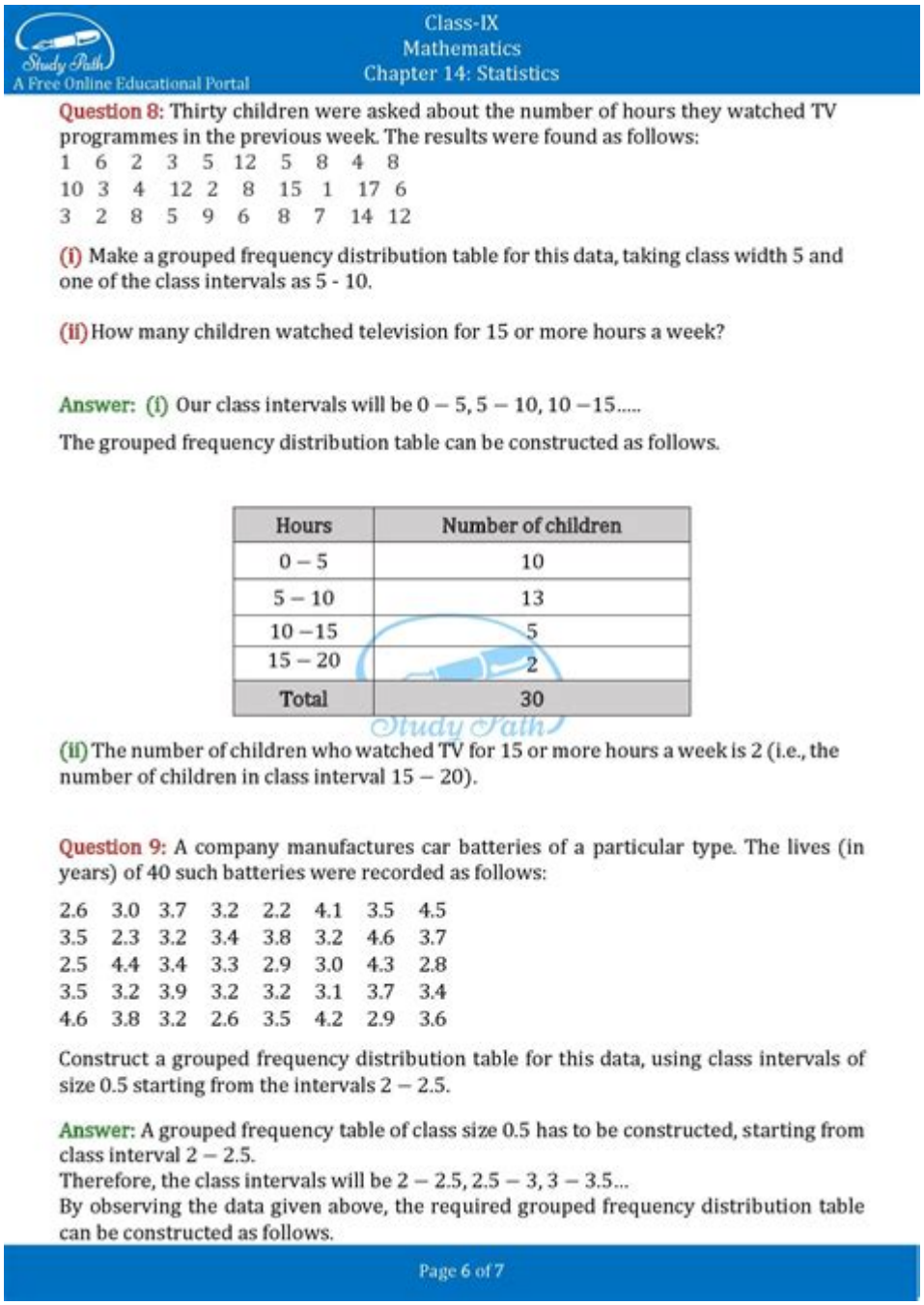
Mathematical Statistics Exercises And Solutions



Class-IX
Mathematics
Chapter 14: Statistics

Study Path
A Free Online Educational Portal

Question 8: Thirty children were asked about the number of hours they watched TV programmes in the previous week. The results were found as follows:

1 6 2 3 5 12 5 8 4 8
10 3 4 12 2 8 15 1 17 6
3 2 8 5 9 6 8 7 14 12

(i) Make a grouped frequency distribution table for this data, taking class width 5 and one of the class intervals as 5 - 10.

