Mean deviation or Mean distance:

- The mean deviation is a statistical measure that is used to calculate the average deviation from the mean value of the given data set.
- In statistics, the mean deviation is used to give the spread of data about the central point (mean, median or mode). It is a type of average absolute deviation.
- Formula: (Ungrouped data) $MD = \frac{\sum_{i=1}^{n}|x_i - \bar{x}|}{n}$
- Formula: (Grouped data) $MD = \frac{\sum_{i=1}^{n} f_i|x_i - \bar{x}|}{n}$

Standard deviation:

- Standard Deviation is the measure of dispersion. It means how far the data values are spread out from the mean value.
- Standard Deviation is a measure which shows how much variation (such as spread, dispersion, spread,) from the mean exists. The standard deviation indicates a “typical” deviation from the mean. It is a popular measure of variability because it returns to the original units of measure of the data set. Like the variance, if the data points are close to the mean, there is a small variation whereas the data points are highly spread out from the mean, then it has a high variance. Standard deviation calculates the extent to which the values differ from the average. Standard Deviation, the most widely used measure of dispersion, is based on all values. Therefore a change in even one value affects the value of standard deviation. It is independent of origin but not of scale. It is also useful in certain advanced statistical problems.

For sample

- Formula: (Ungrouped data) $s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$
- Formula: (Grouped data) $s = \sqrt{\frac{\sum_{i=1}^{n} f_i(x_i - \bar{x})^2}{n-1}}$

For population

- Formula: (Ungrouped data) $\sigma = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \mu)^2}{n}} = \sqrt{\frac{\sum_{i=1}^{n} x_i^2}{n} - \mu^2}$
- Formula: (Grouped data) $\sigma = \sqrt{\frac{\sum_{i=1}^{n} f_i(x_i - \mu)^2}{n}} = \sqrt{\frac{\sum_{i=1}^{n} f_i x_i^2}{n} - \mu^2}$

Why Divide by (n – 1)?

- There are only $\boldsymbol{n-1}$ values that can assigned without constraint. With a given mean, we can use any numbers for the first $\boldsymbol{n-1}$ values, but the last value will then be automatically determined.
- With division by $\boldsymbol{n-1}$, sample variances $\boldsymbol{s}^2$ tend to center around the value of the population variance $\boldsymbol{\sigma}^2$; with division by $\boldsymbol{n}$, sample variances $\boldsymbol{s}^2$ tend to underestimate the value of the population variance $\boldsymbol{\sigma}^2$.

Variance:

- **Variance** is the measure of how notably a collection of data is spread out. If all the data values are identical, then it indicates the variance is zero. All non-zero variances are considered to be positive. A little variance represents that the data points are close to the mean, and to each other, whereas if the data points are highly spread out from the mean and from one another indicates the high variance. In short, the variance is defined as the average of the squared distance from each point to the mean.

- Formula: (Grouped data) $\boldsymbol{s^2 = \frac{\sum_{i=1}^{n} f_i(x_i-\overline{x})^2}{n-1}}$

- Formula: (Grouped data) $\boldsymbol{\sigma^2 = \frac{\sum_{i=1}^{n} f_i(x_i-\mu)^2}{n}}$

Coefficient of Standard Deviation OR Coefficient of Variation:
The coefficient of standard deviation is a relative measure of dispersion and is given by:

$$\textbf{Coeficient of S.D} = \frac{\textbf{Standard Deviation}}{\textbf{Mean}}$$

The coefficient of standard deviation is also called the coefficient of variation, denoted by C.V and is given by:

$$\textbf{C.V} = \frac{\textbf{Standard Deviation}}{\textbf{Mean}} \times \textbf{100}\%$$

Weighted Average

$$\textbf{Weighted Average} = \frac{\textbf{Sum of weighted Terms}}{\textbf{Total number of Terms}}$$

Example: A class of 25 students took a science test. 10 students had an average (arithmetic mean) score of 80. The other students had an average score of 60. What is the average score of the whole class?

Solution:

Step 1: To get the sum of weighted terms, multiply each average by the number of students that had that average and then sum them up.

$80 \times 10 + 60 \times 15 = 800 + 900 = 1700$

Step 2: Total number of terms = Total number of students = 25

Step 3: Using the formula,

$$\textbf{Weighted Average} = \frac{\textbf{Sum of weighted Terms}}{\textbf{Total number of Terms}} = \frac{\mathbf{1700}}{\mathbf{25}} = \mathbf{68}$$

Answer: The average score of the whole class is 68.

Practice Problem:

A sports club has a volleyball team and a hockey team. The heights of the 6 members of the volleyball team are summarised by $\Sigma x = 1050$ and $\Sigma x^2 = 193\,700$, where x is the height of a member in cm. The heights of the 11 members of the hockey team are summarised by $\Sigma y = 1991$ and $\Sigma y^2 = 366\,400$, where y is the height of a member in cm.

(a) Find the mean height of all 17 members of the club.

(b) Find the standard deviation of the heights of all 17 members of the club.