UNIT 2 DESCRIPTIVE AND INFERENTIAL STATISTICS

Structure

2.0 INTRODUCTION

In this unit we will be dealing with descriptive and inferential statistics. First we start with defining descriptive statistics and indicate how to organise the data , classify, tabulate etc. This unit also presents as to how the data should be presented graphically. Once the data is collected the same has to be made meaningful which can be done through averaging the data or working out the variances in the data etc. Then we deal with the advantages and disadvantages of descriptive statistics. This is followed by defining what is inferential statistics and delineating its meaning. In this unit the student will also gain knowledge regarding point and interval estimation so as to validate the results. We also learn in this unit about hypothesis testing, how it is done and the methods thereof. We also deal with different types of errors in hypothesis testing including sampling error etc.

2.1 OBJECTIVES

After going through this unit, you will be able to:

- define the nature and meaning of descriptive statistics;
- describe the methods of organising and condensing raw data;
- explain concept and meaning of different measures of central tendency;
- analyse the meaning of different measures of dispersion;
- define inferential statistics;
- explain the concept of estimation;
- distinguish between point estimation and interval estimation; and
- explain the different concepts involved in hypothesis testing.

2.2 MEANING OF DESCRIPTIVE STATISTICS

The word statistics has different meaning to different persons. For some, it is a one-number description of a set of data. Some consider statistics in terms of numbers used as measurements or counts. Mathematicians use statistics to describe data in one word. It is a summary of an event for them. Number , n, is the statistic describing how big the set of numbers is, how many pieces of data are in the set.

Also, knowledge of statistics is applicable in day to day life in different ways. Statistics is used by people to take decision about the problems on the basis of different types of information available to them. However, in behavioural sciences the word 'statistics' means something different, that is its prime function is to draw statistical inference about population on the basis of available quantitative and qualitative information.

The word statistics can be defined in two different ways. In singular sense 'Statistics' refers to what is called statistical methods. When 'Statistics' is used in plural sense it refers to 'data'.

In this unit we will use the term 'statistics' in singular sense. In this context, it is described as a branch of science which deals with the collection of data, their classification, analysis and interpretations of statistical data.

The science of statistics may be broadly studied under two headings:

i) Descriptive Statistics, and (ii) Inferential Statistics

i) Descriptive Statistics: Most of the observations in this universe are subject to variability, especially observations related to human behaviour. It is a well known fact that attitude, intelligence and personality differ from individual to individual. In order to make a sensible definition of the group or to identify the group with reference to their observations/ scores, it is necessary to express them in a precise manner. For this purpose observations need to be expressed as a single estimate which summarises the observations.

Descriptive statistics is a branch of statistics, which deals with descriptions of obtained data. On the basis of these descriptions a particular group of population is defined for corresponding characteristics. The descriptive statistics include classification, tabulation, diagrammatic and graphical presentation of data, measures of central tendency and variability. These measures enable the researchers to know about the tendency of data or the scores, which further enhance the ease in description of the phenomena. Such single estimate of the series of data which summarises the distribution are known as parameters of the distribution. These parameters define the distribution completely.

Bascially descriptive statistics involves two operations:

(i) Organisation of data, and (ii) Summarination of data

2.3 ORGANISATION OF DATA

There are four major statistical techniques for organising the data. These are:

i) Classification

ii) Tabulation

iii) Graphical Presentation, and

iv) Diagrammatical Presentation

2.3.1 Classification

The arrangement of data in groups according to similarities is known as classification. A classification is a summary of the frequency of individual scores or ranges of scores for a variable. In the simplest form of a distribution, we will have such value of variable as well as the number of persons who have had each value.

Once data are collected, it should be arranged in a format from which they would be able to draw some conclusions. Thus by classifying data, the investigators move a step ahead in regard to making a decision.

A much clear picture of the information of score emerges when the raw data are organised as a frequency distribution. Frequency distribution shows the number of cases following within a given class interval or range of scores. A frequency distribution is a table that shows each score as obtained by a group of individuals and how frequently each score occurred.

2.3.1.1 Frequency Distribution can be with Ungrouped Data and Grouped Data

i) An ungrouped frequency distribution may be constructed by listing all score values either from highest to lowest or lowest to highest and placing a tally mark (/) besides each scores every times it occurs. The frequency of occurrence of each score is denoted by ‘f’.

ii) Grouped frequency distribution: If there is a wide range of score value in the data, then it is difficult to get a clear picture of such series of data. In this case grouped frequency distribution should be constructed to have a clear picture of the data. A group frequency distribution is a table that organises data into classes.

