# MEASUREMENT SCALING

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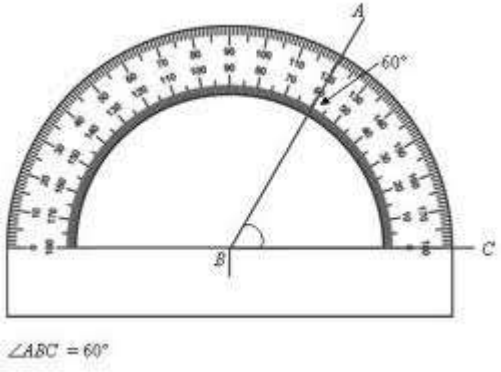
# MEASUREMENT AND SCALING


# Types of scale

Nominal Scale

Ordinal Scale

Interval Scale

Ratio Scale

# Nominal Scale

- Naming variable
- Red=1, Green =2,blue=3
- Categorical
- Cannot perform mathematical computations
- Mutually exclusive
- Other example:
- Gender : Male , Female
- Political Affiliation: Republican, democrat and independent.

# Ordinal

- Ordered attributes
- Likert scale (subjective)
- Eg. Unlikely=1,very likely=2 highly likely=3
- Cant not determine “exact difference ” between values.
- Can perform mathematical computations.
- Other example:
- 1=good,2=very good, 3=excellent,4=superior
- 1=never, 2=sometime, 3=always

# Interval

- Ordinal ranking
- Added attributes of equal spacing
- Eg. Temperature in fahrenheit
- 40degree is more than 20degree
- 60degree is more than 40 degrees.
- Difference between both the example is of 20degrees.
- No true zero value
- Zero degree does not mean there is no temperature
- It means it is extremely cold.

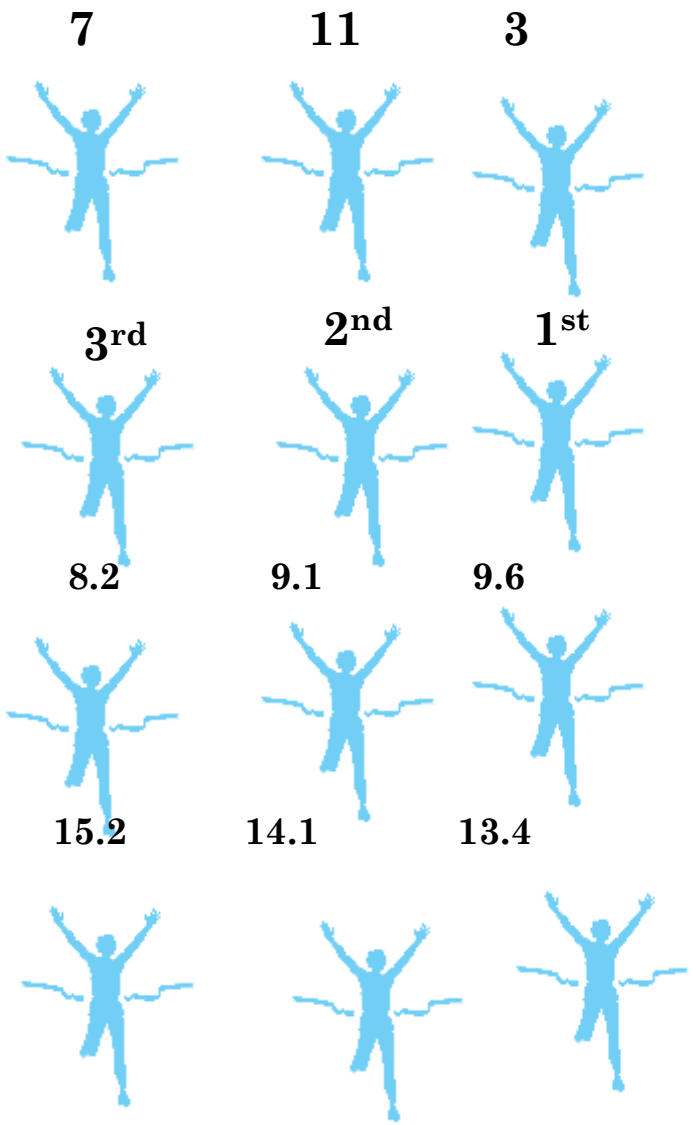
# Ratio

- Ordinal ranking
- Equal spacing
- Added attribute of true zero value
- Eg. Annual income
- Allows  for most in depth statistical  analysis

- Ratio: absolute Zero
- Interval : distance is meaningful
- Ordinal: attribute of rank order
- Nominal : Attributes are only names.

