I J C R M

International Journal of Contemporary Research In Multidisciplinary

Research Article

Measurement Scales in Statistics and Selection of Appropriate Statistical Tests

Dr. Gagandeep Singh[1*]

[1]Assistant Professor, PG Department of Commerce, Mata Gujri College, Fatehgarh Sahib, Punjab, India

Corresponding Author: *Dr. Gagandeep Singh

DOI: https://doi.org/10.5281/zenodo.15052362

Abstract

For statistical analysis, data is collected and categorized to allow appropriate analytical techniques to be used. But the most important part of this analysis is which type of data is collected and according to that how that must be analyzed. Measurement Scale depends on the category of data. This Research paper explores the four basic types of measurement scales; Nominal, Ordinal, Interval, and Ratio. Each of the scales has been characterized with different parameters and respective tools to be applied. Additionally, the paper focuses on the applicability of measurement of scales with appropriate examples and statistical techniques.

Manuscript Information

- **ISSN No:** 2583-7397
- **Received:** 23-01-2025
- **Accepted:** 20-02-2025
- **Published:** 17-03-2025
- **IJCRM:**4(2); 2025: 46-52

- **Plagiarism Checked:** Yes
- **Peer Review Process:** Yes

How to Cite this Article

Singh G. Measurement Scales in Statistics and Selection of Appropriate Statistical Tests. Int J Contemp Res Multidiscip. 2025;4(2):46-52.

Access this Article Online

www.multiarticlesjournal.com

KEYWORDS: Measurement Scales, Statistical Tests, Data Categorization, Variables in Statistics, Probability Distributions.

INTRODUCTION

Measurement of desired study variables is a crucial part of statistical analysis, which enables researchers to understand the data so collected for which type of classification, comparison, and conclusions would be applied. Measurement scales depend on the type of data to be collected. Thus, the first step is to identify the type of data and which type of measuring scale would be applicable. The choice of measurement scale depends upon the variable type. Afterward, these measurement scales identify related statistical tools to be applied to them.

Variable: In Mathematics variable is a symbol that denotes quantity, attribute, or value. In the case of Statistics and Research, it is a set of random events or attributes, these may be dependent variables based on the function of independent

variables with which they are formed or being produced or created.

Types of Variables or Data

Different types of data and their measurement in statistics along with models that fit them are being discussed in further sections.

1. **Binary variables:** When there are only two possible answers in 'yes' or 'no' then in programming they can be coded into 0 and 1 for that purpose Bernoulli model of probability distribution can be applied and thus for statistical calculations Mode and Chi-square test can be applied.
2. **Categorical Variables:** Where different arbitrary levels can be given in such case mode and the chi-square test can be applied because they can be given values in different numbers from 1-n and thus multinomial probability can be applied.
3. **Ordinal ranking categories:** Integers in order or arbitrary scales variables can be studied on the basis of relative comparison with Spearman's rank correlation can be applied.
4. **Binomial variables:** Number of favorable and unfavorable outcomes which are in interval scale add are additive, mean, median, mode, standard deviation, Karl Pearson's coefficient of correlation can be applied.
5. **Counts:** Nonnegative numbers like several births, deaths, and population are in a ratio scale where Poisson distribution of probability is applied and geometric mean is used.
6. **Real valued additive variables:** These are in interval scale where mean median, mode, standard deviation, and linear regression are applied.
7. **Real valued multiplicative:** Are in ratio scale where skewness is visible and here geometric mean and generalized linear model with logarithmic function is applied.

REVIEW OF LITERATURE

Stevens (1946) introduced the theory of measurement scales, categorizing them into nominal, ordinal, interval, and ratio scales. Apart from Steven's typology several other typologies have been introduced by different parameters. Mosteller and Tukey (1977) mentioned that not only four types of measurements are sufficient and they have proposed seven types like Names, Grades like ordinal data with labels, ranks like ordinal data in ascending or descending order, Fractions in rational numbers or percentages, counts for non-negative integers, Amounts for positive numbers and Balances with real numbers. Chrisman (1998) expanded measurement types to ten in numbers like Nominal, Gradation, Ordinal, Interval, Log Interval, Extensive ratio, cyclic ratio, Derived ratio, count, and Absolute. Gradation of graded membership and absolute measurement are used in academic purposes only in fuzzy set theory and Dempster-Shafer theory respectively. The cyclic ratio in geometry, counts are used in ratio, and log interval in graphical measures.

