NCERT solutions for class 11 maths chapter 15 statistics

Question:1 . Find the mean deviation about the mean for the data.

$4, 7, 8, 9, 10, 12, 13, 17$

Answer:

Mean ($\overline{x}$) of the given data:

$$\overline{x} = \frac{1}{8}\sum_{i=1}^{8} x_i = \frac{4+7+8+9+10+12+13+17}{8} = 10$$

The respective absolute values of the deviations from mean, $|x_i - \overline{x}|$ are

6, 3, 2, 1, 0, 2, 3, 7

$$\therefore \sum_{i=1}^{8} |x_i - 10| = 24$$

$$\therefore M.D.(\overline{x}) = \frac{1}{n}\sum_{i=1}^{n} |x_i - \overline{x}|$$

$$= \frac{24}{8} = 3$$

Hence, the mean deviation about the mean is 3.

Question:2. Find the mean deviation about the mean for the data.

$38, 70, 48, 40, 42, 55, 63, 46, 54, 44$

Answer:

Mean ($\overline{x}$) of the given data:

$$\overline{x} = \frac{1}{8}\sum_{i=1}^{8} x_i = \frac{38+70+48+40+42+55+63+46+54+44}{10}$$

$$= \frac{500}{10} = 50$$

The respective absolute values of the deviations from mean, $|x_i - \overline{x}|$ are

12, 20, 2, 10, 8, 5, 13, 4, 4, 6

$$\therefore \sum_{i=1}^{8} |x_i - 50| = 84$$

$$\therefore M.D.(\overline{x}) = \frac{1}{n}\sum_{i=1}^{n} |x_i - \overline{x}|$$

$$= \frac{84}{10} = 8.4$$

Hence, the mean deviation about the mean is 8.4.

Question:3. Find the mean deviation about the median.

13, 17, 16, 14, 11, 13, 10, 16, 11, 18, 12, 17

Answer:

Number of observations, n = 12, which is even.

Arranging the values in ascending order:

10, 11, 11, 12, 13, 13, 14, 16, 16, 17, 17, 18.

Now, Median (M)

The respective absolute values of the deviations from median, $|x_i - M|$ are

3.5, 2.5, 2.5, 1.5, 0.5, 0.5, 0.5, 2.5, 2.5, 3.5, 3.5, 4.5

$$\therefore \sum_{i=1}^{8} |x_i - 13.5| = 28$$

$$\therefore M.D.(M) = \frac{1}{12}\sum_{i=1}^{n} |x_i - M|$$

$$= \frac{28}{12} = 2.33$$

Hence, the mean deviation about the median is 2.33.

Question:4. Find the mean deviation about the median.

$36, 72, 46, 42, 60, 45, 53, 46, 51, 49$

Answer:

Number of observations, n = 10, which is even.

Arranging the values in ascending order:

36, 42, 45, 46, 46, 49, 51, 53, 60, 72

Now, Median (M)

The respective absolute values of the deviations from median, $|x_i - M|$ are

11.5, 5.5, 2.5, 1.5, 1.5, 1.5, 3.5, 5.5, 12.5, 24.5

$$\therefore \sum_{i=1}^{8} |x_i - 47.5| = 70$$

$$\therefore M.D.(M) = \frac{1}{10}\sum_{i=1}^{n} |x_i - M|$$

$$= \frac{70}{10} = 7$$

Hence, the mean deviation about the median is 7.

Question:5 Find the mean deviation about the mean.

