

### - Standard deviation :

Is the positive square root of the variance. The average deviation of the values of the observations from the mean arithmetic and thus gives an idea of the degree of similarity or homogeneity between the values of the sample observations .

$$S = \sqrt{S^2}$$

### - Characteristics of standard deviation :

1. The standard deviation of the fixed amount is zero. That is, if we have the following readings:  $X = a, a, a, a, \dots, a$  where  $a$  is a fixed amount and  $S_x$  reflect the standard deviation of  $X$  values.
2. If a fixed amount is added to each value of the vocabulary values, the standard deviation of the new values (values after the addition) is equal to the standard deviation of the original values (values before addition). If the original values  $X = x_1, x_2, x_3, x_4, \dots, x_n$  and a fixed amount ( $a$ ) were added to a value of  $X$  values, the standard deviation of the new values is:

$$X = x_1, x_2, x_3, x_4, \dots, x_n .$$

$$Y = x + a .$$

$$Y = x_1 + a, x_2 + a, x_3 + a, x_4 + a, \dots, x_n + a .$$

$$S_y = S_x .$$

**Example 1.** The diet program was used to fattening of broiler, which was weight gains to every chicken was 0.50 kg. The five of broilers were withdrawn from chicken farm and were weight gains as follows: 1, 1.750, 2, 1.250, 2.500 kg .

- Find the following :
1. The standard deviation of chicken weight before applying the diet program ?
  2. The standard deviation of chicken weight after applying the diet program ?

### Solution:

1. Standard deviation of weight before application of diet program :

Poultry weight $X$	$X^2$
1	1
1.750	3.0625
2	4
1.250	1.5625
2.500	6.25
Sum = 8.500	15.875

$$S_x = \sqrt{\frac{\sum xi^2 - (\sum xi)^2 / n}{n - 1}}$$

$$S_x = \sqrt{\frac{(15.875) - (8.500)^2 / 5}{5-1}} =$$

$$S_x = \sqrt{\frac{(15.875) - (72.25) / 5}{4}} =$$

$$S_x = \sqrt{\frac{15.875 - 14.45}{4}} =$$

$$S_x = \sqrt{\frac{1.425}{4}} =$$

$$S_x = \sqrt{0.35625}$$

$$S_x = 0.5968 .$$

2. Determine the standard deviation of chicken weight after application of the diet program.

It is expected that each chicken after the application of the program of food by 0.5 kg This means that the weight after the application of the food program .

$Y = X + 0.5$  and the standard deviation of the new weight is equal to the standard deviation of the original values ie  $0.5968 = S_y = S_x$  .

Poultry weight Y	$Y^2$
$1 + 0.5 = 1.500$	2.25
$1.750 + 0.5 = 2.250$	5.0625
$2 + 0.5 = 2.500$	6.25
$1.250 + 0.5 = 1.750$	3.0625
$2.500 + 0.5 = 3.000$	9
Sum = 11.000	25.625

$$S_y = \sqrt{\frac{\sum yi^2 - (\sum yi)^2 / n}{n-1}}$$

$$S_y = \sqrt{\frac{(25.625) - (11)^2 / 5}{5-1}} =$$

$$S_y = \sqrt{\frac{(25.625) - (121) / 5}{4}} =$$

$$S_y = \sqrt{\frac{25.625 - 24.20}{4}} =$$

$$S_y = \sqrt{\frac{1.425}{4}} =$$

$$S_y = \sqrt{0.35625}$$

$$S_y = 0.5968 .$$

$$S_y = S_x = 0.5968 .$$

**3.If was each value of the vocabulary values is multiplied by a constant, the standard deviation of new value equals the standard deviation of original value multiplied by the constant. Where it is a fixed amount.**

$$X = x . \quad , \quad Y = ax$$

$$S_y = aS_x$$

**Example 2: If the standard deviation of a sample of students is (4) degrees if the correction of 50 degrees and the degree is intended to be corrected to 100 degrees and the meaning of each score is multiplied by the original grades in 2 and then calculate the standard deviation of the modified grades As follows:**

$$S_x = 4., \quad S_y = ax$$

$$S_y = aS_x =$$

$$S_y = 2 \times 4 = 8 .$$

**-Advantages of standard deviation:**

1. More commonly used dispersion scales.
2. It is easy to deal with him mathematically.
3. Take all the values into consideration.

**-Disadvantages of standard deviation:**

1. Affected by abnormal values .

**Fifteen workers were doing in the food packaging factory. The number of years of experience for these workers were as follows:**

**Years of experience  $X_i = 5, 13, 7, 14, 12, 9, 6, 8, 10, 13, 14, 6, 11, 12, 10$ .**

Find the following :

1. variance for years of experience in the community .
2. Standard Deviation of Years of Community Experience .

**Solution:**

First. To calculate variance for years of experience in the community?

1.The computational mean of the community ( $\mu$ ) is calculated .

$\mu = \sum X_i / n$  The computational mean of the community .

