significance level of 0.05, the critical value(s) for this hypothesis test would be _____.

Let $z_{0.025} = 1.96$, $z_{0.05} = 1.645$, $z_{0.1} = 1.28$

- A. -1.96; 1.96
- B. 1.28
- C. -1.28
- D. -1.645; 1.645
- E. None of the other choices is true.

Solution

Given:

- $n = 34$
- $\bar{x} = 18200$
- $\sigma = 4200$
- $\alpha = 0.05$

σ known \Rightarrow Case 1

$$\begin{cases} H_0: \mu = 17000 \\ H_1: \mu \neq 17000 \end{cases}$$

$$z_{\frac{\alpha}{2}} = z_{0.025} = 1.96$$

Answer: A

Chapter 10

1. A random sample of 400 adult residents of Maricopa County found that 320 were in favor of increasing the highway speed limit to 75 mph, while another sample of 300 adult residents of Pima County found that 210 were in favor of the increased speed limit. Construct a 90% confidence interval on the difference in the two proportions $p_1 - p_2$ of adults who favor increased speed.

Let $z_{0.025} = 1.96$, $z_{0.05} = 1.65$

- A. 10
B. 755
C. 378
D. None of the other choices is correct.
E. 267

Solution

$$n_1 = 400, f_1 = \frac{320}{400} = 0.8$$

$$n_2 = 300, f_2 = \frac{210}{300} = 0.7$$

$$\alpha = 1 - 0.9 = 0.1$$

$$\begin{aligned} \text{CI} &= \left(f_1 - f_2 - z_{\frac{\alpha}{2}} \sqrt{\frac{f_1(1-f_1)}{n_1} + \frac{f_2(1-f_2)}{n_2}}, f_1 - f_2 + z_{\frac{\alpha}{2}} \sqrt{\frac{f_1(1-f_1)}{n_1} + \frac{f_2(1-f_2)}{n_2}} \right) \\ &= \left(0.8 - 0.7 - z_{0.05} \sqrt{\frac{0.8(1-0.8)}{400} + \frac{0.7(1-0.7)}{300}}, 0.8 - 0.7 + z_{0.05} \sqrt{\frac{0.8(1-0.8)}{400} + \frac{0.7(1-0.7)}{300}} \right) \\ &\approx (0.05, 0.15) \end{aligned}$$

Answer: A

2. The diameter of steel rods manufactured on two different extrusion machines is being investigated. Two random samples of sizes $n_1 = 12$ and $n_2 = 10$ are selected, and the sample means and variances are $\bar{x}_1 = 9.25$, $s_1^2 = 0.4$, $\bar{x}_2 = 8.13$, $s_2^2 = 0.5$. Assume that both populations are normally distributed with the same variance. Find a 90% two sided confidence interval for the difference in the two population means. Let $z_{0.05} = 1.645$, $z_{0.1} = 1.281$, $t_{0.05,20} = 1.725$, $t_{0.1,20} = 1.325$
- A. (0.789, 1.449)
B. (0.622, 1.618)
C. (0.742, 1.498)
D. (0.627, 1.613)
E. None of the other choices is correct.

Solution

$$\begin{aligned} s_p^2 &= \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \\ &= \frac{(12 - 1)0.4 + (10 - 1)0.5}{12 + 10 - 2} \\ &= 0.445 \end{aligned}$$

$$\alpha = 1 - 0.9 = 0.1$$

$$\begin{aligned}
\text{CI} &= \left(\bar{x}_1 - \bar{x}_2 \pm t_{\frac{\alpha}{2}, n_1 + n_2 - 2} \sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)} \right) \\
&= \left(9.5 - 8.13 \pm t_{0.05, 12+10-2} \sqrt{0.045 \left(\frac{1}{12} + \frac{1}{10} \right)} \right) \\
&\approx (0.627, 1.613)
\end{aligned}$$

Answer: D

3. Two types of plastic are used for an electronics component. It is known that the breaking strengths (unit: psi) of plastic 1 and 2 are normal with standard deviation $\sigma_1 = 1.7$ and $\sigma_2 = 1.4$, respectively. Two random samples of sizes $n_1 = 15$ and $n_2 = 12$ are tested, and the sample means are $\bar{x}_1 = 170$ and $\bar{x}_2 = 164.5$. Construct a 95% upper confidence bound for the difference in the two population means $\mu_1 - \mu_2$.