(ii) How many children watched television for 15 or more hours a week?

Answer: (i) Our class intervals will be 0 – 5, 5 – 10, 10 –15.....

The grouped frequency distribution table can be constructed as follows.

Hours	Number of children
0 – 5	10
5 – 10	13
10 –15	5
15 – 20	2
Total	30

(ii) The number of children who watched TV for 15 or more hours a week is 2 (i.e., the number of children in class interval 15 – 20).

Question 9: A company manufactures car batteries of a particular type. The lives (in years) of 40 such batteries were recorded as follows:

2.6 3.0 3.7 3.2 2.2 4.1 3.5 4.5
3.5 2.3 3.2 3.4 3.8 3.2 4.6 3.7
2.5 4.4 3.4 3.3 2.9 3.0 4.3 2.8
3.5 3.2 3.9 3.2 3.2 3.1 3.7 3.4
4.6 3.8 3.2 2.6 3.5 4.2 2.9 3.6

Construct a grouped frequency distribution table for this data, using class intervals of size 0.5 starting from the intervals 2 – 2.5.

Answer: A grouped frequency table of class size 0.5 has to be constructed, starting from class interval 2 – 2.5.
Therefore, the class intervals will be 2 – 2.5, 2.5 – 3, 3 – 3.5...
By observing the data given above, the required grouped frequency distribution table can be constructed as follows.

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Mathematical statistics exercises and solutions are essential for students and professionals looking to deepen their understanding of statistical concepts and methods. By engaging in various exercises, one can develop the analytical skills necessary to interpret data, test hypotheses, and make informed decisions based on statistical findings. This article will explore different types of mathematical statistics exercises, provide solutions, and discuss their significance in the broader context of data analysis.

Understanding Mathematical Statistics

Mathematical statistics is a field that combines mathematics with statistical theory, focusing on the development and application of statistical methods. It is essential for various disciplines, including engineering, economics, biology, and social sciences. The key areas of mathematical statistics include:

- Descriptive Statistics: Summarizing and describing data sets.
- Inferential Statistics: Drawing conclusions about a population based on sample data.
- Probability Theory: The study of random events and the likelihood of occurrences.
- Statistical Inference: Making predictions or generalizations based on data analysis.

Types of Exercises in Mathematical Statistics

Mathematical statistics exercises can be classified into several categories, each focusing on different aspects of the discipline. Below are some common types of exercises:

1. Descriptive Statistics Exercises

These exercises focus on summarizing and describing data. Common tasks include calculating measures of central tendency, variance, standard deviation, and visualizing data using graphs.

Example Exercise:
Given the data set: 5, 8, 12, 15, 20, calculate the following:
1. Mean
2. Median
3. Mode
4. Variance
5. Standard Deviation

Solution:
1. Mean: $\frac{5 + 8 + 12 + 15 + 20}{5} = \frac{60}{5} = 12$
2. Median: The middle value when arranged in order, which is 12.
3. Mode: There is no repeating number; hence, there is no mode.
4. Variance:
$$
\sigma^2 = \frac{(5-12)^2 + (8-12)^2 + (12-12)^2 + (15-12)^2 + (20-12)^2}{5} = \frac{49 + 16 + 0 + 9 + 64}{5} = \frac{138}{5} = 27.6
$$
5. Standard Deviation:

$$
\sigma = \sqrt{27.6} \approx 5.26
$$

2. Probability Exercises

These exercises involve calculating the likelihood of different events occurring. They often require knowledge of different probability distributions.

Example Exercise:
A bag contains 3 red balls and 2 blue balls. If one ball is drawn at random, what is the probability that it is red?

Solution:
Total balls = 3 (red) + 2 (blue) = 5
Probability of drawing a red ball = $\frac{3}{5} = 0.6$

3. Inferential Statistics Exercises

Inferential statistics exercises help in making predictions or generalizations about a population based on sample data. These often include hypothesis testing and confidence intervals.

Example Exercise:
A sample of 30 students has an average score of 75 with a standard deviation of 10. Construct a 95% confidence interval for the average score of all students.

Solution:
1. Calculate the standard error (SE):
$$
SE = \frac{\sigma}{\sqrt{n}} = \frac{10}{\sqrt{30}} \approx 1.83
$$
2. Use the Z-score for a 95% confidence level (Z = 1.96):
$$
CI = \bar{x} \pm Z \cdot SE = 75 \pm 1.96 \cdot 1.83
$$
$$
CI = 75 \pm 3.59
$$
$$
CI \approx (71.41, 78.59)
$$

4. Hypothesis Testing Exercises

These exercises require formulating null and alternative hypotheses and determining whether to accept or reject the null hypothesis based on sample data.