Answer:

x_i	f_i	$f_i x_i$	$\|x_i - \overline{x}\|$	$f_i\|x_i - \overline{x}\|$
5	7	35	9	63
10	4	40	4	16
15	6	90	1	6
20	3	60	6	18
25	5	125	11	55

	$\sum f_i$ = 25	$\sum f_i x_i$ = 350		$\sum f_i\|x_i - \overline{x}\|$ =158

$$N = \sum_{i=1}^{5} f_i = 25; \sum_{i=1}^{5} f_i x_i = 350$$

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{n} f_i x_i = \frac{350}{12} = 14$$

Now, we calculate the absolute values of the deviations from mean, $|x_i - \overline{x}|$ and

$\sum f_i|x_i - \overline{x}|$ = 158

$$\therefore M.D.(\overline{x}) = \frac{1}{25}\sum_{i=1}^{n} f_i|x_i - \overline{x}|$$

$$= \frac{158}{25} = 6.32$$

Hence, the mean deviation about the mean is 6.32

Question:6. Find the mean deviation about the mean.

Answer:

x_i	f_i	$f_i x_i$	$\|x_i - \overline{x}\|$	$f_i\|x_i - \overline{x}\|$
10	4	40	40	160
30	24	720	20	480

50	28	1400	0	0
70	16	1120	20	320
90	8	720	40	320
	$\sum f_i$ = 80	$\sum f_i x_i$ = 4000		$\sum f_i \lvert x_i - \overline{x} \rvert$ =1280

$$N = \sum_{i=1}^{5} f_i = 80; \sum_{i=1}^{5} f_i x_i = 4000$$

$$\overline{x} = \frac{1}{N} \sum_{i=1}^{n} f_i x_i = \frac{4000}{80} = 50$$

Now, we calculate the absolute values of the deviations from mean, $|x_i - \overline{x}|$ and

$\sum f_i |x_i - \overline{x}|$ = 1280

$$\therefore M.D.(\overline{x}) = \frac{1}{80} \sum_{i=1}^{5} f_i |x_i - \overline{x}|$$

$$= \frac{1280}{80} = 16$$

Hence, the mean deviation about the mean is 16

Question:7. Find the mean deviation about the median.

x_i 5 7 9 10 12 15

f_i 8 6 2 2 2 6

Answer:

x_i	f_i	$c.f.$	$\|x_i - M\|$	$f_i\|x_i - M\|$
5	8	8	2	16
7	6	14	0	0
9	2	16	2	4
10	2	18	3	6
12	2	20	5	10
15	6	26	8	48

Now, N = 26 which is even.

Median is the mean of 13^{th} and 14^{th} observations.

Both these observations lie in the cumulative frequency 14, for which the corresponding observation is 7.

Therefore, Median, M $= \frac{13^{th} observation + 14^{th} observation}{2} = \frac{7+7}{2} = \frac{14}{2} = 7$

Now, we calculate the absolute values of the deviations from median, $|x_i - M|$ and

$\sum f_i|x_i - M|$ = 84

$$\therefore M.D.(M) = \frac{1}{26}\sum_{i=1}^{6}|x_i - M|$$

$$= \frac{84}{26} = 3.23$$

Hence, the mean deviation about the median is 3.23

Question:8 Find the mean deviation about the median.

x_i 15 21 27 30 35

f_i 3 5 6 7 8

Answer:

x_i	f_i	$c.f.$	$\|x_i - M\|$	$f_i\|x_i - M\|$
15	3	3	13.5	40.5
21	5	8	7.5	37.5
27	6	14	1.5	9
30	7	21	1.5	10.5
35	8	29	6.5	52

Now, N = 30, which is even.

Median is the mean of 15^{th} and 16^{th} observations.

Both these observations lie in the cumulative frequency 21, for which the corresponding observation is 30.

Therefore, Median, M $= \frac{15^{th} observation + 16^{th} observation}{2} = \frac{30+30}{2} = 30$

Now, we calculate the absolute values of the deviations from median, $|x_i - M|$ and

$\sum f_i|x_i - M|$ = 149.5

$\therefore M.D.(M) = \frac{1}{29}\sum_{i=1}^{5}|x_i - M|$

$= \frac{149.5}{29} = 5.1$

Hence, the mean deviation about the median is 5.1

Question:9. Find the mean deviation about the mean.

