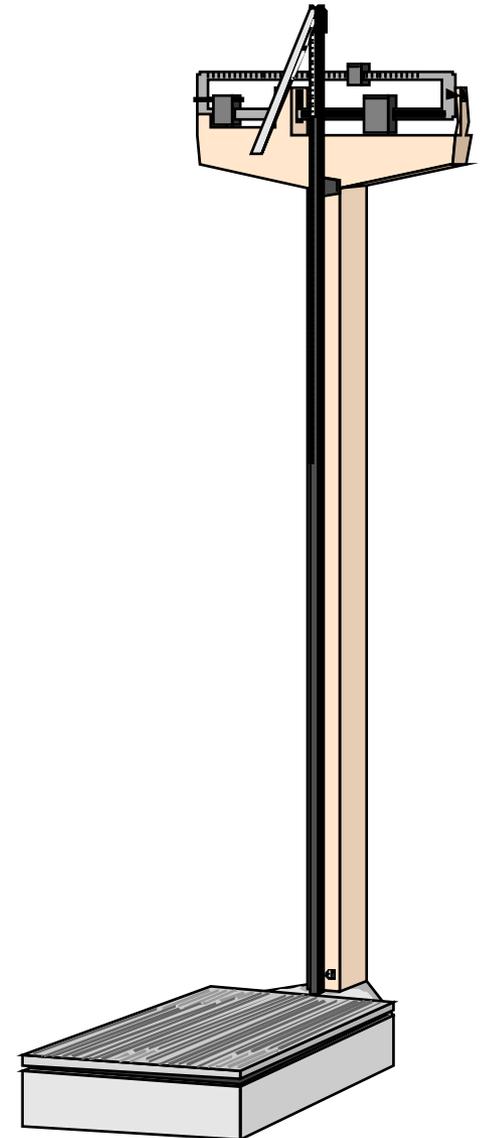


Measurement Scaling and Sampling

Bijay Lal Pradhan

Measurement and Scaling

- 1) Definition of measurement and scale
- 2) Type of Physical scale
 - i. Nominal Scale
 - ii. Ordinal Scale
 - iii. Interval scale
 - iv. Ratio Scale
- 3) Need of scaling
- 4) Criteria of good scaling
- 5) Validity and Reliability of scale and its test
- 6) Percentile and ranking scale



Measurement and Scaling

Measurement means assigning numbers or other symbols to characteristics of objects according to certain prespecified rules.

- One-to-one correspondence between the numbers and the characteristics being measured.
- The rules for assigning numbers should be standardized and applied uniformly.
- Rules must not change over objects or time.

Measurement and Scaling

Scaling involves creating a continuum upon which measured objects are located.

Consider an attitude scale from 1 to 100. Each respondent is assigned a number from 1 to 100, with 1 = Extremely Unfavorable, and 100 = Extremely Favorable. Measurement is the actual assignment of a number from 1 to 100 to each respondent. Scaling is the process of placing the respondents on a continuum with respect to their attitude toward department stores.

Types of Scales

- Nominal - Identification only
 - Ex (players numbers, male=1 female=0)
- Ordinal -Ranking
 - Ex (grades?) SEI score
- Interval –Ranks and distinguishes intervals
 - Ex (temperature)
- Ratio – absolute quantities
 - Ex (weight, degrees Kelvin)

Physical Measurement

Scale
Nominal

Numbers
Assigned
to Runners



Finish

Ordinal

Rank Order
of Winners



Interval

Performance
Rating on a
0 to 10 Scale

8.2 9.1 9.6

Ratio

Time to Finish, in
Seconds

15.2 14.1 13.4

Nominal Scale

- The numbers serve only as labels or tags for identifying and classifying objects.
- When used for identification, there is a strict one-to-one correspondence between the numbers and the objects.
- The numbers do not reflect the amount of the characteristic possessed by the objects.
- The only permissible operation on the numbers in a nominal scale is counting.
- Only a limited number of statistics, all of which are based on frequency counts, are permissible, e.g., percentages, and mode.

Ordinal Scale

- A ranking scale in which numbers are assigned to objects to indicate the relative extent to which the objects possess some characteristic.
- Can determine whether an object has more or less of a characteristic than some other object, but not how much more or less.
- Any series of numbers can be assigned that preserves the ordered relationships between the objects.
- In addition to the counting operation allowable for nominal scale data, ordinal scales permit the use of statistics based on centiles, e.g., percentile, quartile, median.

