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INTRODUCTION

Chapter - 1

Meaning of statistics :-

- Statistics is the science of collecting, organising, presenting, analysing and interpreating the numerical data. The complete definition of statistics in plural sense is :-

- statistics are aggregate of facts.
- statistics are affected to a marked extent by multiplicity of causes.
- statistics are numerically expressed.
- statistics are enumerated or estimated according to reasonable standard of accuracy.
- statistics are collected in systematic manner
- statistics are collected for pre-determined purpose.
- statistics are placed in relation to each other.

Statistics can be classified in to two parts.

i) Mathematical statistics.
ii) Applied statistics.

i) Mathematical statistics :-

It is application of Mathematics to statistics. It involves collection of facts and analysis of facts using mathematical techniques.
It is divided in to two parts.

(a) Descriptive statistics.
(b) Inferential statistics.

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(a) Descriptive statistics:-
- Statistics which deals with collection of data, presentation of data using table, diagram, graph etc and summarize data using measure of central tendency, dispersion, skewness, Kurtosis etc is called descriptive statistics.

(b) Inferential statistics:-
- Statistics which deals with sample selection from population and statistical techniques used to draw conclusion about population on the basis of statistical measures obtained from sample. It is used in estimation of parameter and statistical testing of hypothesis.

(ii) Applied statistics:-
- Statistics which deals with the application of statistical methods to specific problem is called applied statistics. It prescribes analysis method depending upon nature of data or nature of problem.

Function of Statistics:-
- There are many functions of statistics. Let us consider the following five important functions

1. Condensation.
2. Comparision.
3. Forecasting.
4. Estimation.
5. Sequential analysis.
6. Testing of hypothesis.
7. Empirical Research.

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* Explain the Scope of statistics:

Ans. Statistics play important role in each and every field of physical, biological, social and economical investigation for the sustainable development such as:

- Statistics role in planning:- Statistics is indispensable in to planning in the modern age which is term as "the age of planning". Almost all over the world the govern restoring to planning for economic development which makes the project longlasting and effective.

- Statistics role in economics:- statistical data and and technique of statistical analysis have to immensely useful involving economical problem such as wages price, time series analysis, termed analysis.

- statistics role in business:- Statistics is an irresponsible tool of production control. Business executive are relying more and more on statistical technique for studying the much and desire of valued customers.

- Statistics role in biological science:- In medical science the statistical tools for collection and Incidence of diseases and result of application various drugs and Medicines are of great Importance.

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* Limitation of statistics:-

- Despite its power, essential usefulness and universal applicability statistics has its own limitation and imperfections which are as under.

1. Statistics doesnot study individual.
2. Statistics doesnot study qualitative phenomenon.
3. Statistics data donot revel the story.
4. Statistical results are not always unquestionable.
5. Statistical laws are true on the average or the long run.
6. Statistical data are reliable to be misused easily.

Application of Statistics in the Field of C.S.I.T

- Statistics is important for all branches of science and technology because it is incredibly helpful in making decision making and testing the accuracy of the decisions at the end.

- The computer can perform many statistical calculations easily and quickly such as computation of means, standard devfations, correlation coefficients, and many more.
- computer can perform a systematic representation of user behaviour.
- computer perform as a toolbox for errors detection in decision making, planning or during analysis of data.
- computer acts as a bridge betwn qualitative and quantitave for the quantum work.

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Scales of Measurement:-

- Measurent is a process of assigning number or symbols to any facts or objects or product or items according to some rule where scale is simply a range of level or numbers used for measuring something. hence, it is a tool by which individuals are distinguished on the variable of area under study with the help of scales.
- Different measurement scales are used on the basis of nature of data. they are.

a) Nominal scale.
b) Ordinal scale
c) Interval Scale.
d) Ratio-scale.

(a) Nominal scale:-

- A Nominal Scale is a measurement scale in which numbers serve "tags" or "labels" only to identify or classify an object. A nominal Scale measurement normally deals with only with non-numeric (quantitative) variables or where numbers have no value or mathematical meaning. for example number plate of vechicles.