Income per day in Rs	$0-100$	$100-200$	$200-300$	$300-400$	$400-500$	$500-600$	$600-700$	70
Number of persons	4	8	9	10	7	5	4	

Answer:

Income per day	Number of Persons f_i	Mid Points x_i	$f_i x_i$	$\lvert x_i - \overline{x} \rvert$	$f_i \lvert x_i - \overline{x} \rvert$
0 -100	4	50	200	308	1232
100 - 200	8	150	1200	208	1664
200-300	9	250	2250	108	972
300-400	10	350	3500	8	80
400-500	7	450	3150	92	644

500-600	5	550	2750	192	960
600-700	4	650	2600	292	1168
700-800	3	750	2250	392	1176
	$\sum f_i$ =50		$\sum f_i x_i$ =17900		$\sum f_i\|x_i - \overline{x}\|$ =7896

$$N = \sum_{i=1}^{8} f_i = 50; \sum_{i=1}^{8} f_i x_i = 17900$$

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{8} f_i x_i = \frac{17900}{50} = 358$$

Now, we calculate the absolute values of the deviations from mean, $|x_i - \overline{x}|$ and

$\sum f_i|x_i - \overline{x}|$ = 7896

$$\therefore M.D.(\overline{x}) = \frac{1}{50}\sum_{i=1}^{8} f_i|x_i - \overline{x}|$$

$$= \frac{7896}{50} = 157.92$$

Hence, the mean deviation about the mean is 157.92

Question:10. Find the mean deviation about the mean.

Height in cms	$95-105$	$105-115$	$115-125$	$125-135$	$135-145$	$145-155$
Number of persond	9	13	26	30	12	10

Answer:

Height in cms	Number of Persons f_i	Mid Points x_i	$f_i x_i$	$\lvert x_i - \overline{x}\rvert$	$f_i\lvert x_i - \overline{x}\rvert$
95 -105	9	100	900	25.3	227.7
105 -115	13	110	1430	15.3	198.9
115-125	26	120	3120	5.3	137.8
125-135	30	130	3900	4.7	141
135-145	12	140	1680	14.7	176.4
145-155	10	150	1500	24.7	247

	$\sum f_i$ =100		$\sum f_i x_i$ =12530		$\sum f_i\|x_i - \overline{x}\|$ =1128.8

$$N = \sum_{i=1}^{6} f_i = 100; \sum_{i=1}^{6} f_i x_i = 12530$$

$$\overline{x} = \frac{1}{N} \sum_{i=1}^{6} f_i x_i = \frac{12530}{100} = 125.3$$

Now, we calculate the absolute values of the deviations from mean, $|x_i - \overline{x}|$ and

$\sum f_i|x_i - \overline{x}|$ = 1128.8

$$\therefore M.D.(\overline{x}) = \frac{1}{100} \sum_{i=1}^{6} f_i|x_i - \overline{x}|$$

$$= \frac{1128.8}{100} = 11.29$$

Hence, the mean deviation about the mean is 11.29

Question:11. Find the mean deviation about median for the following data :

Marks	$0-10$	$10-20$	$20-30$	$30-40$	$40-50$	$50-60$
Number of girls	6	8	14	16	4	2

Answer:

Marks	Number of Girls f_i	Cumulative Frequency c.f.	Mid Points x_i	$\|x_i - M\|$	$f_i\|x_i - M\|$
0-10	6	6	5	22.85	137.1
10-20	8	14	15	12.85	102.8
20-30	14	28	25	2.85	39.9
30-40	16	44	35	7.15	114.4
40-50	4	48	45	17.15	68.6
50-60	2	50	55	27.15	54.3
					$\sum f_i\|x_i - M\|$ =517.1

Now, N = 50, which is even.

The class interval containing $\left(\frac{N}{2}\right)^{th}$ or 25^{th} item is 20-30. Therefore, 20-30 is the median class.

