14.4 Measure of dispersion

The degree to which numerical data tend to spread about an average value is called the dispersion of the data. The four measure of dispersion are

(1) Range (2) Mean deviation

(3) Standard deviation (4) Square deviation

(1) **Range:** It is the difference between the values of extreme items in a series. Range = $X_{max} - X_{min}$

The coefficient of range (scatter) $= \frac{x_{max} - x_{min}}{x_{max} + x_{min}}$.

Range is not the measure of central tendency. Range is widely used in statistical series relating to quality control in production.

Range is commonly used measures of dispersion in case of changes in interest rates, exchange rate, share prices and like statistical information. It helps us to determine changes in the qualities of the goods produced in factories.

(2) **Mean deviation:** The arithmetic average of the deviations (all taking positive) from the mean, median or mode is known as mean deviation.

Mean deviation is used for calculating dispersion of the series relating to economic and social inequalities. Dispersion in the distribution of income and wealth is measured in term of mean deviation.

(i) **Mean deviation from ungrouped data (or individual series)**

Mean deviation $= \frac{\Sigma|x - M|}{n}$,

where $|x - M|$ means the modulus of the deviation of the variate from the mean (mean, median or mode) and n is the number of terms.

(ii) **Mean deviation from continuous series:** Here first of all we find the mean from which deviation is to be taken. Then we find the deviation $dM = |x - M|$ of each variate from the mean M so obtained.

Next we multiply these deviations by the corresponding frequency and find the product $f.dM$ and then the sum $\Sigma f dM$ of these products.

Lastly we use the formula, mean deviation $= \frac{\Sigma f|x - M|}{n} = \frac{\Sigma f dM}{n}$, where $n = \Sigma f$.

(3) **Standard deviation:** Standard deviation (or S.D.) is the square root of the arithmetic mean of the square of deviations of various values from their arithmetic mean and is generally denoted by ± read as sigma. It is used in statistical analysis.

(i) **Coefficient of standard deviation:** To compare the dispersion of two frequency distributions the relative measure of standard deviation is computed which is known as coefficient of standard deviation and is given by

Coefficient of S.D. $= \frac{\pm}{\bar{x}}$, where $\bar{x}$ is the A.M.

(ii) **Standard deviation from individual series**

$$\pm = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}}$$

where, $\bar{x}$ = The arithmetic mean of series

N = The total frequency.

(iii) **Standard deviation from continuous series**

$$\pm = \sqrt{\frac{\Sigma f_i(x_i-\bar{x})^2}{N}}$$

where, $\bar{x}$ = Arithmetic mean of series

x_i = Mid value of the class

f_i = Frequency of the corresponding x_i

$N = \Sigma f$ = The total frequency

Short cut method:

(i) $\pm = \sqrt{\frac{\Sigma fd^2}{N} - \left(\frac{\Sigma fd}{N}\right)^2}$ (ii) $\pm = \sqrt{\frac{\Sigma d^2}{N} - \left(\frac{\Sigma d}{N}\right)^2}$

where, $d = x - A$ = Deviation from the assumed mean A

f = Frequency of the item

$N = \Sigma f$ = Sum of frequencies

(4) **Square deviation**

(i) **Root mean square deviation**

$$S = \sqrt{\frac{1}{N}\sum_{i=1}^{n} f_i(x_i - A)^2},$$

where A is any arbitrary number and S is called mean square deviation.