NMIMS Centre for Distance and Online Education (NCDOE)

Course: Quantitative Methods

Internal Assignment Applicable for Dec 2025 Examination

Answer – 1

Introduction

Statistical estimation is an essential part of data analysis that helps researchers, economists, and business professionals make informed conclusions about a large population by studying only a small portion or sample. Since it is often difficult, time-consuming, or costly to collect data from every member of a population, estimation techniques make it possible to predict overall behavior and patterns using a limited dataset. Among the different methods, interval estimation is one of the most reliable because instead of providing just a single number, it gives a range of possible values where the true population parameter is expected to lie, along with a defined level of confidence.

For instance, consider a telecom company that wants to know how many of its customers might subscribe to a new internet plan. A survey is conducted among 250 customers, and 162 of them show interest. Using this data, the company wants to estimate, with 90 percent confidence, the proportion of customers who are likely to subscribe. Rather than providing a single percentage, interval estimation gives a realistic range of possibilities, which helps the company make better and more data-driven business decisions.

Concept and Application

Understanding the Situation

Given data:

- Total customers surveyed (n) = 250
- Customers interested = 162

Sample proportion ($\hat{p}$) = 162 ÷ 250 = 0.648

This means around 64.8 percent of respondents are interested in the new plan. However, since this value is based only on a sample, there will always be some uncertainty. To account for that uncertainty, a confidence interval is calculated, which provides a range that most likely contains the true percentage of interested customers in the total population.

Formula for Confidence Interval for Proportion:

$\hat{p} \pm Z \times \sqrt{[\hat{p}(1 - \hat{p}) \div n]}$

Where:

- $\hat{p}$ = sample proportion
- Z = Z-score corresponding to the confidence level
- n = sample size

For a 90 percent confidence level, the Z-value is 1.645.

Step-by-Step Calculation

1. $\hat{p} = 0.648$
2. $1 - \hat{p} = 0.352$
3. Standard Error (SE) = $\sqrt{[(0.648 \times 0.352) \div 250]} = \sqrt{(0.00091296)} = 0.0302$
4. Margin of Error (E) = 1.645 × 0.0302 = 0.0497
5. Confidence Interval = $\hat{p} \pm E$
    - Lower Limit = 0.648 − 0.0497 = 0.5983
    - Upper Limit = 0.648 + 0.0497 = 0.6977

Thus, the 90 percent confidence interval is between 0.598 and 0.698, or between 59.8 percent and 69.8 percent.

Interpretation of Results

The telecom company can be 90 percent confident that the actual proportion of all customers who would subscribe to the new plan lies between 59.8 percent and 69.8 percent.

If the company has set a goal of at least 60 percent customer interest for profitability, the lower limit of 59.8 percent comes very close to that mark, while the upper limit of 69.8 percent suggests a good chance of success. This information helps managers decide whether to launch the plan, make changes to the offer, or invest more in marketing.

Conceptual Understanding

A confidence interval not only gives an estimate but also tells how reliable that estimate is. If many samples were taken from the same population, about 90 percent of the intervals calculated would contain the true proportion.

The width of the confidence interval depends on several factors:

1. **Sample Size:** Larger samples provide smaller standard errors and narrower intervals, making the estimate more precise.
2. **Confidence Level:** Higher confidence levels, such as 95 or 99 percent, offer more certainty but result in wider intervals.
3. **Sample Proportion:** The interval is widest when $\hat{p}$ is close to 0.5 because that is when variation is greatest.

In this case, with a sample size of 250, the estimate is statistically sound and suitable for use in business analysis.

Managerial Implications

Confidence intervals are very useful in business and management because they help decision-makers evaluate outcomes even when complete information is not available. They help quantify uncertainty and turn sample data into actionable insights.

Some important uses include:

1. **Demand Forecasting:** Helps estimate future demand and avoid excess or shortage of products.
2. **Resource Planning:** Assists in planning workforce, inventory, and financial resources more accurately.

3. **Financial Projections:** Managers can prepare optimistic and conservative forecasts using the upper and lower bounds of the interval.
4. **Performance Evaluation:** Provides a measurable range to assess whether results meet expectations.
5. **Strategic Decisions:** If the lower limit of an interval meets business targets, management can confidently proceed with investments or new projects.