Interval Scale

- Numerically equal distances on the scale represent equal values in the characteristic being measured.
- It permits comparison of the differences between objects.
- The location of the zero point is not fixed. Both the zero point and the units of measurement are arbitrary.
- Any positive linear transformation of the form $y = a + bx$ will preserve the properties of the scale.
- It is meaningful to take ratios of scale values.
- Statistical techniques that may be used include all of those that can be applied to nominal and ordinal data, and in addition the arithmetic mean, standard deviation, and other statistics commonly used.

Ratio Scale

- Possesses all the properties of the nominal, ordinal, and interval scales.
- It has an absolute zero point.
- It is meaningful to compute ratios of scale values.
- Only proportionate transformations of the form $y = bx$, where b is a positive constant, are allowed.
- All statistical techniques can be applied to ratio data.

Primary Scales of Measurement

Scale	Basic Characteristics	Examples	Examples	<u>Permissible Statistics</u>	
				Descriptive	Inferential
Nominal	Numbers identify & classify objects	Social Security nos., numbering of football players	Brand nos., store types	Percentages, mode	Chi-square, binomial test
Ordinal	Nos. indicate the relative positions of objects but not the magnitude of differences between them	Quality rankings, rankings of teams in a tournament	Preference rankings, market position, social class	Percentile, median	Rank-order correlation, Friedman ANOVA
Interval	Differences between objects	Temperature (Fahrenheit)	Attitudes, opinions, index	Range, mean, standard	Product-moment
Ratio	Zero point is fixed, ratios of scale values can be compared	Length, weight	Age, sales, income, costs	Geometric mean, harmonic mean	Coefficient of variation

Criteria of good measurement

- ❑ **Reliability:** Since a grocer obtain the true measure of a commodity by a kilogram, a cloth merchant obtains true length of cloth by a meter, these measuring instruments have to be reliable. Kilogram and meter always give the same result when they used for measuring commodity. In research also the measure has to be reliable.

RELIABILITY

- **The degree to which measures are free from random error and therefore yield consistent results**
- **Stability and consistency with which the instrument measures the concept and helps to assess the goodness of a measure.**
- **Maintains stability over time in the measurement of a concept.**

a. Stability of Measures

- **Ability of the measure to remain the same over time.**
- **It attests to the “goodness” of measure because the measure of the concept is stable, no matter when it is applied.**
- **Two tests of stability: (1) test-retest reliability, and (2) parallel-form reliability**

1. Test-Retest Reliability:

- **Administering the same test to the same respondents at two separate times**
- **Use instrument for measuring job satisfaction at Satisfied 64%. Repeat after 4 weeks. Same results. Hi stability.**
- **Reliability coefficient obtained with repetition of the same measure on second occasion. Correlation between two scores.**

Three problems with test-retest

It is a longitudinal approach. So:

- 1. The first test may sensitize the respondents so effect on second measure**
- 2. Time may help change the attitude. Also maturation of the subjects.**
- 3. The respondent may think a fresh on the questions and give true and accurate answer.**

Hence the results may not show high correlation.

2. Parallel-Form Reliability

- **Also called equivalent-form reliability.**
- **When responses on two comparable sets of measures tapping the same construct are highly correlated.**
- **Both forms/sets have similar items, same response format. Change the wording/ordering.**
- **Minimum error variance caused by wording, ordering, or other factors**
- **Parallel form reliability → correlation between two form of an instrument.**

b. Internal Consistency of Measures

- **Indicative of the homogeneity of the items in the measure.**
- **Items should 'hang together as a set,'**
- **Each item be capable of independently measuring the same concept.**
- **Examine if the items and subsets of items in the instrument are highly correlated.**
- **Two ways to do it.**

1. Inter-item Consistency Reliability (Rational Equivalence Method)

- Test of consistency of respondents' answers to all items in a measure.**
- To the degree that items are independent measures of the same concept, they will be correlated.**

2. Split-Half Reliability

- Reflects the correlation between two halves of an instrument.**
- One half could be of even numbered items and other half of odd numbered items.**
- High correlation tells us about similarity among items**

Validity

- ❑ The ability of an instrument to measure what is intended to be measured.**
- ❑ Validity of the indicator → Is it a true measure? Are we tapping the concept?**
- ❑ Degree of fit between a construct and its indicators.**

Researchers ask questions:

- Do colleagues agree with my measurement?
- Does my measure correlate with others' measures of the same concept?
- Does it really measure what is expected to measure?