We know,

Median $= l + \frac{\frac{N}{2} - C}{f} \times h$

Here, l = 20, C = 14, f = 14, h = 10 and N = 50

Therefore, Median $= 20 + \frac{25-14}{14} \times 10 = 20 + 7.85 = 27.85$

Now, we calculate the absolute values of the deviations from median, $|x_i - M|$ and

$\sum f_i|x_i - M|$ = 517.1

$\therefore M.D.(M) = \frac{1}{50}\sum_{i=1}^{6} f_i|x_i - M|$

$= \frac{517.1}{50} = 10.34$

Hence, the mean deviation about the median is 10.34

Question:12 Calculate the mean deviation about median age for the age distribution of 100 persons given below:

Age (in years)	$16-20$	$21-25$	$26-30$	$31-35$	$36-40$	$41-45$	$46-50$	$51-55$
Number	5	6	12	14	26	12	16	9

[**Hint** Convert the given data into continuous frequency distribution by subtracting 0.5 from the lower limit and adding 0.5 to the upper limit of each class interval]

Answer:

Age (in years)	Number f_i	Cumulative Frequency c.f.	Mid Points x_i	$\|x_i - M\|$	$f_i\|x_i - M\|$
15.5-20.5	5	5	18	20	100
20.5-25.5	6	11	23	15	90
25.5-30.5	12	23	28	10	120
30.5-35.5	14	37	33	5	70
35.5-40.5	26	63	38	0	0
40.5-45.5	12	75	43	5	60
45.5-50.5	16	91	48	10	160
50.5-55.5	9	100	53	15	135

					$\sum f_i\lvert x_i - M\rvert$ =735

Now, N = 100, which is even.

The class interval containing $\left(\frac{N}{2}\right)^{th}$ or 50^{th} item is 35.5-40.5. Therefore, 35.5-40.5 is the median class.

We know,

Median $= l + \frac{\frac{N}{2} - C}{f} \times h$

Here, l = 35.5, C = 37, f = 26, h = 5 and N = 100

Therefore, Median $= 35.5 + \frac{50 - 37}{26} \times 5 = 35.5 + 2.5 = 38$

Now, we calculate the absolute values of the deviations from median, $\lvert x_i - M\rvert$ and

$\sum f_i\lvert x_i - M\rvert$ = 735

$\therefore M.D.(M) = \frac{1}{100}\sum_{i=1}^{8} f_i\lvert x_i - M\rvert$

$= \frac{735}{100} = 7.35$

Hence, the mean deviation about the median is 7.35

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NCERT solutions for class 11 maths chapter 15 statistics-Exercise: 15.2

Question:1. Find the mean and variance for each of the data.

6, 7, 10, 12, 13, 4, 8, 12

Answer:

Mean ($\overline{x}$) of the given data:

$$\overline{x}=\frac{1}{8}\sum_{i=1}^{8}x_i=\frac{6+7+10+12+13+4+8+12}{8}=\frac{72}{8}=9$$

The respective values of the deviations from mean, $(x_i-\overline{x})$ are

-3, -2, 1 3 4 -5 -1 3

$$\therefore \sum_{i=1}^{8}(x_i-10)^2=74$$

$$\therefore \sigma^2=\frac{1}{n}\sum_{i=1}^{n}(x_i-\overline{x})^2$$

$$\frac{1}{8}\sum_{i=1}^{8}(x_i-\overline{x})^2=\frac{74}{8}=9.25$$

Hence, Mean = 9 and Variance = 9.25

Question:2. Find the mean and variance for each of the data.

First n natural numbers.