It shows the number of observations from the data set that fall into each of the class.

Construction of frequency distribution

To prepare a frequency distribution it is essential to determine the following:

1) The range of the given data =, the difference between the highest and lowest scores.

2) The number of class intervals = There is no hard and fast rules regarding the number of classes into which data should be grouped. If there are very few scores it is useless to have a large number of class-intervals. Ordinarily, the number of classes should be between 5 to 30.

3) Limits of each class interval = Another factor used in determining the number of classes is the size/ width or range of the class which is known as 'class interval' and is denoted by 'i'.

Class interval should be of uniform width resulting in the same-size classes of frequency distribution. The width of the class should be a whole number and conveniently divisible by 2, 3, 5, 10, or 20.

There are three methods for describing the class limits for distribution:

(i) Exclusive method, (ii) Inclusive method and (iii) True or actual class method.

i) **Exclusive method**

In this method of class formation, the classes are so formed that the upper limit of one class become the lower limit of the next class. In this classification, it is presumed that score equal to the upper limit of the class is exclusive, i.e., a score of 40 will be included in the class of 40 to 50 and not in a class of 30 to 40 (30-40, 40-50, 50-60)

ii) **Inclusive method**

In this method the classes are so formed that the upper limit of one class does not become the lower limit of the next class. This classification includes scores, which are equal to the upper limit of the class. Inclusive method is preferred when measurements are given in whole numbers. (30-39, 40-49, 50-59)

iii) **True or Actual class method**

Mathematically, a score is an internal when it extends from 0.5 units below to 0.5 units above the face value of the score on a continuum. These class limits are known as true or actual class limits. (29.5 to 39.5, 39.5 to 49.5) etc.

2.3.1.2 Types of Frequency Distribution

There are various ways to arrange frequencies of a data array based on the requirement of the statistical analysis or the study. A couple of them are discussed below:

i) Relative frequency distribution: A relative frequency distribution is a distribution that indicates the proportion of the total number of cases observed at each score value or internal of score values.

ii) Cumulative frequency distribution: Sometimes investigator may be interested to know the number of observations less than a particular value. This is possible by computing the cumulative frequency. A cumulative frequency corresponding to a class-interval is the sum of frequencies for that class and of all classes prior to that class.

iii) Cumulative relative frequency distribution: A cumulative relative frequency distribution is one in which the entry of any score of class interval expresses that score's cumulative frequency as a proportion of the total number of cases.

Self Assessment Questions

1) Complete the following statements

   i) Statistics in plural means ....

   ii) Statistics in singular means ....

   iii) Data collection is .... step in statistics.

   iv) The last step in statistics is ....

2) Define following concepts

   1) Descriptive statistics

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   2) Inferential statistics

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   3) Exclusive method of classification

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   4) Actual method of classification

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   5) Frequency distribution

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2.3.2 Tabulation

Frequency distribution can be either in the form of a table or it can be in the form of graph. Tabulation is the process of presenting the classified data in the form of a table. A tabular presentation of data becomes more intelligible and fit for further statistical analysis. A table is a systematic arrangement of classified data in row and columns with appropriate headings and sub-headings. The main components of a table are:

i) Table number: When there is more than one table in a particular analysis a table should be marked with a number for their reference and identification. The number should be written in the center at the top of the table.

ii) Title of the table: Every table should have an appropriate title, which describes the content of the table. The title should be clear, brief, and self-explanatory. Title of the table should be placed either centrally on the top of the table or just below or after the table number.

iii) Caption: Captions are brief and self-explanatory headings for columns. Captions may involve headings and sub-headings. The captions should be placed in the middle of the columns. For example, we can divide students of a class into males and females, rural and urban, high SES and Low SES etc.

iv) Stub: Stubs stand for brief and self-explanatory headings for rows.

v) Body of the table: This is the real table and contains numerical information or data in different cells. This arrangement of data remains according to the description of captions and stubs.

vi) Head note: This is written at the extreme right hand below the title and explains the unit of the measurements used in the body of the tables.

vii) Footnote: This is a qualifying statement which is to be written below the table explaining certain points related to the data which have not been covered in title, caption, and stubs.

viii) Source of data: The source from which data have been taken is to be mentioned at the end of the table.

