Data Analysis and Interpretations

MEASUREMENTS AND SCALES

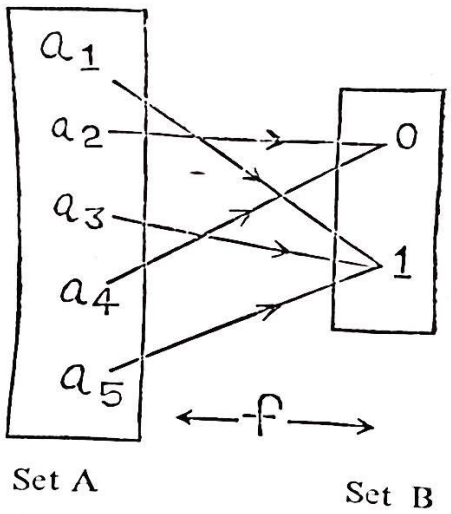
Definition of Measurement:

Measurement is the assignment of numerals to objects or events according to some rules. A numeral is a symbol used to distinguish objects from each other and has no quantitative meaning unless we give such a meaning. In other words, numerals are the symbols assigned to objects according to some prescribed rule. Numerals are usually the symbols 1. 2, 3...or I, II, III...etc ascribed to the objects such as players (Ex: Football players).

When numerals are assigned quantitative meaning, they become numbers. The term assignment means mapping of objects of **one set** onto the objects of **another se**t. A function, f, is the rule of correspondence.

Example 1: Suppose a family consists of five persons and we want to measure their sex. Assuming that we have a prior rule that allows unambiguously to determine the sex, the rule is to assign a symbol if the person is male and another symbol if the person is female. If the symbols used are 1 and 0 respectively, then we have two sets. A={a_1 , a_2 , a_3 , a_4, a_5} and B=(1, 0} where a_1 , a_2, a_3, a_4 and a_5 are the members of the family A.

If the members a_1, a_3 and a_5 are males, then the mapping of the sets will be as:



Thus, measurement may be defined as the map-ping of objects of one set to objects of other set.

The kind of measurement achieved is a function of the rule which assigns the numerals (symbols) to objects/observations. The rule is called a **scale**.

Indicants: Actually measurement is not of the objects, but the properties or characteristics of these objects. Strictly speaking, this is also not true. Actually measurements are done on the indicants of the properties of objects. Indicant is merely a convenient word used to mean something that points to something else. If a boy continually strikes other boys, his behavior is an **indicant** of his underlying hostility. The indicants from which properties of the objects are inferred are specified by **operational definitions** that specify the activities or operations necessary to measures variables (or constructs).

Constructs:

A construct is an invented name for a property such as **Authoritarianism, Achievement, Intelligence, Persistence,** etc. An operational definition is necessary in order to measure a property or a construct. This is done by specifying the activities or operations necessary to measure it.

Steps in Measurement Procedure:

The **first** step in any measurement procedure is to define the objects of the universe of discourse. **Second,** the properties of the objects must be defined. Then the universe `U' is partitioned into at least two mutually exclusive and exhaustive subsets, That is, each object must be assigned to one subset only and all objects must be so assigned.

After the objects of the universe have been classified into designated subsets, the member of the sets can be counted. When set members are counted in this fashion, all objects of a sub-set are considered to be equal to each other and unequal to the members of other sub-sets.

Example: Let U= All tenth grade pupils in a certain high school. Let the measurement characteristics be sex of the pupil. Then U is partitioned into two mutually sub-sets B and G where B is the subset of U which includes all males of U and G is the subset of U which includes all females of U so that U= B+ G

Postulates: There are three basic postulates of measurements. These postulates concern about the relationships between the objects being measured.

The postulates are:

(1) Either $x = y$ or $x \neq y$ but not both

(2) If $x=y$ and $y = z$, then $x= z$

(3) if $x > y$ and $y > z$, then $x>z$

It should be understood that when we say $x = y$, it is not necessary that x and y are same. It is meant to indicate that they are sufficiently the same to be classified as member of the same set if viewed with respect to some criterion.

In physical measurements, the postulate (3) is always true. But in case of behavior, it may not be so. For instance, if 'a' is longer than 'b' and 'b' is longer than 'c' then 'a' is definitely longer than 'c'. But suppose 'a' (Wife) dominates 'b' (Husband) and 'b' (Husband.) dominates 'c' (Child), it is not necessarily true that 'a' dominates 'c' instead 'c' may dominate 'a' (Mother). Thus the postulates should not be assumed to be true. It should be proved to be true.

Physical Scales: There are four types of physical scales. They are:

Nominal Scale

A nominal scale is one that allows the researcher to assign subjects to certain categories or groups. This is simplest and lowest form of data and it gives very basic information. This sale is usually used to obtain personal data, where grouping of individuals or objects is required.

EXAMPLE	Gender:	Male, Female
	Religion:	Hindu, Buddhist, Muslim, Christian
	Occupation:	Teacher, Manager, Doctor, Businessman, Civil servant
	Nationality:	Nepali, Indian, American, Japanese
	Department:	Sales, Finance, Personnel, Production

All categories are mutually exclusive. Every respondent has to fit into one of these categories. Therefore, one cannot rank these and say that a male is a higher value than a female, or that 3 teacher has a high value than a manager. Nominal data results from qualitative variables.

