1. Introduction

Welcome to the series of E-learning modules on Parameter. In this module we are going to cover the basic concept and definitions of parameter, role of parameters in sampling, various types of parameters, vital parameters which explains the population, Parameters in experimental population.

By the end of this session, you will be able to:

- Explain about Population parameters
- Explain the role of parameters in sampling
- Describe various types of parameters
- List some important parameters which explains the population
- Explain Parameters in Experimental population

What is a parameter?
Parameter is a quantity or statistical measure that a given population is used as the value of a variable in some general distribution or frequency function to make it **descriptive** of that population.
Parameter is a function of the population observations and characteristic of the population.

Role of parameters in sampling theory
A sampling theory is a study of relationships existing between a population and a sample drawn from the population.

The population is a complete group of items about which knowledge is sought. The main problem of sampling theory is the problem of relationship between a parameter and a statistic.

The theory of sampling is concerned with estimating the properties of the population from those of the sample and also with gauging the precision of the estimate. This sort of movement from the particular towards general is known as statistical Induction or Statistical Inference.

In order to be able to follow this inductive method we first follow deductive argument that is we imagine a population or universe (finite or infinite) and investigate the behaviour of the sample drawn from this universe applying the laws of probability. The methodology dealing with all this is known as sampling theory.

Sampling theory is designed to attain one or more of the following objectives:
1) Statistical Estimation: Sampling theory helps in estimating unknown population parameters from knowledge of statistical measures based on sample studies. The main objective of sampling theory is to obtain estimate of the parameter from statistics.
2) Statistical Hypothesis: The second objective of sampling theory is to enable us to decide whether to accept or reject hypothesis based on the parameters. The sampling theory helps in determining whether the observed differences between the actual value of the parameters and its estimated values are actually due to the chance or whether they are really significant.
3) Statistical Inference: Sampling theory helps in making generalization about the population

or universe from the studies based on samples drawn from it. It also helps in determining the accuracy of such generalization.

The ultimate goal of sampling theory is to understand the properties of the population which are explained by the statistical constants “Parameters”.

2. Distribution of Parent Population

Distribution of Parent population
When a parent population is in the form of a Normal population, the means of samples drawn from such a population are themselves i.e. Normally distributed. But when sampling is not from a Normal population the sample size “n” plays a critical role.

When n is small the shape of the distribution will depend largely on the shape of the parent population but when n gets large (n greater than thirty) the shape of the sampling distribution become more and more like a Normal distribution irrespective of the shape of the parent population.

Central limit theorem allows us to make use of Normal distribution for the population in sampling theory in most of the situations. The characteristics of Normal Distribution is revealed by two statistical constants (parameters) mue and sigma square where mue is the mean and sigma square is the finite variance of the population. Hence, when the sampling is from a Normal population the parameters are mean mue and finite variance sigma square.

The other measures that we use in sampling are population median, population mode, population correlation or the like which describes the characteristic of the population known as parameter(s).

Prof. R. A. Fisher termed the statistical constants of the population, using Greek letters mean (mue), the variance (sigma square), the skewness (beta one), kurtosis (beta two), correlation coefficient (Rho) etc. Hence, the prime objective of sampling analysis is to estimate these parameters if they are unknown. But usually these parameters are unknown.

Types of Parameters in sample survey:
In survey sampling we consider two types of parameters: Enumerative and Analytical.
Around what time did statisticians start thinking of two types of parameters: enumerative or survey population parameters on one hand and analytical/super population parameters on the other? The importance of the question just raised can be seen in the context of concept of “parameter” itself. This concept as distinct from the earlier frequency concepts is the basis of the modern theory estimations and the consequent notions of likelihood, sufficiency, etc.

It is illuminating to see historically how the distinction between two types of parameters one of the super populations (analytical) and the other of survey populations (enumerative) got established in Statistics. This distinction in the past was not often at all understood.

Consider a population is supposed to be generated by outcomes (x) of hypothetical indefinite, independent repetitions of some chance experiment. In this population the frequency distribution of the variate x is completely specified up to an unknown constant theta called as a parameter. This unknown parameter could be estimated by drawing random sample from the hypothetical population.

A parameter is a value, usually unknown (which therefore has to be estimated), used to represent a certain population characteristic. For example, the population mean is a parameter that is often used to indicate the average value of a quantity. Within a population, a parameter is a fixed value which does not vary.