The answers provide some evidence of the measure's validity.

Validity

- If you wish to find out about age, income, height or weight**
- The effectiveness of a program, service provided by organization**
- Tangible concept like effectiveness, attitude or satisfaction etc**
- Need to ask several questions in order to cover different aspect of concept**

Types of Validity

- **1. Content validity**
- **2. Criterion-related validity**
- **3. Construct validity**

1. Content Validity:

- Each question or item on the scale must have a logical link with an objective
- *Each item and question must cover the full range of the issue or attitude being measured.*

Content Validity

- **Items that are supposed to measure a concept, do on the face look like they measure the concept.
For example:**
- **Measure a college student's math ability → ask: $2+2=?$ Not a valid measure of college level math ability.**
- **Subjective agreement among professionals about the measuring content.**

Content Validity

Problems:

- ❑ **The judgment is based upon subjective logic, hence, no definite conclusion can be drawn. Different people may have different opinion.**
- ❑ **The validity or its extent may vary with the questions selected for an instrument.**

2. Criterion-Related Validity

- Uses some standard or criterion to indicate a construct accurately.**
- Compare the measure with another accepted measure of the same construct.**

3. Construct Validity

- Used for measures with multiple indicators.
- Do various indicators operate in consistent manner?
- How well the results obtained from the use of the measure fit the theories around which the test is designed? This is assessed through (a) *convergent* and (b) *discriminant* validity.

a. Convergent Validity

- **Multiple indicators of a concept converge or are associated with one another.**
- **Multiple indicators hang together, or operate in similar ways. For example, we measure “education” as a construct.**

Construct “education”

- **Ask the level of education completed.**
- **Verify the certificates.**
- **Give a test measuring school level knowledge.**
- **If the measures do not converge i.e. People claiming college degree but not supported by college records, or those with college degree perform no better than hi school drop-out on the test.**
- **The outcome of each does not converge. Weak convergent validity. Do not combine the three indicators into one measure.**

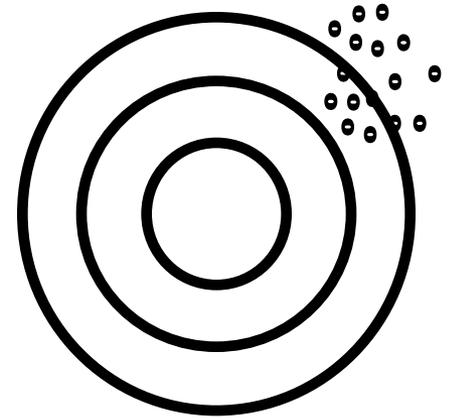
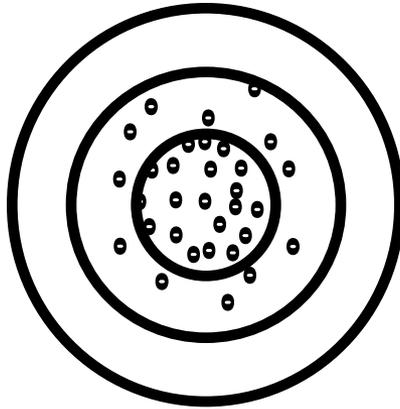
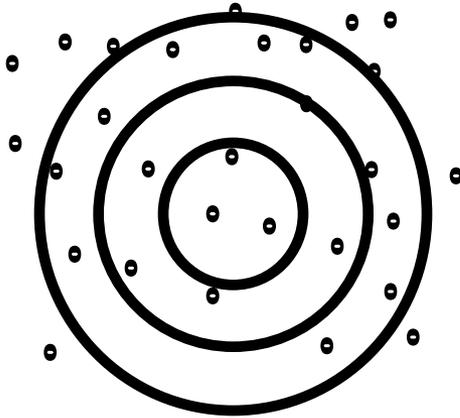
b. Discriminant Validity

- **Divergent validity.**
- **Indicators of one concept hang together or converge, but also diverge or are negatively associated with opposing constructs.**
- **If two constructs A and B are very different then measures of A and B should not be associated.**
- **Example of *political conservatism*.**

Measuring political conservatism

- **We have 10 questions to measure P C.**
- **People answer all 10 in similar ways.**
- **We put 5 additional questions that measure liberalism.**
- **Two scores are theoretically predicted to be different and are empirically found to be so.**
- **If the 10 conservatism items hang together and are negatively associated with 5 liberalism ones.**
- **It has discriminant validity**