The information that can be generated from nominal scaling is to calculate the percentages and frequencies. For example, if you interviewed 150 students in a campus, and assigned a code number 1 to all male students and number 2 to all female students, then computer analysis of data might reveal that 100 were male and 50 were female students. This frequency distribution tells you that 66.6 percent of the respondents are male and 33.4 percent female. Nominal scale, thus, tells you nothing more than basic or gross information. Chi-square test is the most common test applicable to nominal data. Due to its limitations concerning statistical treatment, a nominal scale has the characteristic of exploratory research where the emphasis is on uncovering relationships rather than on specifying the form of relationship.

Ordinal Scale

A scale is ordinal when objects can be assigned order on some characteristic but they cannot be assigned values that represent degree of difference on that characteristic. An ordinal scale of

measurement, in addition to the function of classification, also allows cases to be ordered by degree according to measurements of the variable. This scale is usually used to rate the preferences of the respondents. It applies to data which can be ranked according to value but cannot be given a particular numerical value which actually is descriptive of the data. For example, one can rank drinks (coca-cola, tea, coffee, soda water, mineral water) in order of his or her preference from most preferred to least preferred. This means one likes coca-cola better than soda water or prefers coffee to mineral water.

EXAMPLE Rank the following occupations in terms of their social status.

Jobs.	**Rank of Social Status**
Manager	.....
Doctor	.....
Engineer	.....
Professor	.....
Lawyer	.....
Civil Servant	.....
Police Officer	.....

In this example, if the respondents give higher rank to doctors than engineers, we can say doctors have relatively higher social status than engineers. We cannot, however, conclude that the doctors have three times higher social status than the engineers.

EXAMPLE Rank the following cities in terms of their suitability to open a branch office of a commercial bank.

Cities	**Rank**
Biratnagar	.....
Hetauda	.....
Janakpur	.....
Butawal .	.....
Nepalgunj	.....
Dhangadi	.....

Ordinal scales represent numbers, letters, or any symbols used to rank items. The significant amount of business research relies on ordinal measures. The most common usage of ordinal scale is in obtaining preference measurements. For example, the employees of an organization maybe asked to rank their preferences for the newspapers they would like to read, or the games they would like to play. Ordinal scale thus provides more information than the nominal scale.

In ordinal data, median is an appropriate measure of central tendency. Percentile and quartile analysis are used for measuring dispersion. In most cases, rank-order correlations can be used Because of the nature of data; only non-parametric tests can be used.

Interval Scale

This scale assumes that the data have equal intervals. For example, there are five sisters who are all one year apart in age. Radha, Rambha, Reshma, and Rohini are 4, 3, 2 and 1 year older than the youngest sister Rabina. The important point is that we cannot say that the oldest sister Radha is twice as old as Reshma and four times older than Rohini. The reason is that we do not know what the age of the youngest sister, Rabina, is.

Interval scale is like ordinal but with constant intervals. The numbers tell both position and distance. Thus, the interval scale not only groups individuals according to certain categories and taps the order of these groups; it also measures the magnitude of the differences in the performances among the individuals. As such, it is more powerful scale than the nominal and ordinal scales.

	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
	1	*2*	*3*	*4*	*5*
I know exactly what tasks I am expected to do at all times.	1	2	3	4	5
Members of my team are fully cooperative.	1	2	3	4	5
My salary is regularly paid on time.	1	2	3	4	5
I am adequately trained for what I am doing.	1	2	3	4	5
Our norms of performance are quite realistic.	1	2	3	4	5
Our supervisor is very sympathetic.	1	2	3	4	5
I have the opportunity to work in a team environment.	1	2	3	4	5

Interval scales, or any other attempts at creating such scales, are found often in behavioral research. This is particularly true for measurement of attitudes and certain psychological characteristics, such as intelligence and learning. In analyzing interval data, many options are available. Mean can be appropriately used to measure central tendency. Standard deviation is

widely used for dispersion. Product moment correlation can be calculated, and t-test and F•test can be used for significance testing.

Ratio Scale

The ratio scale is the most powerful of the four scales because it has an absolute zero origin and subsumes all the properties of the other three scales. This allows the researcher to calculate the ratio of difference between the age of the individuals. For instance, one can say that the boy who is 8 years old is twice as old as the boy who is 4 years old. Also, we can say that a man who worked 40 hours, worked twice as many hours as the man who worked 20 hours. Some examples of ratio scales are actual age, income, the number of organizations an individual has worked for. The responses could range from 0 to any figure.

EXAMPLE

How many children do you have? .....

What is your annual household income? .....

How many workers are working in your factory? .....

How many workers are the members of the union? .....

What is the highest level of education you have completed? .....

How long have you lived in Kathmandu? .....

Ratio scales are found more commonly in the physical sciences than in the social sciences. Measurement of weight, length, time intervals, area, velocity, etc., all conform to ratio scales. In social sciences, we do find properties of concern that can be ratio scaled: money, age, years of education, etc. However, successful ratio scaling of behavioral attributes is rare. Various types of statistical analysis and mathematical operations can be done on ratio data. Geometric and harmonic means can be used. Likewise, coefficient of variation can be worked out.