3. Parameters in Population Ecology

For example parameters in Population Ecology
Here is a brief introduction to some of the important parameters that we will need to understand to study population ecology.
For each of the parameters it is important that we know:
(1) The name of the parameter,
(2) The algebraic symbol used to represent the parameter,
(3) The units of measurement for the parameter,
(4) How to calculate the parameter, and
(5) How to describe (in words)

What a particular value of that parameter means?

It is probably easy for me to introduce these concepts using an example:
Imagine that in a population of one hundred elephants, in one year ten elephants are born and five elephants die.

1. Population Size (N) units- Individuals. Measures the number of individuals in a population.

N equals to one hundred individuals.
In this population, there are one hundred elephants.

2. Population Birth Rate (B) units- Number of births per time. Measures the number of births per time that occur in a population.

B is equal to ten births per year
In this population, each year there are ten births.

3. Population Death Rate (D) units- Number of deaths per time.
Measures the number of deaths per time that occur in a population.

D equals to five deaths per year

In this population, each year there are five deaths.

4. Population Growth Rate- Number of individuals per time. Measures the rate of change of the population size.

Population growth rate is equal to B minus D
is equal to Ten births per year minus Five deaths/year equals to Five individuals/year.

In this population, the population size increases by Five individuals each year.

5. **Per Capita Birth Rate** (b) units- births per time per individual. Measures the number of births per time averaged across all members of the population.
b = B by N
b = (Ten births per year) divide by hundred individuals
Equals to zero point one zero births/year/individual
In this population, each year zero point one zero babies are born for each individual in the population.

6. Per Capita Death Rate (d) units - deaths per time per individual. Measures the number of deaths per time averaged across all members of the population.
d = D by N
d = (Five deaths/year)/ hundred individuals = zero point zero five deaths per year per individual
In this population, each year zero point zero zero five individuals die for each individual in the population.

4. Parameters in an Experimental Population

Parameters in an experimental population

Parameters are the variables that we use to describe our experiment or the variables associated with the variety of characteristics of the population.
Sample parameters
Sample parameters are variables that are used to describe the precise condition under which each sample (or measurement) was taken. You may have many parameter values applying to a single sample (such as time, drug concentration, etc.).

OR
Suppose our study is concerned with a sample of college students we may have many parameters from the single sample (such as height, weight, age, intelligence, etc.)

Experiment parameters
Experiment parameters are variables that can incorporate many sample parameter variables. Generally speaking, when the term parameter is used, it means an experimental parameter. As an example, parameters could be:

- Kryptonite Concentration
- Variety of Yeast
- Andromeda Strain Infection
- Test Repeat Number
- Growth rate of students

Parameter-value

Parameter-value is one of the possible values assigned to a variable. As an example, the parameters-values from the previous list could be:

- Kryptonite Concentration in ppm, zero, ten, twenty, thirty,
- Variety of Yeast, A or B
- Andromeda Strain Infection, Healthy or Infected
- Test Repeat Number, one or two
- Growth rate may be Ten percent, twenty percent, etc.

But a parameter in general is a number computed from a population. There is no random variation in a parameter. If the size of the population is large (as is typically the case), then you may find that a parameter is difficult or even impossible to compute.
An example of a parameter would be. The average length of stay in the birth hospital for all infants born in the United States.

When we are sampling from a qualitative population, parameter is a value used to represent a certain quantifiable characteristic of a population. This is like the mean or proportion of a population and often these values are unknown, and are estimated using sample data.

The Characteristics may be Religion, Caste, Language, customs, People, Sex (Male/Female), Culture and traditions etc.

For Example, the population mean is a parameter that is often used to indicate the Number of people quantifiable to different Castes in a certain state.

A character that describes the population is called a parameter. It is often difficult or impossible to measure the entire population, as parameters are most often estimated.
For example: If I were to measure the heights of every single person in the world and find the mean heights of I collected, the resulting value would be the parameter. Of course this would be impossible which is why we go for statistic.

In any statistical investigation the interest usually lies in studying the various characteristics relating to the individuals belonging to a particular population.

For example: If an enquiry is intended to determine the average per capita income of the people in a particular city, the population will comprise all the earning people in the city and the average per capita income of the people in that city is the parameter of the population.