TITLE

Stub Head	**Caption**			
Stub Entries	Column Head I		Column Head II	
	Sub Head	Sub Head	Sub Head	Sub Head
	MAIN BODY	OF	THE TABLE	
Total				

Footnote(s):

Source :

2.3.3 Graphical Presentation of Data

The purpose of preparing a frequency distribution is to provide a systematic way of " looking at" and understanding data. To extend this understanding, the information contained in a frequency distribution often is displayed in graphic and/or diagrammatic forms. In graphical presentation of frequency distribution, frequencies are plotted on a pictorial platform formed of horizontal and vertical lines known as graph.

A graph is created on two mutually perpendicular lines called the X and Y–axes on which appropriate scales are indicated. The horizontal line is called the abscissa and vertical the ordinate. Like different kinds of frequency distributions there are many kinds of graph too, which enhance the scientific understanding of the reader. The commonly used graphs are Histogram, Frequency polygon, Frequency curve, Cumulative frequency curve. Here we will discuss some of the important types of graphical patterns used in statistics.

i) Histogram: It is one of the most popular methods for presenting continuous frequency distribution in a form of graph. In this type of distribution the upper limit of a class is the lower limit of the following class. The histogram consists of series of rectangles, with its width equal to the class interval of the variable on horizontal axis and the corresponding frequency on the vertical axis as its heights.

ii) Frequency polygon: Prepare an abscissa originating from 'O' and ending to 'X'. Again construct the ordinate starting from 'O' and ending at 'Y'. Now label the class-intervals on abscissa stating the exact limits or midpoints of the class-intervals. You can also add one extra limit keeping zero frequency on both side of the class-interval range.

 The size of measurement of small squares on graph paper depends upon the number of classes to be plotted. Next step is to plot the frequencies on ordinate using the most comfortable measurement of small squares depending on the range of whole distribution.

 To plot a frequency polygon you have to mark each frequency against its concerned class on the height of its respective ordinate. After putting all frequency marks a draw a line joining the points. This is the polygon.

iii) Frequency curve: A frequency curve is a smooth free hand curve drawn through frequency polygon. The objective of smoothing of the frequency polygon is to eliminate as far as possible the random or erratic fluctuations that are present in the data.

2.3.3.1 Cumulative Frequency Curve or Ogive

The graph of a cumulative frequency distribution is known as cumulative frequency curve or ogive. Since there are two types of cumulative frequency distribution e.g., " less than" and " more than" cumulative frequencies. We can have two types of ogives.

i) 'Less than' Ogive: In 'less than' ogive , the less than cumulative frequencies are plotted against the upper class boundaries of the respective classes. It is an increasing curve having slopes upwards from left to right.

ii) 'More than' Ogive : In more than ogive , the more than cumulative frequencies are plotted against the lower class boundaries of the respective classes. It is decreasing curve and slopes downwards from left to right.

2.3.4 Diagrammatic Presentation of Data

A diagram is a visual form for the presentation of statistical data. They present the data in simple , readily comprehensible form. Diagrammatic presentation is used only for presentation of the data in visual form, whereas graphic presentation of the data can be used for further analysis. There are different forms of diagram e.g., Bar diagram, Sub-divided bar diagram, Multiple bar diagram, Pie diagram and Pictogram.

i) Bar diagram: Bar diagram is most useful for categorical data. A bar is defined as a thick line. Bar diagram is drawn from the frequency distribution table representing the variable on the horizontal axis and the frequency on the vertical axis. The height of each bar will be corresponding to the frequency or value of the variable.

ii) Sub- divided bar diagram: Study of sub classification of a phenomenon can be done by using sub-divided bar diagram. Corresponding to each sub-category of the data the bar is divided and shaded. There will be as many shades as there will sub portion in a group of data. The portion of the bar occupied by each sub-class reflects its proportion in the total.

iii) Multiple Bar diagram: This diagram is used when comparisons are to be shown between two or more sets of interrelated phenomena or variables. A set of bars for person, place or related phenomena are drawn side by side without any gap. To distinguish between the different bars in a set , different colours , shades are used.

iv) Pie diagram: It is also known as angular diagram. A pie chart or diagram is a circle divided into component sectors corresponding to the frequencies of the variables in the distribution. Each sector will be proportional to the frequency of the variable in the group. A circle represents 360^{O}. So 360^{O} angles is divided in proportion to percentages. The degrees represented by the various component parts of given magnitude can be obtained by using this formula.