$\mu = \sum X_i / n$  الوسط الحسابي للمجتمع

$\mu = (5 + 13 + 7 + 14 + 12 + 9 + 6 + 8 + 10 + 13 + 14 + 6 + 11 + 12 + 10) / 15 = 150/15 = 10 .$

سنوات الخبرة ( $X_i$ )	( $X - \mu$ )	( $X - \mu$ ) <sup>2</sup>
5	5 - 10 = -5	25
13	13 - 10 = 3	9
7	7 - 10 = -3	9
14	14 - 10 = 4	16
12	12 - 10 = 2	4
9	9 - 10 = -1	1
6	6 - 10 = -4	16
8	8 - 10 = -2	4
10	10 - 10 = 0	0
13	13 - 10 = 3	9
14	14 - 10 = 4	16
6	6 - 10 = -4	16
11	11 - 10 = 1	1
12	12 - 10 = 2	4
10	10 - 10 = 0	0
Sum = 150	0	130

$$\sigma^2 = \frac{\sum (x - u)^2}{N}$$

$$\sigma^2 = 130/15 = 8.67 .$$

$$\sigma = \sqrt{\sigma^2} .$$

$$\sigma = \sqrt{8.67} = 2.94 .$$

**Second : To calculate the standard deviation of years of experience in the community ?**

$$\sigma = \sqrt{\frac{\sum yi^2 - (\sum yi)^2 / n}{n - 1}}$$

سنوات الخبرة (X)	( X <sup>2</sup> )
5	25
13	169
7	49
14	196
12	144
9	81
6	36
8	64
10	100
13	169
14	196
6	36
11	121
12	144
10	100
Sum = 150	1630

$$\sigma = \sqrt{\frac{\sum Xi^2 - (\sum Xi)^2 / n}{n - 1}}$$

$$\sigma = \sqrt{[1630 - (150)^2 / 15] 15 - 1 =}$$

$$\sigma = \sqrt{[1630 - (22500) / 15] 14 =}$$

$$\sigma = \sqrt{[1630 - (1500)] 14 =}$$

$$\sigma = \sqrt{[130] / 14 =}$$

$$\sigma = \sqrt{9.285} =$$

$$\sigma = 3.04 .$$

**Example 4.** A sample of five workers was withdrawn from food package factory and the number of years of experience of these workers was recorded as follows:

Years of experience  $X = 8, 13, 10, 5, 9$ .

Find the following:

First. variance for years of experience in the sample?

Second. Standard deviation of years of experience in the sample?

The solution:

First. To calculate variance for years of experience in the sample?

1. The arithmetic mean of the sample ( $\bar{X}$ ) is calculated .

The arithmetic mean of the sample is  $\bar{X} = \sum X_i / n$  .

$$\bar{X} = (8 + 13 + 10 + 5 + 9) / 5 = 45/5 = 9 .$$

سنوات الخبرة ( $X_i$ )	( $X - \bar{X}$ )	( $X - \bar{X}$ ) <sup>2</sup>
8	$8 - 9 = -1$	1
13	$13 - 9 = 4$	16
10	$10 - 9 = 1$	1
5	$5 - 9 = -4$	16
9	$9 - 9 = 0$	0
Sum = 45	0	34

$$S^2 = \sum (X - \bar{X})^2 / n$$

$$S^2 = 34/5 = 6.8 .$$

$$S = \sqrt{S^2} .$$

$$S = \sqrt{6.8} = 2.61 .$$

Second. To calculate the standard deviation of years of experience in the community?

$$S = \sqrt{\frac{\sum X_i^2 - (\sum X_i)^2 / n}{n - 1}}$$

سنوات الخبرة ( $X_i$ )	( $X_i^2$ )
8	64
13	169
10	100
5	25
9	81
Sum = 45	439

$$S = \sqrt{\frac{\sum X_i^2 - (\sum X_i)^2 / n}{n - 1}}$$

$$S = \sqrt{[439 - (45)^2 / 5] / 5 - 1} =$$

$$S = \sqrt{[439 - (2025) / 5] / 4} =$$

$$S = \sqrt{[439 - (405)] / 4} =$$

$$S = \sqrt{[34] / 4} =$$

$$S = \sqrt{8.50} = , S = 2.92 .$$

#### - Standard deviation in the classified data :

If the data of a phenomenon is classified in a frequency distribution table, the standard deviation is calculated using the following equation :

$$\begin{aligned} s &= \sqrt{\frac{\sum (x - \bar{x})^2 f}{n - 1}} \\ \text{or} \quad s &= \sqrt{\frac{\sum x^2 f - \frac{(\sum xf)^2}{n}}{n - 1}} \end{aligned} \quad (12-4)$$

whereas:  $S^2$  represents is the sample variation .

$S$  is the standard deviation of the sample.

$X$  represents the class center.

$\bar{X}$  The mean of the sample.

$F$  is the frequency.

$n$  is number of duplicates .

**Example 5.** Calculate the standard deviation of monthly household expenditure for these families following ?

Classes (expenditure)	$f_i$ (No. of families)	Class centers (X) (مركز الفئة)	$Xf_i$	$X^2 f_i$
2 - 5	1	3.5	3.5	12.25
5 - 8	8	6.5	52	338
8 - 11	13	9.5	123.5	1173.25
11 - 14	10	12.5	125	1562.50
14 - 17	8	15.5	124	1922
sum	40		428	5008

$$S = \sqrt{\frac{[\sum X^2 f - (\sum X f)^2 / f]}{f - 1}}$$

$$S = \sqrt{[5008 - (428)^2 / 40] / 40 - 1} = \sqrt{[5008 - (183184) / 40] / 39} =$$

$$S = \sqrt{[5008 - 4579.60] / 39} = \sqrt{[428.40] / 39} = \sqrt{10.98} = S = 3.314$$

**S = 3.314** is a standard deviation of household monthly expenditure .