(b) Ordinal scale:-

Ordinal Scale is the second level of measurement that reports the ranking and ordering of the data without actually establishing the gaps between the positions of the numberals it is the qualified quantification of items by ranking. In this scale, it represent qualitative

Value in ascending or descending order. For example, assigning rank in qualification. Such as 1st rank for topper student and. Last rank for weak student.

(c) Interval scale:-

The Interval Scale of measure is a type of measurement scale that is characterized by equal intervals between scale unit. It assumes data have equal Intervals. The Scale doesnot have absolute zero but only arbitary zero. The Intervals between the Ordered numerals are adjusted in terms of some rule.

For example, scale of temperature is an example of ordinal scale. i.e. (32°F to 42°F) and from (64°F + 74°F).

(d) Ratio scale:-

Ratio scale is a type of variable measurement Scale which is quantitative in nature. It possesses the characteristics of nominal, ordinal and interval Scale which allows to any researcher to compare the intervals or differences. Ratio scale is the fourth level of measurement and possesses a zero point or character of Origin. This is a unique feature of ratio scale So it is also called Ideal Scale.

For example:- the temp^{r} of outside is 0-degree Celsius. 0 degree doesnot mean its not hot or cold. It is a value.

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Variable:-

An element which changes or varies is called variable. It is generally denoted by x, y, z etc. The value of variables vary from one to another. Variable is classified in to two types.

i) Qualitative variable
ii) Quantitative variable.

i) Qualitative Variable:- The variable which varies in kind rather than in magnitude is called Qualitative variable. Qualitative variable present in nominal and ordinal scales. e.g. hair color, gender, academic achievement & Social status etc.

(ii) Quantitative variable:- The variable which varies in magnitude and can be expressed numerically is called quantitative variable. It present in interval and ratio scales. Quantitative variable further divided in to two types.

(a) Discrete variable
(b) continuous variable.

(a) Discrete Variable:-

- A variable which can take whole number or countable number of values is called discrete variables.

(b) continuous variable:-

- A variable which can take all possible values (whole number and fractions) within certain range is called continuous variable.

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Data.

- An information of facts and figures collected for a definite purpose in any manner is termed as data. simply collection of raw, facts and figures is called Data. On the basis of collection procedure data is divided in to two types.

a) primary data
b) Secondary data.

a) primary data :- The data which are original collected by investigator or reasearcher for the first time for the purpose of statistical enquiry is called primary data.

Different methods used for collecting primary data are as follows.

i) Direct personal interview.
ii) Indirect Oral interview.
iii) Mailed questionnarie.
iv) Information through telephone.
v) Information through Correspondents.
vi) Schedule sent through enumerator.

(b) Secondary data :- The data that has been already collected for a particular purpose and used for next purpose is called secondary data.

Sources of secondary data are :-

i) published source.
ii) Unpublished source.

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(i) Published Source!- the published sources of secondary data are national and international organization or agencies. Such as WHO, World Bank, Nepal electricity Authority and so on.

(ii) Unpublished Source!- All the statistical information may not be in published form and some of Governmental and private organizations donot publish statistical information such as records of schools, colleges, trade centre, VDC and many more.

*. Cross section data!-
- Data for a single point or single factor is called cross section data. It is snapshot of information at a particular point.
e.g. popⁿ of children in census year 2068.

*. Time series data!-
The data which can be recorded over different period of time is called time series data.
e.g. popⁿ of Nepal in census year 2048, 2058, 2068.

*. Failure time Data!-
The data of each units is recorded for each follow up time till the occurrence of event or till the unit fail is called failure time data. It is also called time to event data. It is obtained from clinical studies, cancer studies and so on.

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Panel Data:
It is longitudinal or cross sectional time series data. It is related to behaviour of entities observed across time. Data of individuals is recorded repeatedly over number of years.

* Population :-
- The total number of units or items under studying belonging to a particular a class or group. e.g. children in a school, parents in hospital, fruits in a tree, etc.. population can be divided into finite and infinite population according to number of individuals belonging to the group.

• Finite population:-
Population containing countable number of individuals is called finite population. E.g. vechicles in workshop, passenger in vechicle etc.

• Infinite population:-
Population containing uncountable number of number of individuals is called infinite population. E.g. fishes in an ocean, stars in the sky, living beings in earth etc.

