# LAB. METEOROLOGICAL STATISTICS ........ FOURTH STAGE

**(First Semester)**

**Department of Atmospheric Sciences**

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## C- The standard deviation

The standard deviation of a set of N values $x_1, x_2, \ldots \ldots x_N$ is denoted ( S )

**1- Calculation the Standard deviation for unclassified data:**

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

*For example*\\ calculate the standard deviation of the following data?
 **( 2,3.5,4,4.5,5)**

| $x_i$ | $(x_i - \bar{x})$ | $(x_i - \bar{x})^2$ |
|-------|-------------------|---------------------|
| 3     | 3-4=-1            | 1                   |
| 3.5   | 3.5-4= -0.5       | 0.25                |
| 4     | (4-4) = 0         | 0                   |
| 4.5   | (4.5-4 )= 0.5     | 0.25                |
| 5     | (5-4)=   1        | 1                   |
|       |                   | $\sum (x_i - \bar{x})^2 = 2.5$ |

$$SD = \sqrt{\frac{\sum(x_i - \bar{x})^2}{N}} \quad \longrightarrow \quad \sqrt{\frac{2.5}{5}} = \sqrt{0.5}$$

**H.W \\  find the standard deviation from the following data :**

**( 2,8,3,7,6,4)**

**2-Calculation the standard deviation of the classified data:**

The standard deviation some times called root mean square deviation ( Rms ) if $x_1$ ,$x_2, \ldots \ldots x_N$ is mid point of classes and $f_1, f_2, \ldots \ldots f_N$ is frequency the standard deviation can be by :

$$SD = \sqrt{\frac{\sum f_i(x - \bar{x})^2}{\sum f_i}}$$

*For example*\\ calculate The Standerd deviation of the following data?

| Class | $f_i$ | $x_i$ | $f_i x_i$ |
|-------|-------|-------|-----------|
| 15-19 | 3 | 17 | 51 |
| 20-24 | 5 | 22 | 110 |
| 25-29 | 7 | 27 | 189 |
| 30-34 | 15 | 32 | 480 |
| 35-39 | 10 | 37 | 370 |
| 40-44 | 6 | 42 | 252 |
| 45-49 | 4 | 47 | 188 |
|  | $\sum f_i = 50$ |  | $\sum f_i x_i = 1640$ |

$$SD = \sqrt{\frac{\sum f_i (x - \bar{x})^2}{\sum f_i}}$$

$$\bar{x} = 32.8$$

| Class | $f_i$ | $x_i$ | $f_i x_i$ | $(x_i - \bar{x})$ | $(x_i - \bar{x})^2$ | $f_i(x_i - \bar{x})^2$ |
|-------|-------|-------|-----------|-------------------|---------------------|------------------------|
| 15-19 | 3 | 17 | 51 | -15.8 | 249.64 | 748. 92 |
| 20-24 | 5 | 22 | 110 | -10.8 | 116.64 | 583.2 |
| 25-29 | 7 | 27 | 189 | -5.8 | 33.64 | 235.48 |
| 30-34 | 15 | 32 | 480 | -0.8 | 0.64 | 9.6 |
| 35-39 | 10 | 37 | 370 | 4.2 | 17.64 | 176.4 |
| 40-44 | 6 | 42 | 252 | 9.2 | 84.64 | 507.8 |
| 45-49 | 4 | 47 | 188 | 14.2 | 201.64 | 806.56 |
|  | $\sum f_i = 50$ |  | $\sum f_i x_i = 1640$ |  |  | $\sum f_i(x_i - x)^2 = 3068$ |

$$SD = \sqrt{\frac{\sum f_i(x_i - \bar{x})^2}{\sum f_i}} \qquad \longrightarrow \sqrt{\frac{3068}{50}} = \sqrt{61.36} = 7.83$$

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**_D-The variance_** ($S^2$): The variance depends on the dispersion and the divergence of the data from its mean, so the variance is large if the data is divergent from its mean and vice versa.

