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Topic- MEASURES OF DISPERSION

An averages can represent a series only as best as a single figure can, but it certainly cannot reveal the entire story of any phenomenon under study. Specially it fails to give any idea about the scatter of the values of items of a variable in the series around the true value of average. In order to measure this scatter, statistical devices called measures of dispersion are calculated. Important measures of dispersion are (a) range, (b) mean deviation, and (c) standard deviation.

(a) *Range* is the simplest possible measure of dispersion and is defined as the difference between the values of the extreme items of a series. Thus,

$$\text{Range} = \begin{pmatrix}\text{Highest value of an} \\ \text{item in a series}\end{pmatrix} - \begin{pmatrix}\text{Lowest value of an} \\ \text{item in a series}\end{pmatrix}$$

The utility of range is that it gives an idea of the variability very quickly, drawback is that range is affected very greatly by fluctuations of sampling. Its value is never stable, being based on only two values of the variable. As such, range is mostly used as a rough measure of variability and is not considered as an appropriate measure in serious research studies.

(b) *Mean deviation* is the average of difference of the values of items from some average of the series. Such a difference is technically described as deviation. In calculating mean deviation we ignore the minus sign of deviations while taking Mean When mean deviation is divided by the average used in finding out the mean deviation itself, the resulting quantity is described as the *coefficient of mean deviation*. Coefficient of mean deviation is a relative measure of dispersion and is comparable to similar measure of other series. Mean deviation and its coefficient are used in statistical studies for judging the variability, and thereby render the study of central tendency of a series more precise by throwing light on the typicalness of an average. It is a better measure of variability than range as it takes into consideration the values of all items of a series.

Mean deviation from mean $(\delta_{\overline{X}}) = \dfrac{\Sigma|X_i - \overline{X}|}{n}$, if deviations, $|X_i - \overline{X}|$, are obtained from

or arithmetic average.

Mean deviation from median $(\delta_m) = \dfrac{\Sigma|X_i - M|}{n}$, if deviations, $|X_i - M|$, are obtained

or from median

Mean deviation from mode $(\delta_z) = \dfrac{\Sigma|X_i - Z|}{n}$, if deviations, $|X_i - Z|$, are obtained from

mode.

where δ = Symbol for mean deviation (pronounced as delta);
X_i = ith values of the variable X;
n = number of items;
$\overline{X}$ = Arithmetic average;
M = Median;
Z = Mode.

(c) *Standard deviation* is most widely used measure of dispersion of a series and is commonly denoted by the symbol 'σ' (pronounced as sigma). Standard deviation is defined as the square-root of the average of squares of deviations, when such deviations for the values of individual items in a series are obtained from the arithmetic average. It is worked out as under:

$$\text{Standard deviation}^* (\sigma) = \sqrt{\frac{\Sigma\left(X_i - \overline{X}\right)^2}{n}}$$

* If we use assumed average, A, in place of X while finding deviations, then standard deviation would be worked out as under

$$\sigma = \sqrt{\frac{\Sigma(X_i - A)^2}{n} - \left(\frac{\Sigma(X_i - A)}{n}\right)^2}$$

Or

$$\sigma = \sqrt{\frac{\Sigma f_i(X_i - A)^2}{\Sigma f_i} - \left(\frac{\Sigma f_i(X_i - A)}{\Sigma f_i}\right)^2}, \text{ in case of frequency distribution.}$$

This is also known as the short-cut method of finding σ.

Or

$$\text{Standard deviation}(\sigma) = \sqrt{\frac{\Sigma f_i\left(X_i - \overline{X}\right)^2}{\Sigma f_i}}, \text{ in case of frequency distribution}$$

, in case of frequency distribution

where *fi* means the frequency of the *i*th item.

When we divide the standard deviation by the arithmetic average of the series, the resulting quantity is known as *coefficient of standard deviation which* happens to be a relative measure and is often used for comparing with similar measure of other series. When this coefficient of standard deviation is multiplied by 100, the resulting figure is known as *coefficient of variation*. Sometimes, we work out the square of standard deviation, known as *variance*, which is frequently used in the context of analysis of variation.

The standard deviation (along with several related measures like variance, coefficient of variation, etc.) is used mostly in research studies and is regarded as a very satisfactory measure of dispersion in a series. It is amenable to mathematical manipulation because the algebraic signs are not ignored in its calculation (as we ignore in case of mean deviation). It is less affected by fluctuations of sampling. These advantages make standard deviation and its coefficient a very popular measure of the scatteredness of a series. It is popularly used in the context of estimation and testing of hypotheses.

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