- Population cand be further divided into homogeneous and heterogeneous according to type of individuals in population.

• Homogeneous population:-
Population consisting of individuals of same type is homogeneous population. e.g. population of graduate passed out student.

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• Heterogeneous population:-
- population consisting of individuals of different types is called Heterogeneous population. Eg. population of United states.

Write short notes on

(a) Sample:-
- A sample refers to a smaller, manageable version of a larger group. It is a subset containing the characteristics of a larger population. Sample are used in statistical testing when population sizes are too large for the test.

(b) Entities:-
- Entities refers to the things with distinct and independent existences for eg. a person, a product or an object etc.

*. Define statistical population:-
A statistical population is a set of people, things or concepts that share a set of properties population is the entire pool from which a statistical sample is drawn. In statistics population can bereferred as people, objects, events, measurement etc.

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DESCRIPTIVE STATISTICS
Chapter-2

Central Tendency :-
The central tendency is stated as the statistical measure that represents the single value of the entire distribution or the data set. It aims to provide an accurate description of the entire data in the distribution. The process of for obtaining an average value from the entire data is known as central tendency.

Objectives :-
- To get a single value that represents the characteristics of the entire data.
- To facilitate Comparision.

Requisites of a Good average.
i) It should be rigidly defined.
ii) It should be easy to understand
iii) It should be easy to compute.
iv) It should be suitable for further algebraic treatment.
v) It should not be affected by extreme items.

Measure of Central Tendency :-
The following are the measures of central tendency.
1. Arithmetic Mean (A.M.) 2. Geometric Mean (G.M)
3. Harmonic Mean (H.M) 4. Median.
5. Mode.

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1. Arithmetic Mean:
The arithmetic mean is the simplest and most widely used measure of a mean, or average. It simply involves taking the sum of a group of numbers then dividing that the number of terms used in the series. Arithmetic mean may be either
(a) Simple arithmetic mean.
(b) Weighted arithmetic mean.

*. calculation of Simple Arithmetic mean
1. Direct method.
2. Deviation method.
3. Step deviation method.

1. Direct method.
Mathematically,

$$\bar{x} = \frac{x_1 + x_2 + \dots + x_n}{n} = \frac{\sum x}{n}$$

where,
$\sum x$ = total sum of the numerical values.
n = number of terms present in the series.

Example:- 1.
The following table gives the yearly income (000Rs) of the 10 computer programmers working in the Software company.
Income → 1780, 1760, 1680, 1750, 1830, 1940, 1100, 1800, 1060, 1950, find the average income of programmers.

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Sol^n: Here,

Let $\bar{x}$ be the average income of a programmer.

then,

We know that

$$\bar{x} = \frac{\Sigma x}{N}$$

$$\bar{x} = \frac{1750 + 1760 + 1680 + 1750 + 1830 + 1940 + 1150 + 1850 + 1060 + 1950}{10}$$

$$\bar{x} = \frac{16650}{10}$$

$$\bar{x} = \text{Rs } 1665$$

The average income of programmers is Rs 1665.

2. Deviation method.

Mathematically

$$\bar{x} = A + \frac{\Sigma d}{n}$$

where A = assumed mean

d = x - A (also called change of origin)

n = no. of observation.

* Calculate the average income by shortcut method from example 1.

Sol^n: Here.

Let assumed mean (A) = 1850.

Calculation of A.M.

X (Rs)	$d = x - A = (x - 1800)$
1780	-20
1760	-40
1680	-120
1750	-50
1830	30
1940	140
1100	-700
1800	0
1060	-740
1950	150
	$\Sigma d = -1350$

$$\bar{x} = A + \frac{\Sigma d}{n}$$

$$\bar{x} = 1800 + \frac{(-1350)}{10}$$

$$\bar{x} = Rs\,1665.$$

3. Step Deviation Method.

Mathematically,

$$\bar{x} = A + \frac{\Sigma d'}{n} \times h$$

where

A = Assumed mean

h = a common factor in the data

n = Number of observation.

- This method is also called the method of changes of origin & scales.

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Calculate the average income by step deviation method of example 1.