Types of Measurement Scales

1. **Nominal Data:** The nominal scale is the most basic form of measurement, used for categorical data where numbers or labels represent different groups without any inherent order. Categorical Data are those which can be counted for respective categories. Such persons can't fall simultaneously into two categories. For example, a person may be male or female, a person may be married, divorced, or unmarried and in case of person falls in a particular group of income. It is also termed as named variables. For these types of data where only categories are selected in the case of deferential statistics analysis Mode and for inferential analysis mostly chi-square tests are used.

Dichotomous data: A special type of nominal data used to find the relation of variables with frequency. It represents a discrete or continuous series.

a) Discrete Dichotomous variables or Discrete Series are separate variables and have no order with frequency.
b) Continuous Dichotomous variable or Continuous Series is in order with frequency.

2. **Ordinal Scale Data:** The ordinal scale extends the nominal scale by introducing a meaningful order among categories. However, the intervals between the categories are not necessarily equal. It describes values in order from low to high. Order of heights in ascending or descending order, Likert scale data for Qualitative data with rages for satisfying levels for agreement and disagreement, educational levels of persons because primary educated is succeeded by middle and then by secondary and senior secondary and so on, next order is higher than its predecessor, etc. It is a named and ordered variable. For deferential analysis mostly median and for inferential analysis non-parametric Mann Whitney-U Test is used for statistical analysis.

3. **Interval Scale Data:** It measures equal intervals between two variables. The distance between any two points on the scale is the same. Class interval in Continuous series which has quantitative figures. This scale allows for meaningful addition and subtraction but not multiplication or division. Differential analysis is done with mean and standard deviation and for inferential analysis parametric tests like t-test and ANOVA are used. It is a named, ordered, and proportional interval between variables. For example, equal class interval data of Celsius, credit score, etc.

4. **Ratio Scale Data:** It has comparison between intervals and quantitative data and it originates from zero point. It is a named, ordered, proportionate interval between variables and can accommodate absolute zero. Weight, Speed, Time, Age, Distance etc., which are in comparison to each other. Statistical analyses are used in case of differential purposes, for ratio data include geometric mean, and coefficient of

variation, and for inferential purposes, regression analysis is mostly in usage.

Table 1: Summary Table for selection of Level of Measurement

Characteristics/Level of Measurement	Nominal	Ordinal	Interval	Ratio
Mutually exclusive	√	√	√	√
Order to scale		√	√	√
Standardized Scale			√	√
Meaningful Zero				√

Source: Drews D. 2013

Objectives of the Data Analysis

Study of the particular phenomenon to convert raw data into information with a set of processing termed as data analysis. It involves statistical techniques with which the objective of obtaining an answer to the research question is derived.

Hypothesis for selected Objectives

After framing a research question, theoretical efforts to find a solution for a particular question start. For this purpose, the tentative solution is assumed, which is known as Hypothesis for said study to be conducted. The main aim is to have a direction in which the study would be initiated. The hypothesis testing process starts with the framing of two opposite possibilities at the end of the study as Null Hypothesis which shows without significant effect of a particular change and on the other hand Alternate Hypothesis as with significant effect of a particular change.

Hypothesis Testing: Involves following the procedure

1. Formulation of Null and Alternate Hypothesis
2. Selecting relevant tests and appropriate probability distribution
3. Selecting critical value with significance level and degree of freedom
4. Collection of Data and Test Statistics
5. Comparing the test statistics and the critical value
6. Taking the final decision to reject the null hypothesis or failing to reject the null hypothesis.

Parametric Tests

If data is normally distributed then parametric tests are applied. Mostly Ratio and Interval data are in parametric test categories.

Non-Parametric Tests

If otherwise data is not normally distributed then it is skewed to the left or right side then non-parametric tests are applied. Ordinal data is categorized in the non-parametric test category.