After the calculation of the angles for each component, segments are drawn in the circle in succession, corresponding to the angles at the center for each segment. Different segments are shaded with different colours, shades or numbers.

Self Assessment Questions

1) In ‘ less than’ cumulative frequency distribution, which class limit is omitted

   i) upper

   ii) lower

   iii) last

   iv) none of these

2) Differentiate between following components of a statistical table that is “Caption” and “Stub head” “Head note” and “Foot note”.

   ....

   ....

3) Explain the following terms

   i) Histogram,

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   ii) Bar diagram,

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   iii) Frequency polygon, and

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   iv) Pie diagram.

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2.4 SUMMARISATION OF DATA

In the previous section we have discussed about tabulation of the data and its representation in the form of graphical presentation. In research, comparison between two or more series of the same type is needed to find out the trends of variables. For such comparison, tabulation of data is not sufficient and it is further required to investigate the characteristics of data. The frequency distribution of obtained data may differ in two ways, first in measures of central tendency and second, in the extent to which scores are spread over the central value. Both types of differences are the components of summary statistics.

2.4.1 Measures of Central Tendency

It is the middle point of a distribution. Tabulated data provides the data in a systematic order and enhances their understanding. Generally, in any distribution values of the variables tend to cluster around a central value of the distribution. This tendency of the distribution is known as central tendency and measures devised to consider this tendency is know as measures of central tendency. A measure of central tendency is useful if it represents accurately the distribution of scores on which it is based. A good measure of central tendency must possess the following characteristics:

It should be clearly defined- The definition of a measure of central tendency should be clear and unambiguous so that it leads to one and only one information.

It should be readily comprehensible and easy to compute.

It should be based on all observations- A good measure of central tendency should be based on all the values of the distribution of scores.

It should be amenable for further mathematical treatment.

It should be least affected by the fluctuation of sampling.

In Statistics there are three most commonly used measures of central tendency. These are:

1) Arithmetic Mean 2) Median, and 3) Mode

1) Arithmetic Mean: The arithmetic mean is most popular and widely used measure of central tendency. Whenever we refer to the average of data, it means we are talking about its arithmetic mean. This is obtained by dividing the sum of the values of the variable by the number of values. It is also a useful measure for further statistics and comparisons among different data sets. One of the major limitations of arithmetic mean is that it cannot be computed for open-ended class-intervals.

2) Median: Median is the middle most value in a data distribution. It divides the distribution into two equal parts so that exactly one half of the observations is below and one half is above that point. Since median clearly denotes the position of an observation in an array, it is also called a position average. Thus more technically, median of an array of numbers arranged in order of their magnitude is either the middle value or the arithmetic mean of the two middle values. It is not affected by extreme values in the distribution.

3) Mode: Mode is the value in a distribution that corresponds to the maximum concentration of frequencies. It may be regarded as the most typical of a series value. In more simple words, mode is the point in the distribution comprising maximum frequencies therein.

2.4.2 Measures of Dispersion

In the previous section we have discussed about measures of central tendency. By knowing only the mean, median or mode, it is not possible to have a complete picture of a set of data. Average does not tell us about how the score or measurements are arranged in relation to the center. It is possible that two sets of data with equal mean or median may differ in terms of their variability. Therefore, it is essential to know how far these observations are scattered from each other or from the mean. Measures of these variations are known as the 'measures of dispersion'. The most commonly used measures of dispersion are range, average deviation, quartile deviation, variance and standard deviation.

i) Range

Range is one of the simplest measures of dispersion. It is designated by 'R'. The range is defined as the difference between the largest score and the smallest score in the distribution. It gives the two extreme values of the variable. A large value of range indicates greater dispersion while a smaller value indicates lesser dispersion among the scores. Range can be a good measure if the distribution is not much skewed.

ii) Average deviation

Average deviation refers to the arithmetic mean of the differences between each score and the mean. It is always better to find the deviation of the individual observations with reference to a certain value in the series of observation and then take an average of these deviations. This deviation is usually measured from mean or median. Mean, however, is more commonly used for this measurement.