Answer:

Mean ($\overline{x}$) of first n natural numbers:

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{\frac{n(n+1)}{2}}{n} = \frac{n+1}{2}$$

We know, Variance $\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2$

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}\left(x_i - \frac{n+1}{2}\right)^2$$

We know that $(a-b)^2 = a^2 - 2ab + b^2$

$$\implies \sigma^2 = \frac{(n+1)(2n+1)}{6} + \frac{(n+1)^2}{4} - \frac{(n+1)^2}{2}$$

Hence, Mean = $\frac{n+1}{2}$ and Variance = $\frac{n^2-1}{12}$

Question:3. Find the mean and variance for each of the data

First 10 multiples of 3

Answer:

First 10 multiples of 3 are:

3, 6, 9, 12, 15, 18, 21, 24, 27, 30

Mean ($\overline{x}$) of the above values:

The respective values of the deviations from mean, $(x_i - \overline{x})$ are

-13.5, -10.5, -7.5, -4.5, -1.5, 1.5, 4.5, 7.5, 10.5, 13.5

$$\therefore \sum_{i=1}^{10}(x_i - 16.5)^2 = 742.5$$

$$\therefore \sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2$$

$$\frac{1}{10}\sum_{i=1}^{10}(x_i - \overline{x})^2 = \frac{742.5}{10} = 74.25$$

Hence, Mean = 16.5 and Variance = 74.25

Question:4. Find the mean and variance for each of the data.

x_i	6	10	14	18	24	28	30
f_i	2	4	7	12	8	4	3

Answer:

x_i	f_i	f_ix_i	$(x_i - \overline{x})$	$(x_i - \overline{x})^2$	$f_i(x_i - \overline{x})^2$
6	2	12	-13	169	338
10	4	40	-9	81	324
14	7	98	-5	25	175
18	12	216	-1	1	12
24	8	192	5	25	200
28	4	112	9	81	324
30	3	90	13	169	363
	$\sum f_i$ = 40	$\sum f_ix_i$ = 760			$\sum f_i(x_i - \overline{x})^2$ =1736

$$N = \sum_{i=1}^{7} f_i = 40; \sum_{i=1}^{7} f_ix_i = 760$$

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{n} f_ix_i = \frac{760}{40} = 19$$

We know, Variance, $\sigma^2 = \frac{1}{N}\sum_{i=1}^{n}(x_i - \overline{x})^2$

$$\implies \sigma^2 = \frac{1736}{40} = 43.4$$

Hence, Mean = 19 and Variance = 43.4

Question:5. Find the mean and variance for each of the data.

x_i	92	93	97	98	102	104	109
f_i	3	2	3	2	6	3	3

Answer:

x_i	f_i	$f_i x_i$	$(x_i - \overline{x})$	$(x_i - \overline{x})^2$	$f_i(x_i - \overline{x})^2$
92	3	276	-8	64	192
93	2	186	-7	49	98
97	3	291	-3	9	27
98	2	196	-2	4	8
102	6	612	2	4	24
104	3	312	4	16	48

109	3	327	9	81	243
	$\sum f_i$ = 22	$\sum f_i x_i$ = 2200			$\sum f_i(x_i - \overline{x})^2$ =640

$$N = \sum_{i=1}^{7} f_i = 22; \sum_{i=1}^{7} f_i x_i = 2200$$

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{n} f_i x_i = \frac{2200}{22} = 100$$

We know, Variance, $\sigma^2 = \frac{1}{N}\sum_{i=1}^{n}(x_i - \overline{x})^2$

$$\implies \sigma^2 = \frac{640}{22} = 29.09$$

Hence, Mean = 100 and Variance = 29.09

Question:6 Find the mean and standard deviation using short-cut method.

x_i	60	61	62	63	64	65	66	67	68
f_i	2	1	12	29	25	12	10	4	5

Answer:

Let the assumed mean, A = 64 and h = 1

x_i	f_i	$y_i = \frac{x_i - A}{h}$	y_i^2	$f_i y_i$	$f_i y_i^2$
60	2	-4	16	-8	32
61	1	-3	9	-3	9
62	12	-2	4	-24	48
63	29	-1	1	-29	29
64	25	0	0	0	0
65	12	1	1	12	12
66	10	2	4	20	40
67	4	3	9	12	36
68	5	4	16	20	80
	$\sum f_i$ =100			$\sum f_i y_i$ = 0	$\sum f_i y_i^2$ =286

$$N = \sum_{i=1}^{9} f_i = 100; \sum_{i=1}^{9} f_i y_i = 0$$

Mean,

$$\overline{x} = A + \frac{1}{N}\sum_{i=1}^{n} f_i y_i \times h = 64 + \frac{0}{100} = 64$$

