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:

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

For example\\ calculate the standard deviation of the following data?

(2,3.5,4,4.5,5)

$\mathbf{x_i}$	$(\mathbf{x_i} - \bar{\mathbf{x}})$	$(\mathbf{x_i} - \bar{\mathbf{x}})^2$
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
		$\sum (\mathbf{x_i} - \bar{\mathbf{x}})^2 = \mathbf{2.5}$

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

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 :

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

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

$\bar{x}$ **= 32.8**

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

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

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

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:

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

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
$\sum x_i = 20$	$\sum x_i^2 = 82.5$

$\bar{x}^2 = 16$

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

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

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

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

SD = $\sqrt{S^2} \longrightarrow$ **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

$\bar{x} = \frac{\sum f_i x_i}{\sum f_i} = \frac{1640}{50} = 32.8$ ⟶ $\bar{x}^2$=32.8*32.8=1075.84

$1 - S^2 = \frac{\sum x_i^2 f_i}{\sum f_i} - \bar{x}^2$ ⟶ $S^2 = \frac{56860}{50} - 1075.84$

$S^2 = 61.36$

2- S = $\sqrt{\frac{\sum f_i (x_i - \bar{x})^2}{\sum f_i}}$ ⟶ S = $\sqrt{1137.2 - 1075.84}$ = 7.833

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

H.W \\ 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	