Reliability and Validity on Target



Difficulties of Scaling

- 1. Social phenomenon is complex and cannot easily measured quantitatively. The main problem is comes in defining a phenomenon.**
- 2. There are no universally accepted measures of values.**
- 3. Since attitude of persons often differ, A scale prepared for a particular group is not often suitable for another.**

Difficulties of Scaling

- 4. Most of the social phenomenon is intangible in nature which cause difficulty in measuring validity of the scale.**
- 5. It is not possible to measure the magnitude of various variables influencing the social phenomenon without the knowledge of these causative factors, the scaling becomes only a guesswork.**

Measuring attitude (example)

- Attitude of student towards a Lecturer
 - Organization of materials
 - Lecturer's ability to communicate material
 - The presentation style
 - Knowledge of the subject
 - Responsiveness
 - Punctuality

Difficulties in Attitudinal Scale

- Which aspects of a situation or issue should be included when seeking to measure an attitude?
- What procedure should be adopted for combining the different aspects to obtain an overall picture?
- How can one ensure that a scale really is measuring what it is supposed to measure?

Likert Scale

- Self- report technique for attitude measurement in which the subjects are asked their degree of agreement and disagreement with each of statements.
- The summing score is the total attitude score, is the Likert scale.
- Example
 - **Most people can be trusted.**
 - **Strongly agree5_ Agree4_ Undecided3_ Disagree2_ Strongly disagree1**
- Any body select 1 to 5

Likert Scale

- Take other similar items- to find out general attitude of indication
- Add the total score- the top 25% - the most favourable attitude and bottom 25%- the least favourable attitude toward the topic being studied;
- Assumption – Each statement on the scale has equal attitudinal value, importance

Likert Scale example

The Lecturer	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. Knows subject well					
2. Is unenthusiastic about teaching					
3. Shows concern for students					
4. Makes unreasonable demands					
5. Has poor communication skills					
6. Knows how to teach					
7. Can explain difficult concepts in simple terms					
8. Is hard to approach					
9. Is liked by some students and not by others					
10. It is difficult to get along with					

Procedure

- Assemble or construct statements that are reflective of attitude towards the main issue in question. Statements should be worded to reflect both positive and negative attitudes towards issue. The statements must have logical link with the main issue.
- Administer the statements to a small group of people.
- Analyse the responses by assigning a weighting – a numerical value – to the responses. Numerical value are assigned differently to positive and negative statements.
- Calculate each respondent's attitudinal score by adding numerical values assigned in step 3 to the responses s/he gave to each statement.

Procedure (cont.)

- Compare all respondents' score for each item to identify non-discriminative items. Non discriminative statements do not help to distinguish respondents with respect to attitude as almost everyone responds to them in the same way.
- Eliminate non discriminative items.
- Construct a questionnaire schedule comprising the selected statements/items.

Calculating Likert Scale

The Lecturer	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. Knows subject well +	⊕				⊖
2. Is unenthusiastic about teaching -		⊖			⊕
3. Shows concern for students +			⊕		⊖
4. Makes unreasonable demands -		⊖			⊕
5. Has poor communication skills -		⊖			⊕
6. Knows how to teach +		⊕		⊖	
7. Can explain difficult concepts in simple terms +	⊕	⊖			
8. Is hard to approach -			⊕ ⊖		
9. Is liked by some students and not by others +				⊕ ⊖	
10. It is difficult to get along with -			⊖		⊕

Likert

- Statement 1 2 3 4 5 6 7 8 9 10
- Respondent Θ 5 + 5 + 3 + 5 + 5 + 4 + 5 + 3 + 2 + 5 = 42
- Respondent ϕ 1 + 2 + 1 + 2 + 2 + 2 + 4 + 3 + 2 + 3 = 20
- The analysis shows that overall respondent Θ has a more positive attitude towards the lecturer than respondent ϕ .

Thurstone scale

- The thurstone scale calculates a **weight** or **attitudinal value** for each statements.
- The **weight** (equivalent to median value) for each statement is calculated on the basis of rating assigned by a group of **judges**.
- Indicating **agreement** or **disagreement**
- Some items are given **higher value** than other items.