Soln: Here,

Let Assumed mean A = 1700

Calculation of Arithmetic mean.

x(Rs)	$d = x - A = x - 1700$	$d' = \frac{x-A}{h} = \frac{x-1700}{10}$
1780	80	8
1760	60	6
1680	-20	-2
1750	50	5
1830	130	13
1940	240	24
1100	-600	-60
1800	100	10
1060	-640	-64
1950	250	-25
	$\Sigma d'$	-35

We have,

$$\bar{x} = A + \frac{\Sigma d' \times h}{N}$$

$$\bar{x} = 1700 + \frac{(-35) \times 10}{10}$$

$$\bar{x} = Rs\,1665 \quad \text{Ans}$$

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For discrete series: Let observation x_1 occurs f_1 times, observation occurs f_2 times, observation x_3 occurs f_3 times.... observation x_n occurs f_n times then the arithmatic mean is denoted by $\bar{x}$ and is given by,

$$\bar{x} = \frac{f_1x_1 + f_2x_2 + f_3x_3 + \dots + f_nx_n}{f_1 + f_2 + f_3 + \dots + f_n}$$

$$\bar{x} = \frac{\Sigma fx}{N} \leftarrow \text{By direct method.}$$

- By shortcut method:

Let $d = x - A$

$$\bar{x} = A + \frac{\Sigma fd}{N}$$

where

A = Assumed value (mean)

$d = x - A$

N = sum of frequency

- By step deviation method (coading method)

Let

$$d' = \frac{x - A}{h}$$

$$\bar{x} = A + \frac{\Sigma fd'}{N} \times h$$

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Example:-

Find the mean by (i) direct (ii) shortcut and (iii) step deviation method of

x	1780	1760	1750	1830	1940	1100	1800	1060	1950
f	10	6	6	8	9	07	11	10	7

Calculation Table.

x	f	fx	$d = x - A$ $= x - 1750$	$d' = \frac{x-A}{h}$	fd	fd'
178						
1780	10	17800	30	3	360	30
1760	6	10560	10	1	60	6
1680	4	6720	-70	-7	-280	-28
1750	8	14000	0	0	0	0
1830	9	16470	80	8	720	72
1940	7	13580	190	19	1330	133
1100	11	12100	-650	-65	-7150	-715
1800	10	18000	50	5	500	50
1060	7	7420	-690	-69	-4830	-483
1950	8	15600	200	20	1600	160
	N=80	132250	-7750	-775	-7750	-775

(i) By direct method

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{132250}{80} = 1653.125$$

(ii) By shortcut method

$$\bar{x} = A + \frac{\Sigma fd}{N} = 1750 + \frac{(-7750)}{80} = 1653.125$$

(iii) By step deviation method

$$\bar{x} = A + \frac{\Sigma fd'}{N} \times h. = 1750 + \frac{(-775)}{80} \times 10$$

$\therefore 1653.125.$

Ans

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Mean for continuous series:-

class :	0-10	10-20	20-30
f :	5	7	9

(Exclusive type continuous series)

class :	0-9	10-19	20-29	30-39	40-49
f :	7	5	6	9	8

(Inclusive type continuous series)

Changing inclusive in to exclusive

Correction factor (K) = $\frac{\text{Lower Limit of 2nd} - \text{Upp. limit of 1st}}{2}$

$$K = \frac{10-9}{2} = \frac{1}{2} = 0.5$$

Now exclusive class = (Lower − K) − (upper + K)

Exclusive class is.

class :	-0.5-9.5	9.5-19.5	19.5-29.5	29.5-39.5 ....
f :	7	5	6	9 ....

(a). Direct method : Mean $(\bar{x}) = \frac{\Sigma fx}{N.}$

Where x = mid-value

(b) By short cut method :-

Mean $(\bar{x}) = A + \frac{\Sigma fd}{N.}$

(c) By step deviation method :-

Mean $(\bar{x}) = A + \frac{\Sigma fd'}{N} \times h$

where $d = x - A$, $d' = \frac{x-A}{h}$

A = assumed mean

Example:-
Find mean by (i) direct method (ii) shortcut metho. and (iii) step deviation method.

Class:	0-10	10-20	20-30	30-40	40-50	50-60
f :	5	6	10	8	9	7.