# PRIMARY SCALE

| | |
|---|---|
| NOMINAL | Number Assigned to Runners |
| ORDINAL | Rank Order of Winners |
| INTERVAL | Performance Rating on a 0 to 10 Scale |
| RATIO | Time to Finish in Seconds |



| Scale | Basic characteristics | Common examples | Marketing example | Permissible statistics | |
|---|---|---|---|---|---|
| | | | | Descriptive | Inferential |
| Nominal | Numbers identify and classify objects | Student registration numbers, numbers on football players' shirts | Gender classification, bank types | Percentages, mode | Chi-square, binomial test |
| Ordinal | Numbers indicate the relative positions of the objects but not the magnitude of differences between them | Rankings of the top 4 teams in the football World Cup | Ranking of service quality delivered by a number of banks. Rank order of favourite television programmes | Percentile, median | Rank-order correlation, Friedman ANOVA |
| Interval | Differences between objects can be compared; zero point is arbitrary | Temperature (Fahrenheit, Celsius) | Attitudes, opinions, index numbers | Range, mean, standard deviation | Product-moment correlations, t-tests, ANOVA, regression, factor analysis |
| Ratio | Zero point is fixed; ratios of scale values can be computed | Length, weight | Age, income, costs, sales, market shares | Geometric mean, harmonic mean | Coefficient of variation |

# Types of Measurement Scale

**Nominal scale:** This is the lowest level of measurement. Here, numbers are assigned for the purpose of identification of the objects. Any object which is assigned a higher number is in no way superior to the one which is assigned a lower number.

**Example:**

• Are you married?

(a) Yes (b) No

- Married person may be assigned a no. 1.
- Unmarried person may be assigned a no. 2.

The assigned numbers cannot be added, subtracted, multiplied or divided. The only arithmetic operations that can be carried out are the count of each category. Therefore, a frequency distribution table can be prepared for the nominal scale variables and mode of the distribution can be worked out.

- **Ordinal scale: This is the next higher level of measurement. One of the limitations of the nominal scale measurements is that we cannot say whether the assigned number to an object is higher or lower than the one assigned to another option. The ordinal scale measurement takes care of this limitation. An ordinal scale measurement tells whether an object has more or less of characteristics than some other objects.**

**Example:**

**Rank the following attributes while choosing a restaurant for dinner. The most important attribute may be ranked one, the next important may be assigned a rank of 2 and so on.**

| Attribute | Rank |
|---|---|
| Food quality | 1 |
| Prices | 5 |
| Menu variety | 2 |
| Ambience | 3 |
| Service | 4 |

- In the ordinal scale, the assigned ranks cannot be added, multiplied, subtracted or divided. One can compute median, percentiles and quartiles of the distribution. The other major statistical analysis which can be carried out is the rank order correlation coefficient.

**Interval scale:** **The interval scale measurement is the next higher level of measurement.**

- **It takes care of the limitation of the ordinal scale measurement where the difference between the score on the ordinal scale does not have any meaningful interpretation.**
- **In the interval scale the difference of the score on the scale has meaningful interpretation.**
- Suppose we are given the following temperature readings (in degrees Fahrenheit):
- 58°, 63°, 70°, 95°, 110°, 126° and 135°.
- In this case, we can write 100° > 70° or 95° < 135° which simply means that 110° is warmer than 70° and that 95° is cooler than 135°.
- We can also write for example 95° – 70° = 135° – 110°, since equal temperature differences are equal in the sense that the same amount of heat is required to raise the temperature of an object from 70° to 95° or from 110° to 135°.

**Ratio scale: This is the highest level of measurement and takes care of the limitations of the interval scale measurement, where the ratio of the measurements on the scale does not have a meaningful interpretation.**

- In ratio scale, there is a natural zero (origin).