Let $z_{0.025} = 1.96$, $z_{0.05} = 1.645$, $t_{0.025, 25} = 2.06$, $t_{0.05, 25} = 1.708$

A. 6.519

B. 6.729

C. 6.482

D. None of the other choices is correct.

Solution

$$\alpha = 1 - 0.95 = 0.05$$

$$\begin{aligned}
\text{CI} &= \left(-\infty, \mu_1 - \mu_2 + z_{\alpha} \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}} \right) \\
&= \left(-\infty, 170 - 164.5 + z_{0.05} \sqrt{\frac{1.7^2}{15} + \frac{1.4^2}{12}} \right) \\
&\approx 6.482
\end{aligned}$$

Answer: C

Chapter 11

1. The correlation when we use y to predict x is _____ the correlation when we use x to predict.
- A. the same as
 - B. greater than
 - C. less than
 - D. None of the other choices is correct

Solution

$$r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$$

Answer: A

2. Eight students in a mathematics anxiety workshop are given a questionnaire on math anxiety (y) and an inventory test on basic arithmetic skills (x). Given that $\sum x_i = 492$; $\sum y_i = 379$; $\sum x_i^2 = 32894$; $\sum y_i^2 = 20115$; $\sum x_i y_i = 21087$ Compute the sample correlation coefficient
- A. -0.93
 - B. 0.86
 - C. 0.93
 - D. 0.07
 - E. None of the other choices is correct.

Solution

$$\begin{aligned} r &= \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}} \\ &= \frac{\sum x_i y_i - \frac{1}{n} \sum x_i \sum y_i}{\sqrt{\left(\sum x_i^2 - \frac{1}{n} (\sum x_i)^2\right) \cdot \left(\sum y_i^2 - \frac{1}{n} (\sum y_i)^2\right)}} \\ &= \frac{21087 - \frac{1}{8} \cdot 492 \cdot 379}{\sqrt{\left(32894 - \frac{1}{8} \cdot 492^2\right) \cdot \left(20115 - \frac{1}{8} \cdot 379^2\right)}} \\ &\approx -0.93 \end{aligned}$$

Answer: A

3. Mathematics and Physics grades of 5 students are as below.

Student	Mathematics grade (X)	physics grade (Y)
1	7.5	6
2	6.5	8.5
3	6	5.5
4	4.5	6
5	9.5	9

We want to do linear regression analysis on X and Y . Given the standard error of estimate $\sigma = 1.43$, the estimated slope $\hat{\beta}_1 = 0.56$.

Calculate the test hypotheses

$$H_0 : \beta_1 = 0$$

$$H_1 : \beta_1 > 0$$

- A. 1.86
- B. 1.66
- C. 1.46
- D. 2.06

Solution

$$S_{xx} = \sum x_i^2 - \frac{1}{n} \left(\sum x_i \right)^2 = 245 - \frac{1}{5} \cdot 34^2 = 13.8$$

$$t_0 = \frac{\hat{\beta}_1 - \beta_1}{\sqrt{\frac{\sigma^2}{S_{xx}}}} = \frac{0.56 - 0}{\sqrt{\frac{1.43^2}{13.8}}} \approx 1.46$$

Answer: C

4. The height y and base diameter x of four trees of a certain variety produced the following data

x	2	2	3	5
y	31	36	94	127

Find the equation of the estimated regression line $\hat{y} = a + bx$ of y on x .

- A. $-21.5x + 31.17$
- B. $-21.5 + 31.17x$
- C. None of the other choices is correct.
- D. $21.5 + 31.17x$
- E. $21.5x + 31.17$

Answer: B