Table 2: Relationship between level of measurement and use of Statistical procedures

Variable/Statistical Procedure	Nominal	Ordinal	Interval / Ratio
Nominal	Yes	X	Logical error
Ordinal	OK	Yes	
Interval / Ratio	OK but Recode required		Yes

Source: Drews D. 2013

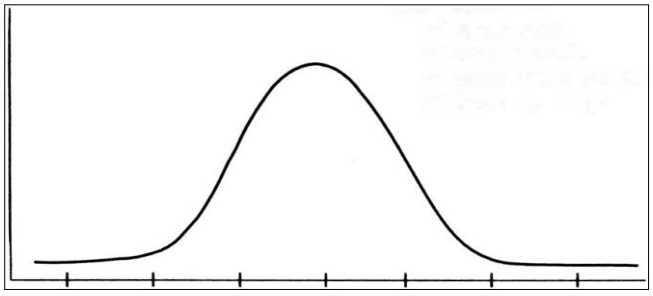
Descriptive Statistics Analysis

Descriptive statistics is used to describe the characteristics of data. Three aspects are described Central value or Tendency, Variation of data, and nature of Distribution.

1. **Measurement of Central Tendency**:
   To find a precise value that represents whole of the data averages or central values are calculated like Mean, Median, and Mode. Mean is the arithmetic average of the whole data. Mean is used in the case of interval or ratio measurements and is part of parametric statistics. Median on the other hand is used to describe the positional central value of ordinal, interval, and ratio data. Mode is the most occurring value in the whole data which shows a trend or mode with which it is mostly repeated in data.

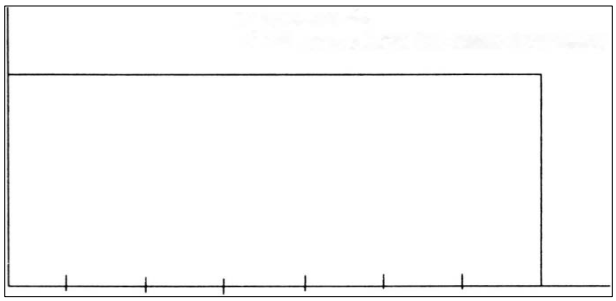
2. **Measurement of Dispersion/Variance**
   The range of Highest and Lowest data values signifies data variation. Quartile Deviation shows variation between the Third Quartile value and First Quartile value of the data which means if data is arranged then the value at one-fourth position and three-fourth position variation is used to check Quartile Deviation. Mean Deviation and Standard Deviation find the deviation of data from that of the Arithmetic mean.

3. **Nature of Distribution**
   The frequency distribution of data is summarized in the form of a graphical shape which categorizes data distribution into different shapes like uniform, bi-modal, multi-modal, positively skewed, negatively skewed, and normal. The distribution of data shows how much symmetry has been observed in the case of data. If it is symmetrically distributed then it's all averages say Mean, Mean, and Mode are the same and it is in bell shape form showing that the pattern is not skewed. But the other way around when extreme values affect data distribution and it is skewed to the left or right the values of Mean, Median, and Mode differ from each other. Where data is not skewed and in symmetry then it is normally distributed otherwise it is non-normal distributed. Due to this distribution, different research tools are used which are based on its skewness. When Normal distribution is considered for analysis then those tools which are based on Mean are taken into consideration. In the case of non-nominal distribution are based on positional averages like Median and Quartile deviation.

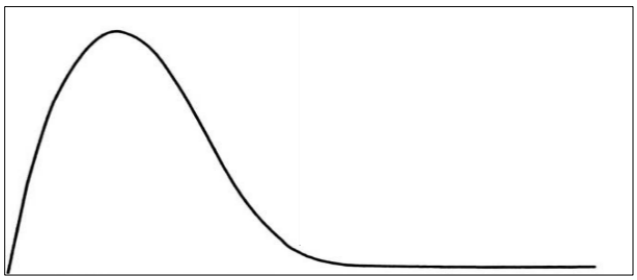


Mean -Median -Mode

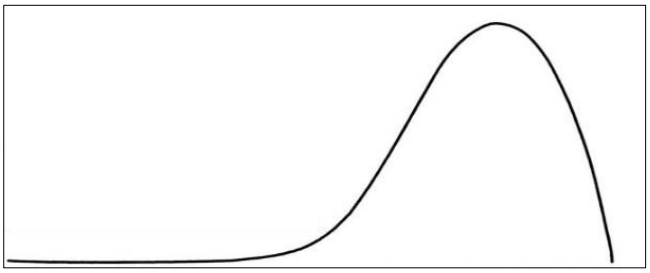
Normal Distribution comprised symmetric, area of equal probability, bell-shaped and under curve 1.0. It has having special feature where Mean, Median and Mode are at same center position.