Merits: It is less affected by extreme values as compared to standard deviation. It provides better measure for comparison about the formation of different distributions.

iii) Standard deviation

Standard deviation is the most stable index of variability. In standard deviation, instead of the actual values of the deviations we consider the squares of deviations and the outcome is known as variance. Further, the square root of this variance is known as standard deviation and designated as SD. Thus, standard deviation is the square root of the mean of the squared deviations of the individual observations from the mean. The standard deviation of the sample (ó) and population denoted by (ì) respectively. If all the score have an identical value in a sample, the SD will be 0 (zero).

Merits: It is based on all observations. It is amenable to further mathematical treatments.

Of all measures of dispersion, standard deviation is least affected by fluctuation of sampling.

2.4.3 Skewness and Kurtosis

There are two other important characteristics of frequency distribution that provide useful information about its nature. They are known as skewness and kurtosis.

i) Skewness

Skewness is the degree of asymmetry of the distribution. In some frequency distributions scores are more concentrated at one end of the scale. Such a distribution is called a skewed distribution. Thus, skewness refers to the extent to which a distribution of data points is concentrated at one end or the other. Skewness and variability are usually related, the more the skewness the greater the variability.

ii) Kurtosis

The term 'kurtosis' refers to the 'peakedness' or flatness of a frequency distribution curve when compared with normal distribution curve. The kurtosis of a distribution is the curvedness or peakedness of the graph.

If a distribution is more peaked than normal it is said to be leptokurtic. This kind of peakedness implies a thin distribution.

On the other hand, if a distribution is more flat than the normal distribution it is known as Platykurtic distribution.

A normal curve is known as mesokurtic.

2.4.4 Advantages and Disadvantages of Descriptive Statistics

The *Advantages* of Descriptive statistics are given below:

- It is essential for arranging and displaying data.
- It forms the basis of rigorous data analysis.
- It is easier to work with, interpret, and discuss than raw data.
- It helps in examining the tendencies, variability, and normality of a data set.
- It can be rendered both graphically and numerically.
- It forms the basis for more advanced statistical methods.

The *disadvantages* of descriptive statistics can be listed as given below:

- It can be misused, misinterpreted, and incomplete.
- It can be of limited use when samples and populations are small.
- It offers little information about causes and effects.
- It can be dangerous if not analysed completely.
- There is a risk of distorting the original data or losing important detail.

Self Assessment Questions

1) Which one of the alternative is appropriate for descriptive statistics?

   i) In a sample of school children, the investigator found an average IQ was 110.

   ii) A class teacher calculates the class average on their final exam. Was 64%.

2) State whether the following statements are *True* (T) or *False* (F).

   i) Mean is affected by extreme values ( )

   ii) Mode is affected by extreme values ( )

iii)	Mode is useful in studying qualitative facts such as intelligence	( )
iv)	Median is not affected by extreme values	( )
v)	Range is most stable measures of variability	( )
vi)	Standard deviation is most suitable measures of dispersion	( )
vii)	Skewness is always positive	( )

2.5 MEANING OF INFERENTIAL STATISTICS

In the previous section we discussed about descriptive statistics, which basically describes some characteristics of data. But the description or definition of the distribution or observations is not the prime objective of any scientific investigation.

Organising and summarising data is only one step in the process of analysing the data. In any scientific investigation either the entire population or a sample is considered for the study.

In most of the scientific investigations a sample, a small portion of the population under investigation, is used for the study. On the basis of the information contained in the sample we try to draw conclusions about the population. This process is known as statistical inference.

Statistical inference is widely applicable in behavioural sciences, especially in psychology. For example, before the Lok Sabha or Vidhan Sabha election process starts or just before the declaration of election results print media and electronic media conduct exit poll to predict the election result. In this process all voters are not included in the survey, only a portion of voters i.e. sample is included to infer about the population. This is called inferential statistics.

Inferential statistics deals with drawing of conclusions about large group of individuals (population) on the basis of observation of a few participants from among them or about the events which are yet to occur on the basis of past events. It provides tools to compute the probabilities of future behaviour of the subjects.

Inferential statistics is the mathematics and logic of how this generalisation from sample to population can be made.

There are two types of inferential procedures: (1) Estimation, (2) Hypothesis testing.