Thurstone Scale

- Assemble or construct statements reflective of attitudes towards the issue in question
- Select a panel of judges who are experts in the field of attitudes being explored.
- Send the statements to these judges with a request to rate each statements importance in reflecting an attitude towards the issue being studied. Ask them to rate each statement on an 11-point scale.
- On the basis of the judges' rating, calculate the median value of their rating for each item.
- If the judges' rating of any item are scattered over the scale, this indicates that even among the experts there is no agreement as to the degree to which that statement reflects an attitude towards the issue in question. Discard such statement.
- From the remaining statement select items that best reflect attitudes towards various aspect of the issue.
- Construct a questionnaire comprising the selected items.

Thurstone scale

Example,

- My job is like a hobby to me. (10.1)
- I am satisfied with my job for the time being. (7.2)
- I am often bored with my job. (3.2)
- Most of the time I have to force myself to get to work. (1.1)

Guttman scale

- Also known as Cumulative scaling or scalogram analysis
- Unlike other two scale it tend to cumulative that is if a person can not answer last items than he or she probably was not able to answer any of the items
- It is most difficult to construct and therefore is rarely used but is relatively easy to administer.

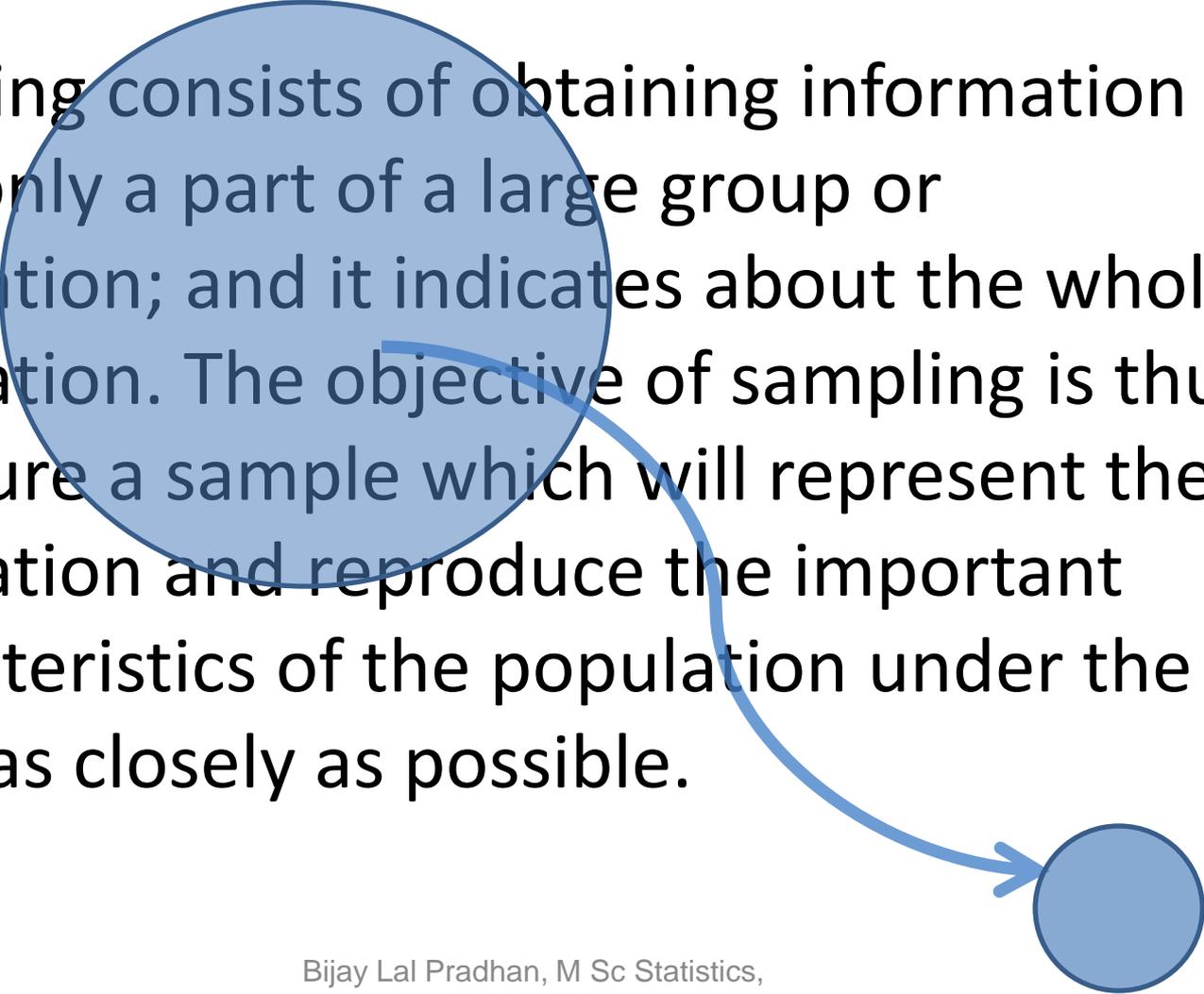
Example

- A) $28 \div 7 = ?$
- B) $8 \times 4 = ?$
- C) $12 + 9 = ?$

Chapter 6 : Sampling

- 1) Its needs, steps, population, sampling units, Sampling frame/list
- 2) Types of sampling (Random Sampling(RS))
 - i. Simple RS
 - ii. Stratified RS
 - iii. Systematic RS
 - iv. Cluster RS
 - v. Multistage RS
- 3) Types of sampling (Non Random Sampling)
 - i. Judgmental
 - ii. Convenient
 - iii. Quota
 - iv. Snowball
- 4) Size of sample, Factors affecting size and method of estimating size, testing reliability of estimation of size

Sampling and its significance in research

- Sampling consists of obtaining information from only a part of a large group or population; and it indicates about the whole population. The objective of sampling is thus to secure a sample which will represent the population and reproduce the important characteristics of the population under the study as closely as possible.
- 

- The value calculated from a defined population, such mean (μ), standard deviation (σ), standard error of mean (s.e.) is called a parameter. It is a constant value because it covers all the members of the population. A value calculated from a sample is called statistic such as mean (\bar{x}). Standard deviation (s) and proportion (P).

Census Vs sampling ??