On the other hand if we want to study the expenditure habit of the families in that city then the population will consist of all the house-hold in that city. The average expenditure or total expenditure habits of the families in that city are the parameters of that population.

Further if we want to study the quality of the manufactured product in an industrial concern during the day then the population will consist of the day's total production and the average quality of the manufactured product of total day's production is the parameter of the population.

We may come across with any type of populations with certain distribution which may be discrete or continuous. These distributions are specified by a set of constants what are known as parameters. Some distributions have only one parameter and some have multiple parameters. These parameters which explain the structure of the population are usually unknown. If the parameters are unknown then our prime emphasis must be to estimate the parameters of the population. In clear terms from the sample we attempt to draw inference concerning the universe by estimating the parameters using statistics.

5. Parameters used in Sampling

Five important parameters used in sampling.
Although sampling is undertaken for many purposes most frequently on five characteristics of the population.
The total number of units in the population is known as population size which is denoted by N.
Let us consider a population consisting of N units. Let the population units be Yone, Ytwo, Ythree, etc Y_N
A function of the population observations that is a function of
Yone, Ytwo, Ythree, etc Y_N is called as the parameter.

1. Mean = Y bar
   (Example: Average number of students per college)
2. Total = Y
   (Example: Total number of acres of wheat in a region)
3. Variance = Sigma square
   (Example: variance of the heights of students in an institution)

4. Ratio of two totals or means R = Y by X = Y bar by X bar
   (Example: Ratio of liquid assets to total assets in a group of families
5. Proportion of units that fall into some defined class

(Example: Proportion of people with false teeth)

Where,
Population Total: Y is equal to Summation Yi, i runs from 1 to N
Population Mean: Y bar is equal to summation Yi divided by N
Population Variance: Sigma square = Summation (Yi minus Y bar) whole square divided by N.
Population Mean square: S square is equal to Summation (Yi minus Y bar) whole square divided by N minus one.

For example: Consider a University hostel in which three thousand students are residing. We are interested to know the average time spent for the studies by the students residing in the hostels of the University. If we get information about the average time spent for the studies by all the three thousand students then such an average time is known as a population parameter. On the other hand if the population average time spent is unknown then we may have to estimate using sampling techniques.

A sample usually gives representative data and the generalization made on the basis of such data usually hold good for the universe.
Our selected Sample should be such that the results of the sample study can be applied, in general, for the population with a reasonable level of confidence.

The most important part of sampling theory is the selection of the samples. A sample study would give dependable conclusions only if the sample is the true representative of the universe that is if the aggregate characteristic of the sample closely approximate those same aggregate characteristics in the population.

Hence, we would much prefer to measure the entire population. If you measure the entire population and calculate a value like a mean or average, we call it a parameter of the population.
The population may be large, finite or infinite real-world class.
– Population size N is large enough then we treat it as a continuous probability distribution

• Population distribution can be described with distribution parameters

(e.g., mue, sigma).

The use of randomization in sampling allows for the analysis of results using the methods of *statistical inference*. Statistical inference is based on the laws of probability, and allows analysts to infer conclusions about a given population based on results observed through random sampling. Hence, Statistical Inference which is based on the theory of Sampling makes use of two key terms, they are *parameter* and *statistic*.

Since we usually cannot examine the entire population of interest and the parameters are generally unknown. A statistic is a number that is computed from sample data. We often use a statistic to estimate an unknown population parameter.

Example

Suppose an analyst wishes to determine the percentage of defective items which are produced by a factory over the course of a week. Since the factory produces thousands of items per week, the analyst takes a sample of three hundred items and observes that fifteen of these are defective.
Based on these results, the analyst computes the *statistic* p cap, fifteen by three hundred equals to point zero five, as an estimate of the *parameter p*, or true proportion of defective items in the entire population.

Hence, we have estimated the parameter value, which is a percentage of defective items produced by a factory per week as five percent, which will be almost nearer to the actual value of the parameter if the samples are true representative of the population in terms of randomness and sample size. Since, parameters are usually unknown in sampling theory we have to estimate the parameter values using the sample observations drawn from the respective population which will be discussed in detail in the next topic.

Here's a summary of our learning in this session:

- Definition of parameter
- Role of parameters in sampling
- Distribution of parent population which specifies parameters