**Examples:**

☺**How many chemist shops are there in your locality?**

☺**How many students are there in the PHD programme at MAU?**

☺**With ratio scales involved one can make statements like "Jyoti's" typing performance is twice as good as that of "Reetu."**

**All mathematical and statistical operations can be carried out using the ratio scale data.**

# Practice Set-I

- **Indicate the type of Scale (Nominal, Ordinal, Interval or Ratio) that is being used in each of the following questions:**
- How large is the market size for shampoos?
- Ans. Ratio

# Practice Set-I

- **Indicate the type of Scale (Nominal, Ordinal, Interval or Ratio) that is being used in each of the following questions:**
- In which of the following areas of Management do you wish to specialize in the second year:

i) Marketing
ii) Finance
iii) HR
iv) IT

- Ans. Nominal

# Practice -I

- **Indicate the type of Scale (Nominal, Ordinal, Interval or Ratio) that is being used in each of the following questions:**

c) State the order of your preference for the following colours:

   i) Grey
   ii) White
   iii) Blue
   iv) Green
   v) Black

- Ans. Ordinal

# Practice -I

- **Indicate the type of Scale (Nominal, Ordinal, Interval or Ratio) that is being used in each of the following questions:**
- Was the Research Methodology difficult to understand:

  Yes..... No.....

Ans. Nominal

# Practice -I

- **Indicate the type of Scale (Nominal, Ordinal, Interval or Ratio) that is being used in each of the following questions:**

How do you rate the quality of food at the Golden Dragon Restaurant?

1= Very Poor

2= Poor

3= Neither good nor Poor

4= Good

5= Very Good

**Ans. Interval**

# Test of Sound measurement

- Test of Sound measurement must meet the tests of validity, reliability and practicality. In fact, these are the three major considerations one should use in evaluating a measurement tool. “Validity refers to the extent to which a test measures what we actually wish to measure. Reliability has to do with the accuracy and precision of a measurement procedure ... Practicality is concerned with a wide range of factors of economy, convenience, and interpretability ...” We briefly take up the relevant details concerning these tests of sound measurement.

# Test of Validity*

- Validity is the most critical criterion and indicates the degree to which an instrument measures what it is supposed to measure. Validity can also be thought of as utility. In other words, validity is the extent to which differences found with a measuring instrument reflect true differences among those being tested. But the question arises: how can one determine validity without direct confirming knowledge? The answer may be that we seek other relevant evidence that confirms the answers we have found with our measuring tool. What is relevant, evidence often depends upon the nature of the research problem and the judgement of the researcher.
- There are three types of validity in this connection:
- Content validity
- Criterion-related validity
- Construct validity.

# Cont....

- Content validity is the extent to which a measuring instrument provides adequate coverage of the topic under study. If the instrument contains a representative sample of the universe, the content validity is good. Its determination is primarily judgemental and intuitive. It can also be determined by using a panel of persons who shall judge how well the measuring instrument meets the standards, but there is no numerical way to express it.
  Criterion-related validity relates to our ability to predict some outcome or estimate the existence of some current condition. This form of validity reflects the success of measures used for some empirical estimating purpose.
- The concerned criterion must possess the following qualities:
- Relevance: (A criterion is relevant if it is defined in terms we judge to be the proper measure.)
  Freedom from bias: (Freedom from bias is attained when the criterion gives each subject an equal opportunity to score well.)
  Reliability: (A reliable criterion is stable or reproducible.)
  Availability: (The information specified by the criterion must be available.)

# Test of Reliability

- The test of reliability is another important test of sound measurement. A measuring instrument is reliable if it provides consistent results. Reliable measuring instrument does contribute to validity, but a reliable instrument need not be a valid instrument. For instance, a scale that consistently overweighs objects by five kgs., is a reliable scale, but it does not give a valid measure of weight. But the other way is not true i.e., a valid instrument is always reliable. Accordingly reliability is not as valuable as validity, but it is easier to assess reliability in comparison to validity. If the quality of reliability is satisfied by an instrument, then while using it we can be confident that the transient and situational factors are not interfering.

# Cont...

- Two aspects of reliability viz., stability and equivalence deserve special mention. The stability aspect is concerned with securing consistent results with repeated measurements of the same person and with the same instrument. We usually determine the degree of stability by comparing the results of repeated measurements. The equivalence aspect considers how much error may get introduced by different investigators or different samples of the items being studied. A good way to test for the equivalence of measurements by two investigators is to compare their observations of the same events. Reliability can be improved in the following two ways:
  - By standardising the conditions under which the measurement takes place i.e., we must ensure that external sources of variation such as boredom, fatigue, etc., are minimised to the extent possible. That will improve stability aspect.
  - By carefully designed directions for measurement with no variation from group to group, by using trained and motivated persons to conduct the research and also by broadening the sample of items used. This will improve equivalence aspect.