2.5.1 Estimation

In estimation, inference is made about the population characteristics on the basis of what is discovered about the sample. There may be sampling variations because of chance fluctuations, variations in sampling techniques, and other sampling errors. Estimation about population characteristics may be influenced by such factors. Therefore, in estimation the important point is that to what extent our estimate is close to the true value.

Characteristics of Good Estimator: A good statistical estimator should have the following characteristics, (i) Unbiased (ii) Consistent (iii) Accuracy . These are being dealt with in detail below.

i) Unbiased

An unbiased estimator is one in which, if we were to obtain an infinite number of random samples of a certain size, the mean of the statistic would be equal to the parameter. The sample mean, ($\overline{x}$) is an unbiased estimate of population mean (μ) because if we look at possible random samples of size N from a population, then mean of the sample would be equal to μ.

ii) Consistent

A consistent estimator is one that as the sample size increased, the probability that estimate has a value close to the parameter also increased. Because it is a consistent estimator, a sample mean based on 20 scores has a greater probability of being closer to (μ) than does a sample mean based upon only 5 scores

ii) Accuracy

The sample mean is an unbiased and consistent estimator of population mean (μ). But we should not over look the fact that an estimate is just a rough or approximate calculation. It is unlikely in any estimate that ($\overline{x}$) will be exactly equal to population mean (μ). Whether or not x is a good estimate of (μ) depends upon the representative ness of sample, the sample size, and the variability of scores in the population.

2.5.2 Point Estimation

We have indicated that $\overline{x}$ obtained from a sample is an unbiased and consistent estimator of the population mean (μ). Thus, if an investigator obtains Adjustment Score from 100 students and wanted to estimate the value of (μ) for the population from which these scores were selected, researcher would use the value of $\overline{x}$ as an estimate of population mean (μ). If the obtained value of x were 45.0 then this value would be used as estimate of population mean (μ).

This form of estimate of population parameters from sample statistic is called point estimation. Point estimation is estimating the value of a parameter as a single point, for example, population mean (μ) = 45.0 from the value of the statistic $\overline{x}$ = 45.0

2.5.3 Interval Estimation

A point estimate of the population mean (μ) almost is assured of being in error, the estimate from the sample will not equal to the exact value of the parameter. To gain confidence about the accuracy of this estimate we may also construct an interval of scores that is expected to include the value of the population mean. Such intervals are called confidence interval. A confidence interval is a range of scores that is expected to contain the value of (μ). The lower and upper scores that determine the interval are called confidence limits. A level of confidence can be attached to this estimate so that, the researcher can be 95% or 99% confidence level that encompasses the population mean.

Self Assessment Questions

1) What is statistical inference?

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2) Explain with illustrations the concept of

   i) Estimation,

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ii) Point estimation,

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iii) Interval estimation

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3) What are the procedures involved in statistical inference?

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2.6 HYPOTHESIS TESTING

Inferential statistics is closely tied to the logic of hypothesis testing. In hypothesis testing we have a particular value in mind. We hypothesize that this value characterise the population of observations. The question is whether that hypothesis is reasonable in the light of the evidence from the sample. In estimation no particular population value need be stated. Rather, the question is , what is the population value. For example, Hypothesis testing is one of the important areas of statistical analyses. Sometimes hypothesis testing is referred to as statistical decision-making process. In day-to-day situations we are required to take decisions about the population on the basis of sample information.

2.6.1 Statement of Hypothesis

A statistical hypothesis is defined as a statement, which may or may not be true about the population parameter or about the probability distribution of the parameter that we wish to validate on the basis of sample information.

Most times, experiments are performed with random samples instead of the entire population and inferences drawn from the observed results are then generalised over to the entire population.

But before drawing inferences about the population it should be always kept in mind that the observed results might have come due to chance factor. In order to have an accurate or more precise inference, the chance factor should be ruled out.

The probability of chance occurrence of the observed results is examined by the null hypothesis (H_0). Null hypothesis is a statement of no differences. The other way to state null hypothesis is that the two samples came from the same population. Here, we assume that population is normally distributed and both the groups have equal means and standard deviations.

Since the null hypothesis is a testable proposition, there is counter proposition to it known as alternative hypothesis and denoted by H_1. In contrast to null hypothesis, the alternative hypothesis (H_1) proposes that

i) the two samples belong to two different populations,

ii) their means are estimates of two different parametric means of the respective population, and

iii) there is a significant difference between their sample means.