**1-Calculation  the variance for unclassified data:**

$$S^2 = \frac{\sum x_i^2}{n} - \left(\frac{\sum x_i}{n}\right)^2 \qquad\qquad S^2 = \frac{\sum x_i^2}{n} - \bar{x}^2$$

*For example*\\ calculate the variance  deviation of the following data?

| $x_i$ | $x_i^2$ |
|-------|---------|
| 3 | 9 |
| 3.5 | 12.25 |
| 4 | 16 |
| 4.5 | 20.25 |
| 5 | 25 |
| $\sum x_i = 20$ | $\sum x_i^2 = 82.5$ |

$$\bar{x}^2 = 16$$

$$S^2 = \frac{\sum x_i^2}{n} - \bar{x}^2 \qquad\longrightarrow$$

$$S^2 = \frac{82.5}{5} - 16 \qquad\longrightarrow\qquad S^2 = 0.5$$

**NOTS:** the standard deviation can be extracted by the second method.

**1- the standard deviation=$\sqrt{\text{variance}}$**

$$SD = \sqrt{S^2} \qquad\longrightarrow\qquad SD = \sqrt{\frac{\sum x_i^2}{n} - \bar{x}^2}$$

*For example*\\   S.D.$= \sqrt{0.5} = 0.707$    **whereas**: $S^2 = S * S =$ 0.707*0.707= 0.5

**2- Standard Deviation   = SQRT (Variance )**

SD = SQRT (0.5)

2- **Calculation  the variance for classified data:**

$$S^2 = \frac{\sum x_i^2 f_i}{\sum f_i} - \bar{x}^2$$

*For example*\\ calculate the variance  deviation of the following data?

| Classes | $f_i$ | $x_i$ | $f_i x_i$ | $x_i^2$ | $f_i x_i^2$ |
|---------|-------|-------|-----------|---------|-------------|
| 15-19 | 3 | 17 | 51 | 289 | 867 |
| 20-24 | 5 | 22 | 110 | 484 | 2420 |
| 25-29 | 7 | 27 | 189 | 729 | 5103 |
| 30-34 | 15 | 32 | 480 | 1024 | 15360 |
| 35-39 | 10 | 37 | 370 | 1369 | 13640 |
| 40-44 | 6 | 42 | 252 | 1764 | 10584 |
| 45-49 | 4 | 47 | 188 | 2209 | 8836 |
| | $\sum f_i =$ 50 | | $\sum f_i x_i$ =1640 | | $\sum f_i x_i^2$ =56860 |

$$\overline{x} = \frac{\sum f_i x_i}{\sum f_i} = \frac{1640}{50} = \mathbf{32.8} \qquad \overline{x}^2 = 32.8*32.8 = 1075.84$$

$$1 - S^2 = \frac{\sum x_i^2 f_i}{\sum f_i} - \overline{x}^2 \qquad\Longrightarrow\qquad S^2 = \frac{56860}{50} - 1075.84$$

$$S^2 = 61.36$$

$$2\text{-} S = \sqrt{\frac{\sum f_i (x_i - \overline{x})^2}{\sum f_i}} \qquad\Longrightarrow\qquad S = \sqrt{1137.2 - 1075.84} = 7.833$$

$$S^2 = (7.833)^2 = 61.36$$

**H.W (1) \\ find The Standerd deviation  and the variance  of the following data**

| Classes | f | $xi$ |
|---------|---|------|
| 2-4 | 2 | 3 |
| 4-6 | 3 | 5 |
| 6-8 | 6 | 7 |
| 8-10 | 2 | 9 |
| 10-12 | 1 | 11 |
| | $\sum f = 14$ | |

**H.W(2) \\ find the variance  and The Standerd deviation  of the following data :**

| Class | fi |
|-------|----|
| 10-14 | 6 |
| 15-19 | 5 |
| 20-24 | 12 |
| 25-29 | 9 |
| 30-34 | 8 |