Sol:-

Calculation Table

Class	f	Mid-value (x)	fx	d=x-A =x-25	$d' = \frac{x-A}{h}$	fd	fd'
0-10	5	5	25	-20	-2	-100	-10
10-20	6	15	90	-10	1	-60	-6
20-30	10	25	250	0	0	0	0
30-40	8	35	280	10	1	80	8
40-50	9	45	405	20	2	180	18
50-60	7	55	385	30	3	210	21
	N=45					310	31

we have,

By direct method

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{1435}{45} = 31.88 \text{ Ans}$$

By shortcut method

$$\bar{x} = A + \frac{\Sigma fd}{N} = 25 + \frac{310}{45}$$
$$= 25 + 6.88$$
$$= 31.88 \text{ Ans}$$

By step-deviation method

$$\bar{x} = A + \frac{\Sigma fd'}{N} \times h = 25 + \frac{31}{45} \times 10$$
$$= 31.88 \text{ Ans}$$

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What is the weighted mean?

The weighted mean is a type of mean that is calculated by multiplying the weight (or probability) associated with a particular event or outcome with its associated quantitative outcome and then summing all the product together,

What is the weighted mean?

The weighted mean is a type of mean that is calculated by multiplying the weight (or probability) associated with a particular event or outcome with its associated quantitative outcome and then summing all the product together.

$$\therefore \text{weighted mean } (\bar{X}_w) = \frac{\Sigma WX}{\Sigma W}$$

Median :-

- The middle most value which divides total observation in to two equal parts is called median.

Calculation of Md :-

1) For individual Series :-

Steps.

(a) Arrange the data either ascending or descending order.

(b) Find the number of observation (n)

(c) Find position of median using formula
$= \left(\frac{n+1}{2}\right)^{th}$ item.

(d) The value corresponding to $\left(\frac{n+1}{2}\right)$ is median.

For example:
Find the median value of:
x: 50, 60, 90, 30, 80, 40, 70, 100, 20.

Soln:
Arranging the data in ascending order
20, 30, 40, 50, 60, 70, 80, 90, 100
$n = 9$

Position of median $= \left(\frac{n+1}{2}\right) = \left(\frac{9+1}{2}\right) = 5^{th}$ item

$\therefore$ Median = Value of 5^{th} item = 60 Ans

Example - 2.
Find the median value of
x: 20, 15, 18, 30, 35, 60

Soln: Here,
Arranging the data in ascending order.
15, 18, 20, 30, 35, 60. $\Rightarrow n = 6$

Position of median $= \left(\frac{n+1}{2}\right)^{th}$ item

$= \left(\frac{6+1}{2}\right) = \frac{7}{2} = 3.5^{th}$ item.

$\therefore$ Median $= \frac{\text{Value of } 3^{rd} + 4^{th} \text{ item}}{2}$

$= \frac{20+30}{2} = \frac{50}{2}$

$= 25$ Ans

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② For discrete series:-

Steps.

1. Arrange the data in ascending or descending order.
2. Prepare cumulative frequency (c.f.) table.
3. Find N (Σf)
4. Find position of median using formula = $\left(\frac{n+1}{2}\right)$
5. The value corresponding to $\left(\frac{N+1}{2}\right)$ in c.f. otherwise just greater than $\left(\frac{n+1}{2}\right)$ in c.f is median.

For example.

Find the median value of

x:	50	20	80	60	90	100
f:	7	9	8	4	6	9

Sol^n:.

Calculation of Median.

x	f	c.f.
20	9	9
50	7	16
60	4	20
80	8	28
90	6	34
100	9	43
	N = 43	

Now

position of median = $\left(\frac{N+1}{2}\right) = \left(\frac{43+1}{2}\right) = 22$

∴ The c.f just greather than 22 is 28 So median = 80 Ans

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(3) For Continuous Series :-

steps.

(1) Arrange the class in ascending order.
(2) prepare c.f table
(3) find N
(4) Find position of median class using formula
Class = $N/2$
(5) then class = $N/2$ corresponding to or just greater than $N/2$ in c.f. is median class.
(6) After finding median class use formula of median as

$$Md = L + \frac{N/2 - c.f. \times h}{f}$$

where
L = Lower Limit of median class
h = median class size
f = Median class frequency.
c.f. = c.f Just before (preceeding) median class c.f.
(Note :- class should be in exclusive form)

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Example-1

Find the median value of.