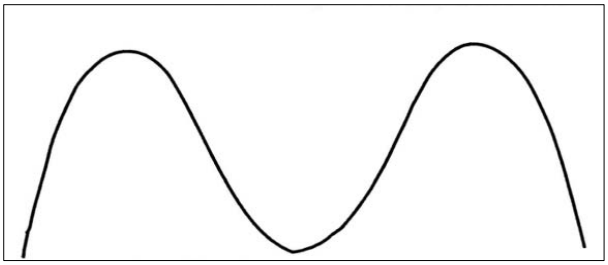
Uniform Distribution has the feature of symmetric and with same frequency for all scores.



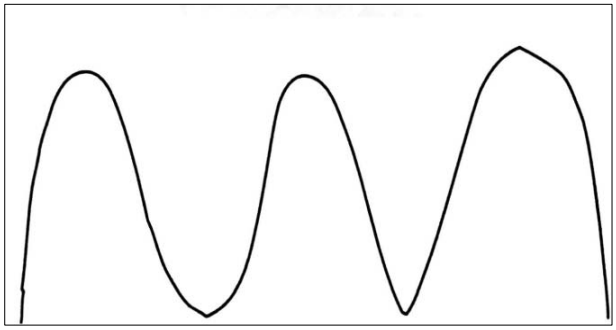
Positive Skewed distribution comprises skewed to the Right and Mean and Median are right to Mode Value



Negative skewed distribution is skewed to left and it's Mean and Median lies to The Mode.



Bi- modal distribution has two modes and Mean and Median are same and lies in between these two modes.



Multi-modal has features of more than two modes.

Categorical Tests

Where data is in categories or named variables then categorical tests are applied. Nominal data type is covered in case of categorical test.

Selection of Appropriate statistical tests are based upon type of data and purpose where it is to be applied. Purpose may be for describing or description, comparison of one group with hypothetical value, comparison of two groups, comparison of three or more groups, to find association between two groups and at last finding future outcome or prediction on the basis of present available data.

Scaling of Data is an important aspect of data collection and then on the basis of their type they are broadly divided into three categories Parametric, Non-Parametric and Categorical data, where different types of tests are applied.

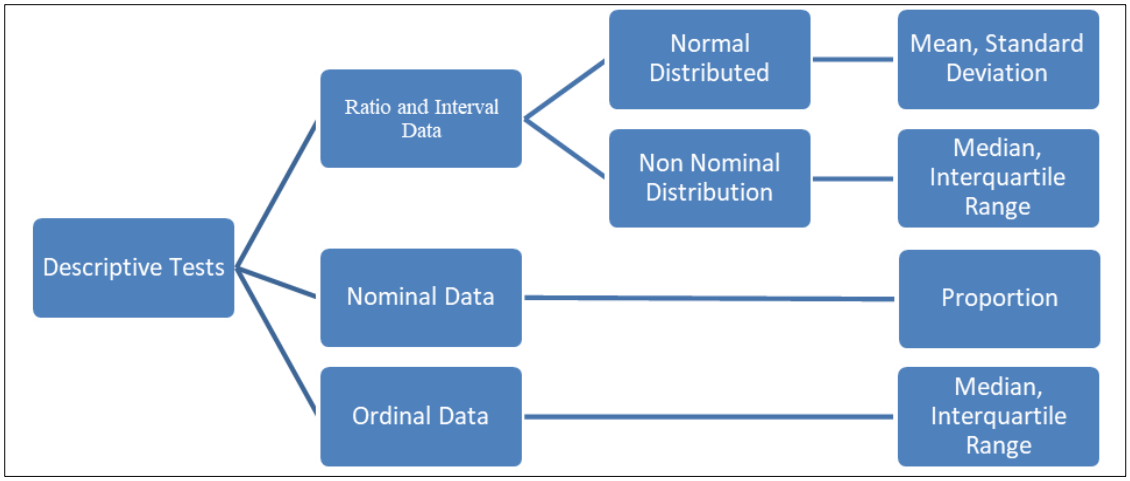


Figure 1: Description of One group: Tests related to descriptive study are based on the following parameters