Confidence intervals thus serve as a bridge between statistical analysis and real-world business decisions. They help managers make reliable predictions while managing uncertainty.

Assumptions and Validity

To ensure the validity of confidence intervals, certain statistical conditions must be satisfied:

- The sample should be random and represent the entire population.
- The sample size must be large enough for normal approximation.
- Each observation must be independent.

Verification:

- $n\hat{p} = 250 \times 0.648 = 162 \geq 5$
- $n(1 - \hat{p}) = 250 \times 0.352 = 88 \geq 5$

Since both conditions are satisfied, applying the normal approximation is appropriate and valid in this case.

Comparison of Confidence Levels

Confidence Level	**Z-Value**	**Approx. Interval**
90%	1.645	(0.598, 0.698)
95%	1.96	(0.589, 0.707)
99%	2.576	(0.570, 0.726)

This table shows that higher confidence levels provide more assurance but lead to wider intervals. Managers must therefore find the right balance between certainty and precision depending on the level of risk they are willing to accept.

Conclusion

From this analysis, the telecom company can be 90 percent confident that the true proportion of customers likely to subscribe to the new plan lies between 59.8 percent and 69.8 percent. This range-based estimate provides more valuable insights than a single-point estimate and helps the company make better decisions.

Confidence intervals are more than just a mathematical concept; they are practical tools that allow organizations to interpret data effectively and plan actions based on measurable accuracy. For the telecom company, this method provides a clearer picture of customer interest and supports decisions on marketing, pricing, and investment.

In summary, interval estimation connects statistical reasoning with real-world decision-making. By using this approach, businesses can manage uncertainties, plan effectively, and make confident and informed decisions in today's data-driven world.

Answer – 2(A)

Introduction

Customer satisfaction plays a crucial role in determining the success of any financial service organization. It reflects how effectively a company understands and fulfills the needs and expectations of its clients while maintaining trust and long-term relationships. However, when multiple financial advisors work with different customers, it becomes challenging to identify which advisor contributes most to high satisfaction levels. For instance, an investment company may want to analyze which advisor is most associated with happy and loyal clients.

To make this evaluation more data-based and reliable, Bayes Theorem can be applied. This statistical method helps firms update their earlier beliefs or assumptions based on new information, making the analysis more precise and logical. In financial institutions, Bayes

Theorem can be used to evaluate advisor performance, predict client satisfaction, and improve decision-making through evidence-driven insights.

Concept and Application

Bayes Theorem is a mathematical formula used to calculate the probability of an event occurring based on the presence of another related event. It helps in revising prior probabilities when new data becomes available, leading to improved accuracy and reliability in conclusions.

The formula is expressed as:
$P(A_i \mid B) = [P(A_i) \times P(B \mid A_i)] / \Sigma\ [P(A_j) \times P(B \mid A_j)]$

Where:

- $P(A_i)$ is the initial probability that advisor i served the client.
- $P(B \mid A_i)$ is the probability that the client is satisfied given that advisor i handled the case.
- $P(A_i \mid B)$ is the updated probability that advisor i served a satisfied client.

In simple terms, Bayes Theorem helps a company re-evaluate which advisor likely handled a satisfied client after considering updated customer feedback.

Practical Example

Let us consider a financial firm with three advisors — A, B, and C.

- Advisor A manages 50% of the clients.
- Advisor B manages 30%.
- Advisor C manages 20%.

Their satisfaction rates are:

- Advisor A: 70% satisfied clients.
- Advisor B: 90% satisfied clients.
- Advisor C: 60% satisfied clients.

If a client reports being satisfied, Bayes Theorem helps estimate which advisor likely handled that client. Since Advisor B has the highest satisfaction rate, he is statistically the most probable one responsible for serving that satisfied customer.

Such analysis allows the company to identify top performers, reward them fairly, and provide support or training to advisors who may need improvement. This approach promotes transparency and encourages performance-based growth.

Relevance and Benefits

Using Bayes Theorem in financial decision-making provides many benefits, including:

- It enables accurate and data-based assessment of advisor performance.
- It helps firms forecast client satisfaction levels more effectively.
- It supports unbiased and fair employee evaluations.
- It assists management in developing better customer retention and service improvement strategies.