- The data is the basic units in statistical analysis and inference; is either collected by experimentation or by sampling methods. Method of collection of statistical data by complete enumeration of the population is **census**. If the data collected by a certain group or part of population is called **sampling** enquiry. The principal **advantages** of sampling as compared to complete enumeration of the population are:
 - Reduced cost
 - Save time and speed up
 - Greater scope and improved accuracy

Some terminology used in sampling

a. **Universe/Population:**

It is the set of object under study. In a census survey, all the universe or population is studied while in a sample survey an appropriate number of units called samples is selected and studied; the generalization is made for the universe or population from which the samples are drawn.

b. **Finite population:**

The number of items or the units under the study is known.

c. **Infinite population:**

The number of units of the items is unknown.

d. **Element:**

Each and every unit of population or universe is called element. An element constitutes one case for analysis.

Some terminology used in sampling

e. Sampling unit:

The smallest unit of population to be sampled is called sampling unit and on which observations can be made.

f. Sample and sample size:

An element or sampling unit from which information is collected is called a sample. A sample should be optimum, effective, representative, reliable and flexible. The term sample size refers to the number of items to be selected from the universe to constitute a sample. This is the number of respondents or units in the population included in a sample for studying the population.

g. Sampling Frame or source list

A list of all the units of population from which a sample is selected is called sampling frame.

Some terminology used in sampling

h. Parameter

A coefficient or value for the population that corresponds to particular statistic from a sample is called parameter. A parameter is characteristic of population. For instance, mean, standard deviation, etc.

i. Statistic

It is characteristics of a sample and is hence computed from the actual data.

j. Respondent

A sampling unit from which information is collected is called respondent.

k. Non- respondent

Those respondents who were included in the sample but failed to respond because they refused, could not reach, or some other responses.

Types of Sampling

- Random sampling

1. Simple random sampling

- a. Lottery method

- b. Use of random number

2. Stratified sampling

3. Cluster sampling

4. Systematic sampling

5. Multistage sampling

- Non Random sampling

1. Judgmental sampling

2. Convenient sampling

3. Quota sampling

4. Snow ball sampling

5. Purposive sampling

Calculating the minimum sample size

- Based on
- How confident you need to be that the estimate is accurate (the level of confidence in the estimate);
- How accurate the estimate need to be (the margin of error that can be tolerated);
- The proportion of responses you expect to have some particular attribute.

