MEASURES OF DISPERSION OR VARIATION

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Dispersion measures the extent to which the items vary from some central value. It may be noted that the measures of dispersion measure only the degree (the amount of variation) but not the direction of variation.

The various measures of central value give us one single figure that represents the entire data. But the average alone cannot adequately describe a set of observations, unless all the observations are the same. It is necessary to describe the variability or dispersion of the observations.

SIGNIFICANCE AND PROPERTIES OF MEASURES OF DISPERSION OR VARIATION

A good measure of dispersion should possess the following properties

- It should be simple to understand.
- It should be easy to compute.
- It should be rigidly defined.
- It should be based on each and every item of the distribution.
- It should be amenable to further algebraic treatment.
- It should have sampling stability.
- Extreme items should not unduly affect it.

There are five measures of dispersion:

- Range
- Inter-quartile range or Quartile Deviation
- Mean deviation or Average Deviation
- Standard Deviation
- Lorenz curve.

1. Range

Range is defined as the difference between the value of largest item and the value of smallest item included in the distribution. Measures of range may be absolute or relative. Formula for calculating range is

$$\textbf{Range} = \textbf{L} - \textbf{S}$$

Where, L = Largest value

S = Smallest Value

$$\textbf{Coefficient of range} = \frac{\textbf{L} - \textbf{S}}{\textbf{L} + \textbf{S}}$$

MERITS OF RANGE

- It should be simple to understand.
- It should be easy to compute.
- It should be rigidly defined

LIMITATIONS OF RANGE:-

- It is based only on two items and does not cover all the items in a distribution.
- It is subject to wide fluctuations from sample to sample based on the same population.
- It fails to give any idea about the pattern of distribution.
- Finally, in the case of open-ended distributions, it is not possible to compute the range.

2.Inter-quartile range or Quartile Deviation

Quartile deviation is half of the difference between upper quartile **(Q_3)** and lower quartile **(Q_1).** Quartile deviation indicates the average amount by which the two quartiles differ from the median. In symmetrical distribution the two quartiles **(Q_1 and Q_3)** are equidistant from the median.

Symbolically, inter quartile range $= Q_3 - Q_1$

Many times the inter quartile range is reduced in the form of semi-inter quartile range or quartile deviation as shown below:

Semi inter quartile range or Quartile deviation $= \frac{(Q_3 - Q_1)}{2}$

Coefficient of Quartile Deviation $= \frac{(Q_3 - Q_1)}{(Q_3 + Q_1)}$

MERITS OF QUARTILE DEVIATION

The following merits are entertained by quartile deviation:

- As compared to range, it is considered a superior measure of dispersion.
- In the case of open-ended distribution, it is quite suitable.
- Since it is not influenced by the extreme values in a distribution, it is particularly suitable in highly skewed or erratic distributions.

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LIMITATIONS OF QUARTILE DEVIATION

- Like the range, it fails to cover all the items in a distribution.
- It is not amenable to mathematical manipulation.
- It varies widely from sample to sample based on the same population.
- Since it is a positional average, it is not considered as a measure of dispersion. It merely shows a distance on scale and not a scatter around an average. In view of the above-mentioned limitations, the inter quartile range or the quartile deviation has a limited practical utility

3.Mean deviation or Average Deviation:-

Average deviation is obtained by calculating the absolute deviations of each observation from median or mean and then averaging these deviations by taking their arithmetic mean. Average deviation is denoted by A.D

Computation of average deviation for ungrouped data:-

In case deviation is taken from median:-

$$A.D_{(Median)} = \frac{\sum |X - Median|}{N}$$

$$\text{Coefficient of } A.D_{(Median)} = \frac{A.D}{Median}$$

In case deviation is taken from mean:-

$$A.D_{(Mean)} = \frac{\sum | X - Mean |}{N}$$

$$\text{Coefficient of } A.D_{(Mean)} = \frac{A.D}{Mean}$$

Computation of average deviation for grouped data:-

In case deviation is taken from median:-

$$A.D_{(Median)} = \frac{\sum f|X - Median|}{N}$$

$$\text{Coefficient of } A.D_{(Median)} = \frac{A.D}{Median}$$

In case deviation is taken from mean:-

$$A.D_{(Mean)} = \frac{\sum f \left| X - Mean \right|}{N}$$

$$\text{Coefficient of } A.D_{(Mean)} = \frac{A.D}{Mean}$$

MERITS OF MEAN DEVIATION

- A major advantage of mean deviation is that it is simple to understand and easy to calculate.
- It takes into consideration each and every item in the distribution. As a result, a change in the value of any item will have its effect on the magnitude of mean deviation.
- The values of extreme items have less effect on the value of the mean deviation.
- As deviations are taken from a central value, it is possible to have meaningful comparisons of the formation of different distributions.

LIMITATIONS OF MEAN DEVIATION

- It is not capable of further algebraic treatment.
- At times it may fail to give accurate results. The mean deviation gives best results when deviations are taken from the median instead of from the mean. But in a series, which has wide variations in the items, median is not a satisfactory measure.
- Strictly on mathematical considerations, the method is wrong as it ignores the algebraic signs when the deviations are taken from the mean.

4. STANDARD DEVIATION

The standard deviation measures the absolute variation of a distribution. The greater the amount of variation, the greater the standard deviation, for the greater will be the magnitude of the deviation on the values from their mean.

A small standard deviation means a high degree of uniformity of the observations as well as homogeneity of a series, a large standard deviation means just opposite.

Hence standard deviation is extremely useful in judging the representativeness of the mean. It is denoted by the small Greek letter σ (read as sigma).

Computation of Standard deviation for Ungrouped data:-

In case deviation is taken from Actual mean:-

$$\sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{N}}$$

In case deviation is taken from Assumed mean:-

$$\sigma = \sqrt{\frac{\sum d^2}{N} - \left[\frac{\sum d}{N}\right]^2}$$

Where

d = X - A

Computation of Standard deviation for grouped data:-

In case deviation is taken from Actual mean:-

$$\sigma = \sqrt{\frac{\sum f\,(X - X)^2}{N}}$$