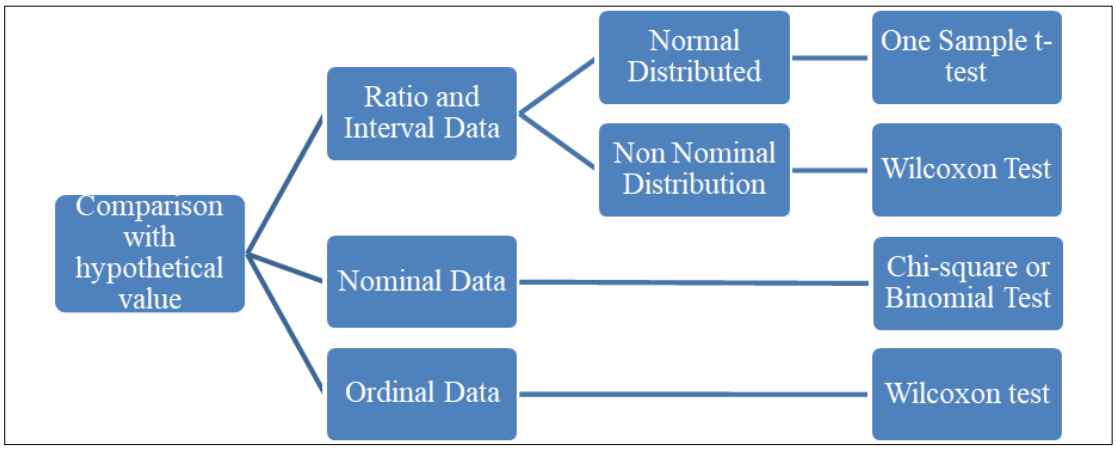


Figure 2: Comparison of one group with a hypothetical value

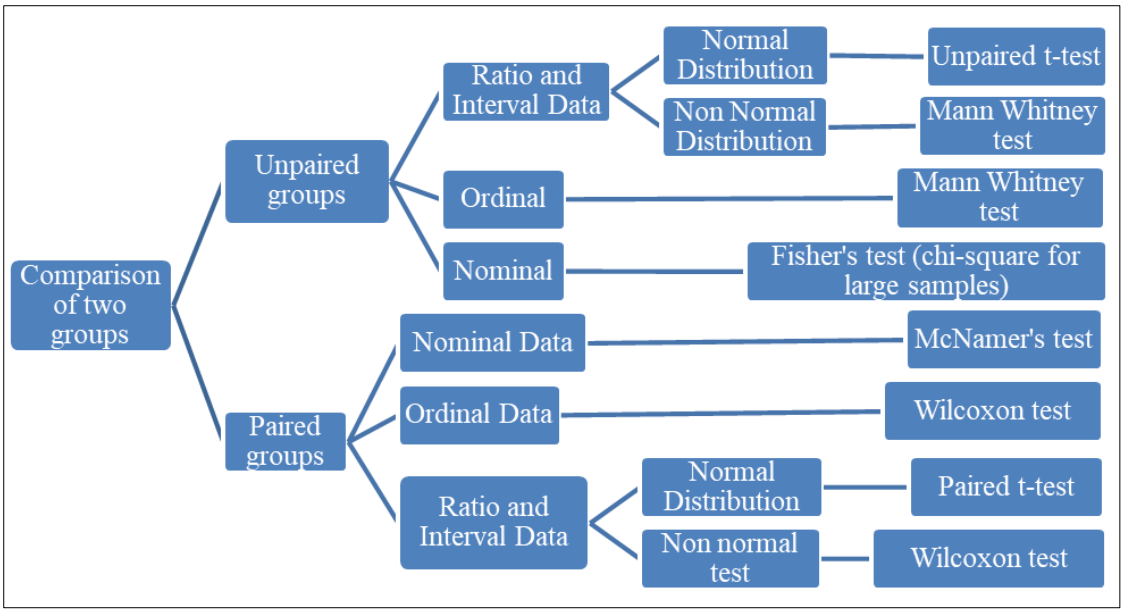


Figure 3: Comparison of two groups

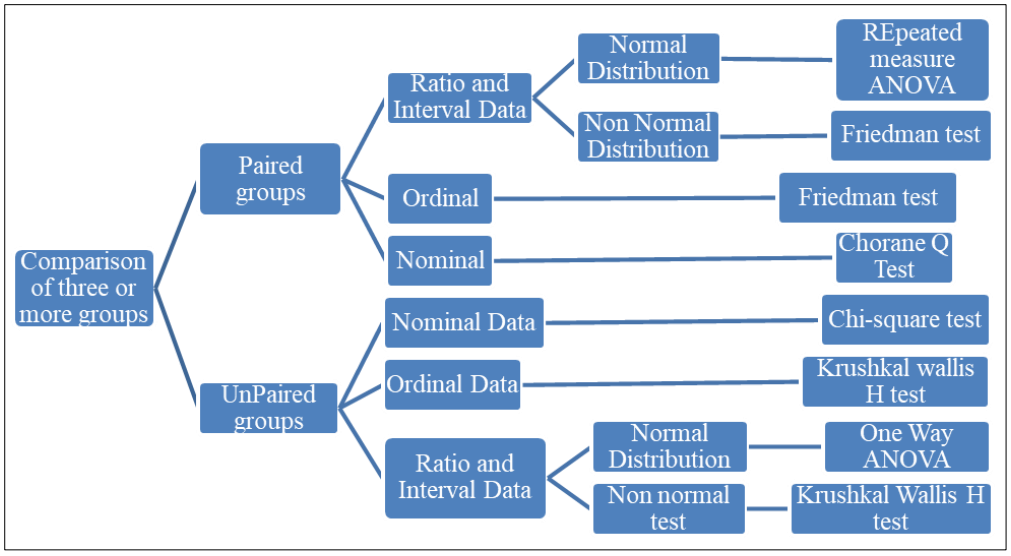


Figure 4: Comparison of three or more groups

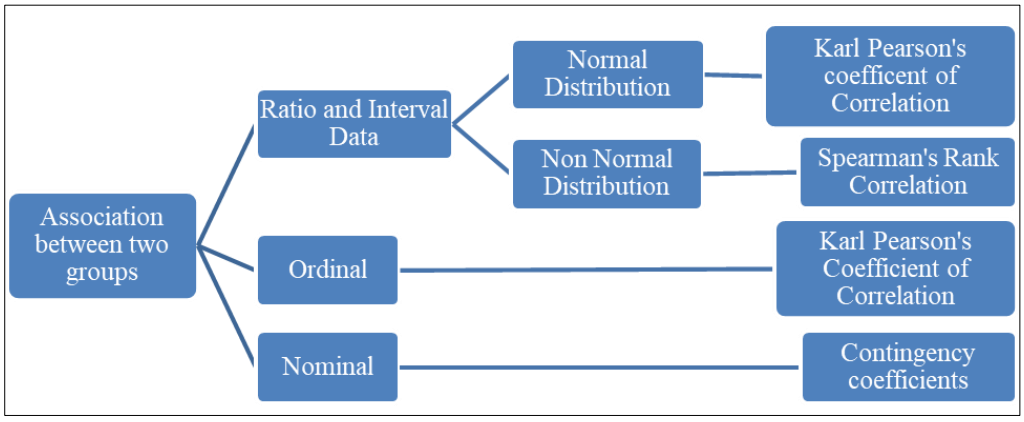


Figure 5: Association between two groups

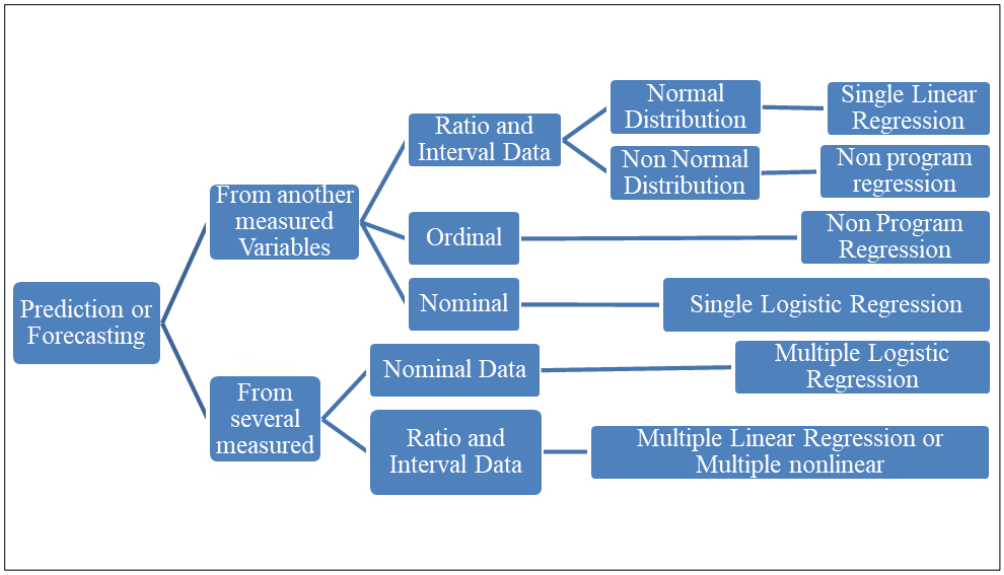


Figure 6: Future Prediction from given data

CONCLUSION

Measurement scales serve as the backbone of statistical research, guiding the selection of appropriate analytical tools. Understanding the differences between nominal, ordinal, interval, and ratio scales enhances the accuracy and validity of statistical findings. Future research should focus on developing hybrid measurement techniques and improving data classification methods to further enhance statistical accuracy.

REFERENCES

1. Kruse G, Drews D. Using performance tasks to improve quantitative reasoning in an introductory mathematics course. International Journal for the Scholarship of Teaching and Learning. 2013;7(2):1-23.
2. Stevens SS. On the theory of scales of measurement. Science. 1946;103(2684):677-680.