# Test of Practicality

The practicality characteristic of a measuring instrument can be judged in terms of economy, convenience and interpretability. From the operational point of view, the measuring instrument ought to be practical i.e., it should be economical, convenient and interpretable. Economy consideration suggests that some trade-off is needed between the ideal research project and that which the budget can afford. The length of measuring instrument is an important area where economic pressures are quickly felt. Although more items give greater reliability as stated earlier, but in the interest of limiting the interview or observation time, we have to take only few items for our study purpose. Similarly, data-collection methods to be used are also dependent at times upon economic factors. Convenience test suggests that the measuring instrument should be easy to administer. For this purpose one should give due attention to the proper layout of the measuring instrument. For instance, a questionnaire, with clear instructions (illustrated by examples), is certainly more effective and easier to complete than one which lacks these features. Interpretability consideration is specially important when persons other than the designers of the test are to interpret the results. The measuring instrument, in order to be interpretable, must be supplemented by (a) detailed instructions for administering the test; (b) scoring keys; (c) evidence about the reliability and (d) guides for using the test and for interpreting results.

# Scaling

- **Scaling** is the procedure of measuring and assigning the objects to the numbers according to the specified rules. In other words, the process of locating the measured objects on the continuum, a continuous sequence of numbers to which the objects are assigned is called as scaling.

# Scale classification

- **(i) Subject orientation:**
- Under it a scale may be designed to measure characteristics of the respondent who completes it or to judge the stimulus object which is presented to the respondent.
- In respect of the farmer, we presume that the stimuli-presented are sufficiently homogeneous so that the between stimuli variation small compared to the variation among respondents.
- In the latter approach, we ask the respondent to judge some specific object in terms of one or more dimensions and we presume that the between respondent variation will be small as compared to the variation among the different stimuli presented to the respondents for judging.

# Cont....

- **(ii) Response form:**
- Under this we may classify the scales as categorical and comparative.
- Categorical scales are also known as rating scales.
- These scales are used when respondent scores some object without direct reference to other objects.
- Under the comparative scales, which are also known as ranking scales, the respondent is asked to compare two or more objects.
- In this sense the respondent may state that one object is superior to the other. The essence of ranking is in fact, a relative comparison of a certain property of two or more objects.

# Cont...

- **(iii) Degree of subjectivity:**
- With this basis the scale data may be based on whether we measure subjective personal preferences or simply make non-preference judgements.
- **(iv) Scale properties:**
- Considering scale properties, one may classify the scales as nominal, ordinal, interval and ratio scales.
- Nominal scales merely classify without indicating order, distance or unique origin, ordinal scales indicate magnitude relationship of 'more than' or 'less than', but indicate no distance or unique origin. Interval scales have both order and distance values, no unique origin. Ratio scales posses all these features.

# Cont...

- **(v) Number of dimensions:**
- In respect of this basis, scales can be classified as 'uni-dimensional' and 'multidimensional' scales under the former we measure only one attribute of the respondent or object; whereas multi dimensional scaling recognises the can object might be described better by using the concept of an attribute space of 'n' dimensions.

# Scale construction techniques

- Arbitrary approach (Arbitrary scale)
- Consensus approach (differential scale :Thurstone differential scale )
- Item analysis approach (summated scale : Likert scale)
- Cumulative scale approach (Cumulative scale :Guttman's Scalogram)
- Factor analysis approach (Factor Scale : Osgood's Semantic differential, Multidimensional Scaling etc)

# (vi) Scale of construction techniques:

- **(i) Arbitrary Approach:**
- It is an approach where scale is developed on 'ad-hoc' basis.
- It is the most widely used approach.
- It is presumed that such scales measure the concepts for which they have been designed, although there is little evidence to support such an assumption.
- **(ii) Consensus Approach:**
- Here a panel of judges evaluates the items chosen for inclusion in the instrument in terms of whether they are relevant to the topic area and unambiguous in approach.

# Cont...

- **(iii) Item Analysis Approach:**
- Under it a number of individual items are developed into a test which is given to a group of respondent.
- After administering the test, the total scores are calculated for every one.
- Individual items are then analysed to determine which items discriminates between persons or objects with high total scores and those with low scores.
- **(iv) Cumulative Scales:**
- Cumulative scales are chosen on the basis of their conforming to some ranking of items with ascending and descending discriminating power.
- **(v) Factor Scales:**
- Factor scales may be constructed on the basis of items which indicate that a common factor accounts for the relationship between items.
- Thus relationship is typically measured through factor analysis method.