However, the reliability of the analysis depends entirely on the quality of the data collected. For meaningful results, the data must be accurate, unbiased, and consistently recorded.

Conclusion

Bayes Theorem offers a logical and evidence-based approach to evaluating customer satisfaction and advisor performance in financial institutions. It replaces guesswork with measurable insights, allowing firms to make fair and informed decisions. By using this method, organizations can recognize their best-performing advisors, improve service quality, and build stronger relationships with clients.

In the competitive world of finance, adopting analytical tools like Bayes Theorem helps turn data into practical strategies. This not only boosts customer trust but also supports long-term organizational growth through smart and data-driven management.

Answer – 2(B)

Introduction

The normal distribution is one of the most fundamental and widely used concepts in statistics. It describes how data values are distributed around the mean in a smooth, bell-shaped curve that is symmetrical. In this pattern, most observations are centered near the mean, while fewer values appear at the higher and lower ends. This concept is essential in various fields such as business, economics, finance, psychology, and research because it helps in estimating probabilities, studying variations, and making predictions.

In practice, two main approaches are used to calculate probabilities and values under the normal curve: the traditional z-table method and the modern Excel functions (NORM.DIST and NORM.INV). Both methods serve the same purpose but differ in terms of their efficiency, speed, and user-friendliness.

Concept and Application

1. Z-Table Method

The z-table method is the classic and manual approach to calculating probabilities in a normal distribution. It relies on the z-score, which measures how far a particular value (X) is from the mean (μ) in terms of standard deviations (σ). The formula used is:

$Z = (X - \mu) / \sigma$

Once the z-score is obtained, a z-table is used to find the corresponding probability. This probability represents the area under the normal curve up to that point. Although the method is slower and requires manual effort, it provides a strong foundation for understanding how probabilities are linked to the mean and standard deviation.

The z-table approach is often used by students and researchers for small datasets where conceptual clarity is more important than computational speed. It helps learners grasp the logic behind the probability distribution before moving to advanced tools.

2. Excel Functions: NORM.DIST and NORM.INV

Modern technology has simplified statistical calculations, especially with tools like Microsoft

Excel. Excel includes two powerful functions that make working with the normal distribution quick and accurate:

- **NORM.DIST(X, μ, σ, TRUE)**: Gives the cumulative probability for a specific value of X.
- **NORM.INV(probability, μ, σ)**: Returns the value of X corresponding to a given probability.

These functions are especially useful for analyzing large datasets where manual calculations would be time-consuming. They minimize human error, deliver precise results, and are convenient for real-time business applications. For professionals such as analysts, economists, or managers, these functions are highly valuable for forecasting, planning, and performance analysis.

Comparison Between the Two Methods

Aspect	**Excel (NORM.DIST / NORM.INV)**	**Z-Table Method**
Accuracy	Highly accurate and consistent	May have minor rounding differences
Speed	Fast and automated	Slower and manual
Ease of Use	Requires basic Excel skills	Simple for small datasets
Understanding	Best for practical use	Builds strong theoretical understanding
Scalability	Suitable for large datasets	Limited for bulk data

From this comparison, it is clear that Excel-based methods are more suitable for professional use, while the z-table remains important for learning the underlying concepts of statistics.

Managerial Implications

In the corporate world, Excel-based tools are preferred because they provide accurate, fast, and reliable results, saving both time and effort. Managers use these tools for forecasting, budgeting, and performance evaluation. However, understanding the z-table method remains equally important because it helps verify automated results and strengthens the user's conceptual understanding.

A balanced approach that combines both methods is ideal — the z-table helps build a strong foundation, while Excel ensures efficient and accurate practical applications.

Conclusion

Both the z-table and Excel methods are based on the same statistical concept of normal distribution. While the z-table method enhances theoretical understanding, Excel provides speed and precision for real-world data analysis. Using both approaches together allows students and professionals to analyze data effectively, make accurate predictions, and improve decision-making. In today’s data-driven environment, mastering these two techniques helps in achieving both statistical accuracy and analytical confidence.