3. Velleman PF, Wilkinson L. Nominal, ordinal, interval, and ratio typologies are misleading. The American Statistician. 1993;47(1):65-72.
4. Ben-Zvi D. Toward understanding the role of technological tools in statistical learning. Mathematical Thinking and Learning. 2000;2(1–2):127–155.
5. Hammerman JK, Rubin A. Strategies for managing statistical complexity with new software tools. Statistics Education Research Journal. 2004;3(2):17–41.
6. Hoffmeister TS, Babendreier D, Wajnberg E. Statistical tools to improve the quality of experiments and data analysis for assessing non-target effects. In: Environmental Impact of Invertebrates for Biological Control of Arthropods: Methods and Risk Assessment. Wallingford UK: CABI Publishing; 2006. p. 222–240.
7. Belouafa S, Habti F, Benhar S, Belafkih B, Tayane S, Hamdouch S, *et al*. Statistical tools and approaches to validate analytical methods: Methodology and practical examples. International Journal of Metrology and Quality Engineering. 2017;8:9-25.
8. In J, Lee S. Statistical data presentation. Korean Journal of Anesthesiology. 2017;70(3):267–276.
9. Benzécri JP. Statistical analysis as a tool to make patterns emerge from data. In: Methodologies of Pattern Recognition. Elsevier; 1969. p. 35–74.
10. Normand SLT. Some old and some new statistical tools for outcomes research. Circulation. 2008;118(8):872–884.
11. Mishra P, Pandey CM, Singh U, Gupta A. Scales of measurement and presentation of statistical data. Annals of Cardiac Anaesthesia. 2018;21(4):419–422.
12. Cobb P. Modeling, symbolizing, and tool use in statistical data analysis. In: Symbolizing, Modeling and Tool Use in Mathematics Education. Springer; 2002. p. 171–195.
13. Ali Z, Bhaskar SB. Basic statistical tools in research and data analysis. Indian Journal of Anaesthesia. 2016;60(9):662–669.
14. Kang CW, Kvam P. Basic Statistical Tools for Improving Quality. John Wiley & Sons; 2012.

About the Corresponding Author

Prof. Gagandeep Singh is an Assistant Professor of Commerce at Mata Gujri College, Fatehgarh Sahib, with 21 years of experience. He holds M.Com., M.Ed., P.G.D.C.A., UGC (NET). He serves in key academic roles and has multiple UGC CARE-listed publications, focusing on taxation, especially GST. A life-term member of the Indian Commerce Association, he actively participates in faculty development programs.