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MC 3020 : Probability and Statistics

**Tutorial-04**

**April 2024**

1. In a study conducted among 300 randomly selected Faculty of Engineering Students, it was found that 90 of them were proficient in coding using R. Calculate a 90% confidence interval for the proportion of engineering faculty students who are proficient in R coding.
2. A Civil engineering department is conducting a survey to estimate the proportion of students who are interested in pursuing postgraduate studies abroad. Previous estimates suggest that this proportion ranges from 30% to 50%. The department aims to obtain a 90% confidence interval estimate with a margin of error no larger than 5%. What sample size should they use for their survey?
3. An engineering college is interested in investigating how the availability of on-campus workshops affects students' participation rates. From a previous study, they estimate the standard deviation of participation rates to be 10%. They aim to conduct a study with a 95% confidence level. How large should the random sample be for each workshop date they are studying in order to estimate the participation rate within a margin of error of 3%?
4. A fertilizer mixing machine is set to give 12 kg of nitrate for every quintal bag of fertilizer. Ten 100 kg bags are randomly selected and examined. The percentages of nitrate in the sample are as follows:

11, 14, 13, 15, 13, 11, 13, 14, 10, 12

Assume that the sample is from a normally distributed population.

- (a) Construct a 98% confidence interval estimate for the mean nitrate content for each 100 kg bag in the company.
  - (b) Construct a 95% confidence interval for the variance nitrate content for each 100 kg bag in the company.
  - (c) By using the results from part(b), construct a 95% confidence interval for the standard deviation nitrate content for each 100 kg bag in the company.
5. The concentration of mercury in a lake has been monitored for a number of years. Measurements taken on a weekly basis yielded an average of 1.20mg/m<sup>3</sup>(milligrams per cubic meter) with a standard deviation of 0.32mg/m<sup>3</sup>. Following an accident at a smelter on the shore of the lake, 15 measurements produced the following mercury concentrations. (Assume that the sample is from a normally distributed population.)

1.60, 1.77, 1.61, 1.08, 1.07, 1.79, 1.34, 1.07, 1.45, 1.59, 1.43, 2.07, 1.16, 0.85, 2.11

- (a) Give a point estimate (samples mean) of the mean mercury concentration after the accident.
- (b) Construct a 95% confidence interval on the mean mercury concentration after the accident. Interpret this interval.

- (c) Is there sufficient evidence that the mean mercury concentration has increased since the accident? Use a  $\alpha = 0.05$ .
6. A Computer engineering department is interested in studying the average time spent by students in completing programming assignments. The completion times are known to range from 0 to 12 hours. Determine the sample size required to obtain a 97% confidence interval estimate of the mean completion time with a half-width of 30 minutes.
7. A civil engineering firm is tasked with designing a new bridge for a city. They need to ensure that the maximum load the bridge can bear exceeds 50 tons to accommodate heavy traffic. After conducting stress tests on a sample of 20 bridge segments, they find that the mean maximum load capacity is 52 tons with a standard deviation of 3 tons. Should they proceed with the design? Justify your answer using a 1% level of significance.
8. A leading automobile manufacturer claims that the fuel efficiency of its new hybrid model is 60 miles per gallon (mpg) on average. The distribution of fuel efficiencies is known to be normal, with a standard deviation of 4 mpg. A sample of 25 cars from this model yields a mean fuel efficiency of 58 mpg. Is there sufficient evidence to refute the manufacturer's claim? Utilize a 5 % level of significance and the P-value method to determine the outcome.
9. As a part of the evaluation of Colombo municipal council employees, the city manager audits the parking tickets issued by city parking officers to determine the number of tickets that were contested by the car owner and found to be improperly issued. In past years, the number of improperly issued tickets per officer had a normal distribution with mean  $\mu = 380$ . Because there has recently been a change in the city's parking regulations, the city manager suspects that the mean number of improperly issued tickets has increased. An audit of 12 randomly selected officers is conducted to test whether there has been an increase in improper tickets. Use the sample data given here which is audit collected from each officers:

390, 380, 369, 392, 398, 393, 392, 396, 399, 391, 387, 393

- (a) Give a point estimate of the mean number of improperly issued tickets. Construct a 95% confidence interval on the mean number of improperly issued tickets. Interpret this interval.
- (b) Is there sufficient evidence that the mean number of improperly issued tickets is greater than 380? Use a  $\alpha = 0.01$ .
- (c) Is there sufficient evidence that the variance number of improperly issued tickets is greater than 35? Use a  $\alpha = 0.05$ .
10. A canning company agrees with their supplier of canning watermelons that a rate of 6% spoiled melons at the loading platform is reasonable. When the cannery takes a sample of 100 melons from a truckload delivered by the supplier and finds at least eight of them are defective, then the cannery returns the whole shipment. In your opinion was this a reasonable action?
- (a) What is the decision rule that should be used?
- (b) What is the probability of the Type I error?
- (c) Explain the meaning of Type I and Type II errors in economic terms as they would be seen by each of the two parties, the canning company and the supplier.