- The formula is:

$$n = pq \left[\frac{z}{e} \right]^2$$

$$n = \left[\frac{z \sigma}{e} \right]^2$$

- If population is less than 1000 then

$$n' = \frac{n}{1 + \left[\frac{n}{N} \right]}$$

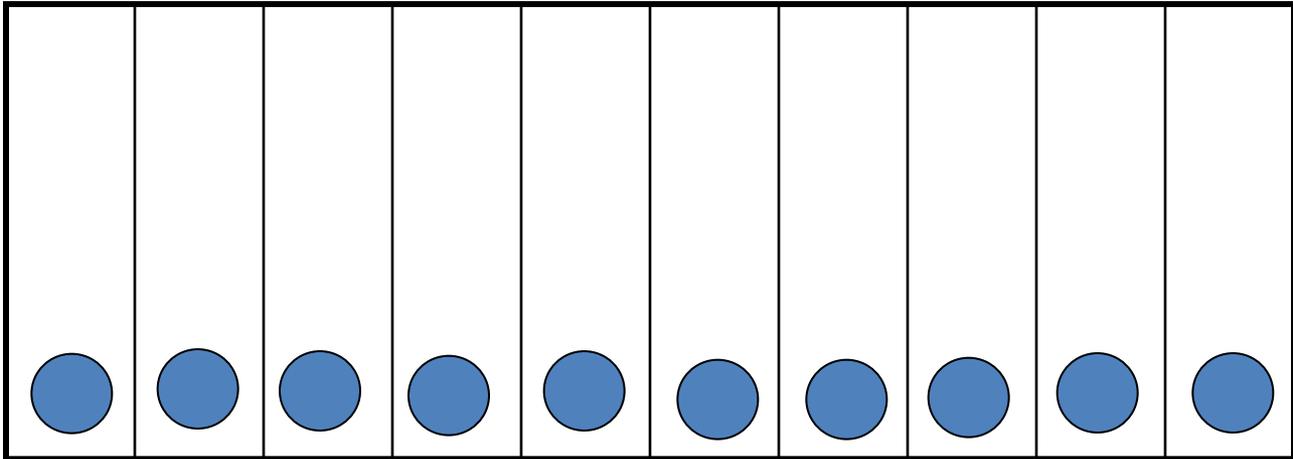
SIMPLE RANDOM SAMPLING

Lottery Method Use of Random Numbers

If the population is heterogeneous then srs may not give representative data

Stratified Random Sampling

Each class is said to be strata

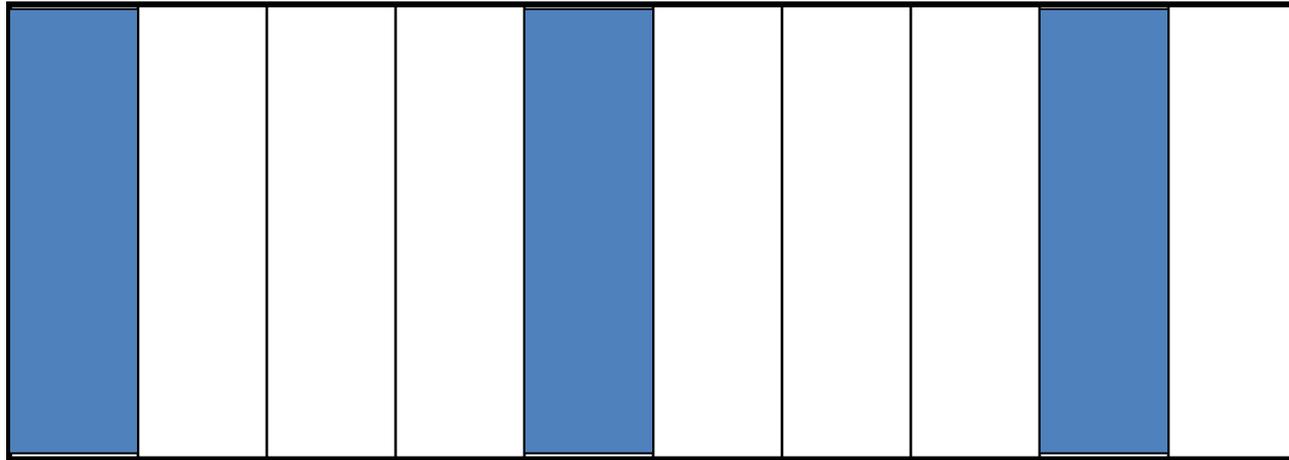


within class homogeneous; between class heterogeneous

If the population is heterogeneous then srs may not give representative data

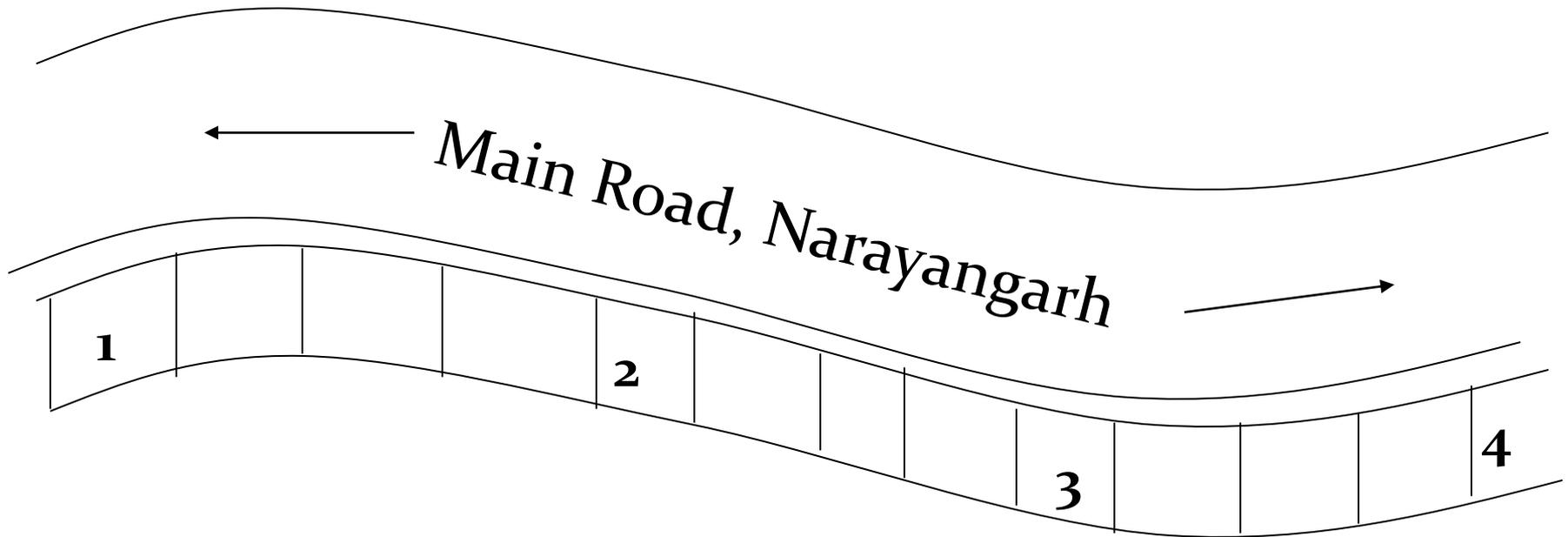
Cluster sampling

Each class is said to be cluster



within class heterogeneous; between class homogeneous

Systematic Sampling



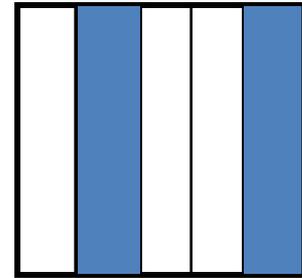
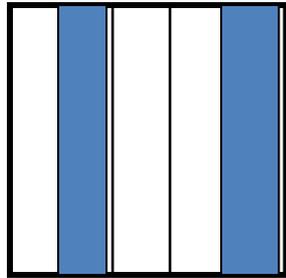
Sampling of households

A study of attitude of Nepalese people towards the Family Planning

5 developmental Region of Nepal

1st	2 nd	3 rd	4 th	5 th
-----	-----------------	-----------------	-----------------	-----------------

Development Region



**Different
Anchal**

- **Similarly**
- **Some districts can be taken as sample from the selected anchal**
- **Likewise VDC, Municipality ward number and house no can be taken as sample**
- **In this way there is**
- **Nepal**
- **Development region**
- **zone**
- **District**
- **VDC Municipality**
- **Ward no**

Non random sampling

Judgmental sampling: choice of sample items depends exclusively on the judgment of the investigator

Convenience sampling: A sample obtained from readily available lists

Quota sampling: In quotas are setup according to some specified characteristics and sample will be taken according to specified quota. Sampling will be depend upon the field representative

Snow ball method

Assumption of this method is that “ if small ball is let roll from the top of snow-peak, it gathers substantial amount of snow and looks like a big ball when it arrives at the bottom of snow hill.

Sampling errors

It is the error of representativeness

It is the difference between total population value and the sampling value

The degree to which sample characteristics approximate the characteristics of total population.

Sapling error = Statistics – Parameter