Class	0-10	10-20	20-30	30-40	40-50
f	5	7	9	8	4

Sol^{n}:

Calculation table

Class	f	c.f.
0-10	5	5
10-20	7	12
20-30	9	21
30-40	8	29
40-50	4	33
	N=33	

Now

position of median class $= N/2 = \frac{33}{2} = 16.5$

∴ The c.f just greater than 16.5 is 21 so median class is = 20-30

Here

$L = 20$, $f = 9$, $cf = 12$, $h = 10$, $N/2 = 16.5$

we Know that,

$$Md = L + \frac{N/2 - cf.}{f} \times h$$

$$Md = 20 + \frac{16.5 - 12}{9} \times 10$$

$$= 20 + \frac{4.5 \times 10}{9}$$

$$= 20 + 45/9$$

$$= 20 + 5$$

$$Md = 25 \quad \text{Ans}$$

Example-2.

Find the median value of:

class	0-9	10-19	20-29	30-39	40-49
f	7	8	10	6	5

Soln

Calculation of median

class	f	c.f
-0.5-9.5	7	7
9.5-19.5	8	15
19.5-29.5	10	25
29.5-39.5	6	31
39.5-49.5	5	36
	N=36	

Now

position of median class = $N/2 = 36/2 = 18$

The c.f just greater than 10 is 25 so

median class = 19.5-29.5

Here,

$L = 19.5$, $f = 10$, $cf = 15$, $h = 10$, $N/2 = 18$

we have,

$$Md = L + \frac{N/2 - cf}{f} \times h$$

$$Md = 19.5 + \frac{18-15}{10} \times 10$$

$$Md = 19.5 + 3$$

$$Md = 22.5 \text{ Ans}$$

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Partition Values:-

These variate values which divides total observation in to equal numbers of parts are called partition values. If total observation is divided in to four equal parts that is quartiles. (Q_i) (Q_1, Q_2, Q_3). If total observation is divided into 10 equal parts that is deciles (D_i) ($D_1, D_2, \ldots D_9$) If total observation is divided in to 100 equal parts that is percentiles. (P_K) ($P_1, P_2 \ldots P_{99}$)

calculation of partition values:-

1. For individual series:- Other process is same as median.

Position of quartiles (Q_i) = $i\frac{(n+1)}{4}^{th}$ item

position of deciles (D_i) = $i\left(\frac{n+1}{10}\right)^{th}$ item

position of percentiles (P_K) = $K\frac{(n+1)}{100}^{th}$ item

For example.

Find 3rd quartile, 7th decile and 48th decil percentile of:

x: 10, 25, 80, 60, 39, 75, 60, 78, 99, 120, 150

$n = 11$

For 3rd quartile (Q_3):

position of $Q_3 = 3\frac{(n+1)}{4}^{th}$ item

$= 3\left(\frac{11+1}{4}\right)^{th}$ item

$= 9^{th}$ item

$\therefore Q_3$ = Value of 9^{th} item = 99 Ans

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For 7th decile :-

position of 7th decile (D_7) = $7\frac{(n+1)}{10}$ th item

= $7\left(\frac{11+1}{10}\right)$ th item

= 84/10 = 8.4th item.

$\therefore D_7$ = Value of 8th item + 0.4th item (9th − 8th)

= 80 + 0.4 (99 − 80)

= 80 + 0.4 × 19

D_7 = 87.6

For 48th percentile (P_{48}) :-

position of 48th percentile (P_{48}) = $48\frac{(n+1)}{100}$ th item

= $48\frac{(11+1)}{100}$ th item

= 5.76th item

$\therefore P_{48}$ = Value of 5th item + 0.76 (6th − 5th)

= 60 + 0.76 (75 − 60)

= 60 + 0.76 × 15

P_{48} = 71.4

2. For Discrete Series :-

other process is same as median

position of Quartiles (Q_i) = $i\frac{(N+1)}{4}$ th item

position of Deciles (D_i) = $i\left(\frac{N+1}{10}\right)$ th item

position of percentiles (P_K) = $K\left(\frac{N+1}{100}\right)$ th item.