Example Exercise:
Suppose a manufacturer claims that the average lifespan of a light bulb is 1000 hours. A sample of 10 bulbs has an average lifespan of 950 hours with a standard deviation of 100 hours. Test the claim at the 0.05 significance level.

Solution:
1. Formulate Hypotheses:
- Null Hypothesis $H_0: \mu = 1000$
- Alternative Hypothesis $H_a: \mu < 1000$

2. Calculate the test statistic (t):
$$
t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} = \frac{950 - 1000}{\frac{100}{\sqrt{10}}} = \frac{-50}{31.62} \approx -1.58
$$

3. Determine the critical value:
For a one-tailed test at α = 0.05 and 9 degrees of freedom, the critical t-value is approximately -1.833.

4. Decision Rule:
If $t < -1.833$, reject H_0.

5. Conclusion:
Since -1.58 is greater than -1.833, we fail to reject the null hypothesis.

Importance of Practicing Exercises

Engaging with mathematical statistics exercises has several benefits:

- Skill Development: Regular practice enhances problem-solving skills and the ability to analyze data.
- Conceptual Understanding: Exercises help clarify complex concepts by applying them to real-world scenarios.
- Preparation for Advanced Topics: Mastery of foundational exercises prepares students for more advanced statistical methods and analyses.
- Application in Research: Familiarity with statistical methods is crucial for conducting research and interpreting results accurately.

Resources for Further Practice

To continue improving your skills in mathematical statistics, consider the following resources:

1. Textbooks:
- "Mathematical Statistics with Applications" by Dennis Wackerly
- "Introduction to Mathematical Statistics" by Robert V. Hogg

2. Online Courses:
- Coursera and edX offer various courses on statistics and data analysis.
- Khan Academy provides free resources and exercises on statistics.

3. Practice Websites:
- Stat Trek: Offers tutorials and practice problems.
- Brilliant: Features interactive problem-solving opportunities in statistics and probability.

Conclusion

Mathematical statistics exercises and solutions play a vital role in understanding and applying statistical concepts. Through various exercises—ranging from descriptive statistics to hypothesis testing—individuals can develop the skills necessary to analyze data and make informed decisions. By utilizing resources and continually practicing these exercises, one can enhance their statistical literacy and competency, paving the way for success in both academic and professional endeavors.

Frequently Asked Questions

What are some common types of exercises in mathematical statistics?

Common exercises include hypothesis testing, confidence intervals, regression analysis, descriptive statistics, and probability distributions.

How can I approach solving a problem related to hypothesis testing?

Start by defining the null and alternative hypotheses, choose a significance level, calculate the test statistic, and compare it to the critical value or p-value.

What is the importance of understanding probability distributions in statistics?

Probability distributions help in modeling random variables and are essential for making inferences about populations based on sample data.

Can you provide an example of a confidence interval exercise?

Sure! Calculate a 95% confidence interval for the mean of a sample with a mean of 50, standard deviation of 10, and sample size of 30 using the formula: mean ± (z (sd/sqrt(n))).

What is a common mistake when solving regression analysis problems?

A common mistake is not checking for multicollinearity among independent variables, which can distort the results and interpretations of the regression model.

How can one practice mathematical statistics effectively?

Using textbooks with exercises, online platforms offering statistics problems, and engaging in study groups can enhance practice and understanding of mathematical statistics.

What is the Central Limit Theorem and why is it significant?

The Central Limit Theorem states that the sampling distribution of the sample mean approaches a normal distribution as the sample size increases, making it fundamental for inferential statistics.

What types of statistical software can assist in solving exercises?

Software like R, Python (with libraries like pandas and statsmodels), SPSS, and SAS are popular tools for performing statistical analyses and exercises.

How do you interpret the results of a chi-square test?

Interpretation involves comparing the calculated chi-square statistic to the critical chi-square value at the desired significance level to determine if the observed frequencies differ from expected frequencies.

What resources are available for finding solutions to mathematical statistics exercises?

Resources include textbooks with solutions manuals, online forums like Stack Exchange, educational websites, and video tutorials that cover specific statistical problems and their solutions.

Mathematical Statistics Exercises And Solutions

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