The alternative hypothesis (H_1) is not directly tested statistically; rather its acceptance or rejection is determined by the rejection or retention of the null hypothesis. The probability 'p' of the null hypothesis being correct is assessed by a statistical test. If probability 'p' is too low, H_0 is rejected and H_1 is accepted.

It is inferred that the observed difference is significant. If probability 'p' is high, H_0 is accepted and it is inferred that the difference is due to the chance factor and not due to the variable factor.

2.6.2 Level of Significance

The level of significance (p<.05) is that probability of chance occurrence of observed results up to and below which the probability 'p' of the null hypothesis being correct is considered too low and the results of the experiment are considered significant ($p \leq$).

On the other hand, if p exceeds , the null hypothesis (H_0) cannot be rejected because the probability of it being correct is considered quite high and in such case, observed results are not considered significant (p >).

The selection of level of significance depends on the choice of the researcher. Generally level of significance is taken to be 5% or 1%, i.e., = .05 or = .01). If null hypothesis is rejected at .05 level, it means that the results are considered significant so long as the probability 'p' of getting it by mere chance of random sampling works out to be 0.05 or less (p< .05). In other words, the results are considered significant if out of 100 such trials only 5 or less number of the times the observed results may arise from the accidental choice in the particular sample by random sampling.

2.6.3 One-tail and Two-tail Test

Depending upon the statement in alternative hypothesis (H_1), either a one-tail or two-tail test is chosen for knowing the statistical significance. A one-tail test is a directional test. It is formulated to find the significance of both the magnitude and the direction (algebraic sign) of the observed difference between two statistics. Thus, in two-tailed tests researcher is interested in testing whether one sample mean is significantly higher (alternatively lower) than the other sample mean.

2.7 ERRORS IN HYPOTHESIS TESTING

In hypothesis testing, there would be no errors in decision making as long as a null hypothesis is rejected when it is false and also a null hypothesis is accepted when it is true. But the decision to accept or reject the null hypothesis is based on sample data. There is no testing procedure that will ensure absolutely correct decision on the basis of sampled data. There are two types of errors regarding decision to accept or to reject a null hypothesis.

2.7.1 Type I Error

When the null hypothesis is true, a decision to reject it is an error and this kind of error is known as type I error in statistics. The probability of making a type I error is denoted as 'á' (read as alpha). The null hypothesis is rejected if the probability 'p' of its being correct does not exceed the p. The higher the chosen level of p for considering the null hypothesis, the greater is the probability of type I error.

2.7.2 Type II Error

When null hypothesis is false, a decision to accept it is known as type II error. The probability of making a type II error is denoted as 'â' (read as beta). The lower the chosen level of significance p for rejecting the null hypothesis, the higher is the probability of the type II error. With a lowering of p, the rejection region as well as the probability of the type I error declines and the acceptance region (1-p) widens correspondingly.

The goodness of a statistical test is measured by the probability of making a type I or type II error. For a fixed sample size n, á and â are so related that reduction in one causes increase in the other. Therefore, simultaneous reductions in á and â are not possible. If n is increased, it is possible to decrease both á and â.

2.7.3 Power of a Test

The probability of committing type II error is designated by â. Therefore, 1-â is the probability of rejecting null hypothesis when it is false. This probability is known as the power of a statistical test. It measures how well the test is working. The probability of type II error depends upon the true value of the population parameter and sample size n.

Self Assessment Questions

1) Fill in the blanks

   i) Alternative hypothesis is a statement of .... difference.

   ii) Null hypothesis is denoted by ....

   iii) Alternative hypothesis is .... directly tested statistically.

   iv) .... is that probability of chance of occurrence of observed results.

   v) One tail test is a .... statistical test.

   vi) When the null hypothesis is true, a decision to reject is known as.........

   vii) When a null hypothesis is false, a decision to accept is known as.........

2.8 GENERAL PROCEDURE FOR TESTING A HYPOTHESIS

Step 1. Set up a null hypothesis suitable to the problem.

Step 2. Define the alternative hypothesis.

Step 3. Calculate the suitable test statistics.

Step 4. Define the degrees of freedom for the test situation.

Step 5. Find the probability level 'p' corresponding to the calculated value of the test statistics and its degree of freedom. This can be obtained from the relevant tables.

Step 6. Reject or accept null hypothesis on the basis of tabulated value and calculated value at practical probability level.

