1) **Range** :- The range of a distribution is the difference between the largest and smallest observations of the distribution.

$\therefore$ Range, $R = L - S$; $L \rightarrow$ Largest observation
$S \rightarrow$ Smallest observation

Merit : It is easy to understand and calculate.

Demerit : 1) Range depends only on the two extreme values
2) We cannot calculate the range of the distribution having either one or both the first and the last intervals being open.

2) **Quartile deviation** : Half of the difference between the 3rd quartile (Q_3) and the first quartile (Q_1) of a distribution is called quartile deviation (Q.D.).

Thus, Quartile deviation (Q.D.) $= \dfrac{Q_3 - Q_1}{2}$.

Advantages : 1) Q.D. is not affected by entreme values, since the lowest 25% and highest 25% observations are not taken into account in calculating Q.D.

(2) Q.D. is the only measure which can be used to determine the variation of distribution involving open-end class intervals.

Limitations: (1) Q.D. is based on only 50% of the observations of a distribution. Thus it ignores half of the total observations.

(2) It is not amenable for further mathematical expansion

Mean Deviation (MD)

The arithmatic mean of absolute deviation of the observations of a distribution from its mean or median is known as mean deviation.

If a variable x takes n values $x_1, x_2, \ldots, x_n$, Then

$$\text{Mean Deviation (MD)} = \frac{|x_1-A|+|x_2-A|+\cdots+|x_n-A|}{n}$$

$$= \frac{\sum_{i=1}^{n}|x_i-A|}{n} \quad ; A \to \text{Mean or Median}$$

Again, if the frequencies of $x_1, x_2, \ldots, x_n$ are $f_1, f_2, \ldots, f_n$ respectively, Then

$$M.D. = \frac{f_1|x_1-A|+f_2|x_2-A|+\cdots+f_n|x_n-A|}{f_1+f_2+\cdots+f_n}$$

$$= \frac{\sum_{i=1}^{n} f_i|x_i-A|}{N} \quad ; A \to \text{mean or median}$$

N = Total frequency

Advantage: (i) It is based on all the observations.
(ii) It is less affected by extreme values in comparison to standard deviation.
(iii) Since deviations are taken from average (mean or median). So, the mean deviation is considered to be a good measure for comparing variability between two or more distributions.

Limitations: i) In mean deviations, actual signs of deviations are ignored by taking absolute values of the deviations.
(ii) One cannot determine mean deviation for a grouped frequency distribution having open-end classes.

4) **Standard deviation**: (S.D.): The positive square root of the arithmatic mean of the squares of the deviations of the values of the variable from its arithmatic mean, is called Standard deviation of that variable.

If a variable x takes $x_1, x_2 ---x_n$ values and $\bar{x}$ be the arithmatic mean of the values. Then

$$\text{Standard deviation } (\sigma) = \sqrt{\frac{(x_1-\bar{x})^2+(x_2-\bar{x})^2+ ----(x_n-\bar{x})^2}{n}}$$

ie $\sigma = \sqrt{\dfrac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}}$; $\bar{x} = \dfrac{\sum x}{n}$. (4)

Again, in case of frequency distribution ie if the variable x takes the values $x_1, x_2 \dots x_n$ with corresponding frequencies are $f_1, f_2 \dots f_n$ respectively, then the Standard deviation.

$$\sigma = \sqrt{\frac{f_1(x_1-\bar{x})^2 + f_2(x_2-\bar{x})^2 + \dots + f_n(x_n-\bar{x})^2}{f_1+f_2+\dots+f_n}}$$

$$= \sqrt{\frac{\sum f_i(x_i-\bar{x})^2}{N}} \; ; \; \bar{x} = \frac{\sum fx}{N}$$

Advantage :- (i) It is based on all the observations
(ii) It is free from ignoring algebraic sign of deviation.
(iii) It is amenable for further mathematical treatment
(iv) Normal curve can be analysed with the help of standard deviation.

Limitation :- i) It is difficult to calculate.
(ii) It is more affected by extreme values.