We know, Variance, $\sigma^2 = \frac{1}{N^2}\left[N\sum f_i y_i^2 - \left(\sum f_i y_i\right)^2\right] \times h^2$

$$\implies \sigma^2 = \frac{1}{(100)^2}\left[100(286) - (0)^2\right]$$
$$= \frac{28600}{10000} = 2.86$$

We know, Standard Deviation = $\sigma = \sqrt{Variance}$

$\therefore \sigma = \sqrt{2.86} = 1.691$

Hence, Mean = 64 and Standard Deviation = 1.691

Question:â□□â□□â□□â□□â□□â□□â□□7. Find the mean and variance for the following frequency distributions.

Classes	0-30	30-60	60-90	90-120	120-150	150-180	180-210
Frequencies	2	3	5	10	3	5	2

Answer:

Classes	Frequency f_i	Mid point x_i	$f_i x_i$	$(x_i - \overline{x})$	$(x_i - \overline{x})^2$	$f_i(x_i - \overline{x})^2$

0-30	2	15	30	-92	8464	16928
30-60	3	45	135	-62	3844	11532
60-90	5	75	375	-32	1024	5120
90-120	10	105	1050	2	4	40
120-150	3	135	405	28	784	2352
150-180	5	165	825	58	3364	16820
180-210	2	195	390	88	7744	15488
	$\sum f_i$ = N = 30		$\sum f_i x_i$ = 3210			$\sum f_i(x_i - \overline{x})^2$ =68280

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{n} f_i x_i = \frac{3210}{30} = 107$$

We know, Variance, $\sigma^2 = \frac{1}{N}\sum_{i=1}^{n}(x_i - \overline{x})^2$

$$\implies \sigma^2 = \frac{68280}{30} = 2276$$

Hence, Mean = 107 and Variance = 2276

Question:â□□â□□â□□â□□â□□â□□â□□8. Find the mean and variance for the following frequency distributions.

Classes	0-10	10-20	20-30	30-40	40-50
Frequencies	5	8	15	16	6

Answer:

Classes	Frequency f_i	Mid-point x_i	f_ix_i	$(x_i-\overline{x})$	$(x_i-\overline{x})^2$	$f_i(x_i-\overline{x})^2$
0-10	5	5	25	-22	484	2420
10-20	8	15	120	-12	144	1152
20-30	15	25	375	-2	4	60
30-40	16	35	560	8	64	1024
40-50	6	45	270	18	324	1944

	$\sum f_i = N$ = 50		$\sum f_i x_i$ = 1350			$\sum f_i (x_i - \overline{x})^2$ =6600

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{n} f_i x_i = \frac{1350}{50} = 27$$

We know, Variance, $\sigma^2 = \frac{1}{N}\sum_{i=1}^{n}(x_i - \overline{x})^2$

$$\implies \sigma^2 = \frac{6600}{50} = 132$$

Hence, Mean = 27 and Variance = 132

Question:9. Find the mean, variance and standard deviation using short-cut method.

Height in cms	70-75	75-80	80-85	85-90	90-95	95-100	100-105	105-110	110-115
No. of students	3	4	7	7	15	9	6	6	3

Answer:

Let the assumed mean, A = 92.5 and h = 5

Height in cms	Frequency f_i	Midpoint x_i	$y_i = \frac{x_i - A}{h}$	y_i^2	$f_i y_i$	$f_i y_i^2$
70-75	3	72.5	-4	16	-12	48
75-80	4	77.5	-3	9	-12	36
80-85	7	82.5	-2	4	-14	28
85-90	7	87.5	-1	1	-7	7
90-95	15	92.5	0	0	0	0
95-100	9	97.5	1	1	9	9
100-105	6	102.5	2	4	12	24
105-110	6	107.5	3	9	18	54
110-115	3	112.5	4	16	12	48
	$\sum f_i$ =N = 60				$\sum f_i y_i$ = 6	$\sum f_i y_i^2$ =254