There are some situations in which inferential statistics is carried out to test the hypothesis and draw conclusion about the population , for example (i) Test of hypothesis about a population mean (Z test), (ii) Testing hypothesis about a population mean (small sample ' t' test).

2.9 LET US SUM UP

Descriptive statistics are used to describe the basic features of the data in investigation. Such statistics provide summaries about the sample and measures. Data description comprises two operations: organising data and describing data. Organising data includes: classification, tabulation, graphical and diagrammatic presentation of raw scores. Whereas, measures of central tendency and measures of dispersion are used in describing the raw scores.

In the above section, the basic concepts and general procedure involved in inferential statistics are also discussed. Inferential statistics is about inferring or drawing conclusions from the sample to population. This process is known as statistical inference. There are two types of inferential procedures: estimation and hypothesis testing. An estimate of unknown parameter could be either point or interval. Hypothesis is a statement about a parameter. There are two types of hypotheses: null and alternative hypotheses. Important concepts involved in the process of hypothesis testing example, level of significance, one tail test, two tail test, type I error, type II error, power of a test are explained. General procedure for hypothesis testing is also given.

2.10 UNIT END QUESTIONS

1) What is descriptive statistics? Discuss its advantages and disadvantages.

2) What do you mean by organisation of data? State different methods of organising raw data.

3) Define measures of dispersion. Why is it that standard deviation is considered as the best measures of variability?

4) Explain the importance of inferential statistics.

5) Describe the important properties of good estimators.

6) Discuss the different types of hypothesis formulated in hypothesis testing.

7) Discuss the errors involved in hypothesis testing.

8) Explain the various steps involved in hypothesis testing.

2.11 GLOSSARY

Classification : A systematic grouping of data

Cumulative frequency distribution : A classification, which shows the cumulative frequency below, the upper real limit of the corresponding class interval.

Data : Any sort of information that can be analysed.

Discrete data : When data are counted in a classification.

Exclusive classification : The classification system in which the upper limit of the class becomes the lower limit of next class

Frequency distribution : Arrangement of data values according to their magnitude.

Inclusive classification	:	When the lower limit of a class differs the upper limit of its successive class.
Mean	:	The ratio between total and numbers of scores.
Median	:	The mid point of a score distribution.
Mode	:	The maximum occurring score in a score distribution.
Central Tendency	:	The tendency of scores to bend towards center of distribution.
Dispersion	:	The extent to which scores tend to scatter from their mean and from each other.
Standard Deviation	:	The square root of the sum of squared deviations of scores from their mean.
Skewness	:	Tendency of scores to polarize on either side of abscissa.
Kurtosis	:	Curvedness of a frequency distribution graph.
Range	:	Difference between the two extremes of a score distribution.
Confidence level	:	It gives the percentage (probability) of samples where the population mean would remain within the confidence interval around the sample mean.
Estimation	:	It is a method of prediction about parameter value on the basis Statistic.
Hypothesis testing	:	The statistical procedures for testing hypotheses..
Level of significance	:	The probability value that forms the boundary between rejecting and not rejecting the null hypothesis.
Null hypothesis	:	The hypothesis that is tentatively held to be true (symbolised by Ho)
One-tail test	:	A statistical test in which the alternative hypothesis specifies direction of the departure from what is expected under the null hypothesis.
Parameter	:	It is a measure of some characteristic of the population.
Population	:	The entire number of units of research interest.
Power of a test	:	An index that reflects the probability that a statistical test will correctly reject the null hypothesis relative to the size of the sample involved.
Sample	:	A sub set of the population under study.

Statistical inference	:	It is the process of concluding about an unknown population from known sample drawn from it.
Statistical hypothesis	:	The hypothesis which may or may not be true about the population parameter.
t-test	:	It is a parametric test for the significance of differences between means.
Type I error	:	A decision error in which the statistical decision is to reject the null hypothesis when it is actually true.
Type II error	:	A decision error in which the statistical decision is not to reject the null hypothesis when it is actually false.
Two-tail test	:	A statistical test in which the alternative hypothesis does not specify the direction of departure from what is expected under the null hypothesis.

2.12 SUGGESTED READINGS

Asthana, H. S. and Bhushan, B. (2007). *Statistics for Social Sciences* (with SPSS Application). Prentice Hall of India, New Delhi.

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