Mean,

$$\overline{y} = A + \frac{1}{N}\sum_{i=1}^{n} f_i y_i \times h = 92.5 + \frac{6}{60} \times 5 = 93$$

We know, Variance, $\sigma^2 = \frac{1}{N^2}\left[N\sum f_i y_i^2 - \left(\sum f_i y_i\right)^2\right] \times h^2$

We know, Standard Deviation = $\sigma = \sqrt{Variance}$

$$\therefore \sigma = \sqrt{105.583} = 10.275$$

Hence, Mean = 93, Variance = 105.583 and Standard Deviation = 10.275

Question:10. The diameters of circles (in mm) drawn in a design are given below:

Diameters	33-36	37-40	41-44	45-48	49-52
No. of circles	15	17	21	22	25

Calculate the standard deviation and mean diameter of the circles.

[**Hint** First make the data continuous by making the classes as $32.5 - 36.5, 36.5 - 40.4, 40.5 - 44.5, 44.5 - 48.5, 48.5 - 52.5$ and then proceed.]

Answer:

Let the assumed mean, A = 92.5 and h = 5

Diameters	No. of circles f_i	Midpoint x_i	$y_i = \frac{x_i - A}{h}$	y_i^2	$f_i y_i$	$f_i y_i^2$
32.5-36.5	15	34.5	-2	4	-30	60
36.5-40.5	17	38.5	-1	1	-17	17
40.5-44.5	21	42.5	0	0	0	0
44.5-48.5	22	46.5	1	1	22	22
48.5-52.5	25	50.5	2	4	50	100
	$\sum f_i$ =N = 100				$\sum f_i y_i$ = 25	$\sum f_i y_i^2$ =199

Mean,

$$\overline{x} = A + \frac{1}{N}\sum_{i=1}^{n} f_i y_i \times h = 42.5 + \frac{25}{100} \times 4 = 43.5$$

We know, Variance, $\sigma^2 = \frac{1}{N^2}\left[N\sum f_i y_i^2 - (\sum f_i y_i)^2\right] \times h^2$

We know, Standard Deviation = $\sigma = \sqrt{Variance}$

$\therefore \sigma = \sqrt{30.84} = 5.553$

Hence, Mean = 43.5, Variance = 30.84 and Standard Deviation = 5.553

NCERT solutions for class 11 maths chapter 15 statistics-Exercise: 15.3

Question:1. From the data given below state which group is more variable, A or B?

Marks	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Group A	9	17	32	33	40	10	9
Group B	10	20	30	25	43	15	7

Answer:

The group having a higher coefficient of variation will be more variable.

Let the assumed mean, A = 45 and h = 10

For Group A

Marks	Group A f_i	Midpoint x_i	$y_i = \frac{x_i - A}{h} = \frac{x_i - 45}{10}$	y_i^2	$f_i y_i$	$f_i y_i^2$

10-20	9	15	-3	9	-27	81
20-30	17	25	-2	4	-34	68
30-40	32	35	-1	1	-32	32
40-50	33	45	0	0	0	0
50-60	40	55	1	1	40	40
60-70	10	65	2	4	20	40
70-80	9	75	3	9	27	81
	$\sum f_i$ =N = 150				$\sum f_i y_i$ = -6	$\sum f$ =342

Mean,

$$\overline{x} = A + \frac{1}{N}\sum_{i=1}^{n} f_i y_i \times h = 45 + \frac{-6}{150} \times 10 = 44.6$$

We know, Variance, $\sigma^2 = \frac{1}{N^2}\left[N\sum f_i y_i^2 - (\sum f_i y_i)^2\right] \times h^2$

We know, Standard Deviation = $\sigma = \sqrt{Variance}$

$\therefore \sigma = \sqrt{227.84} = 15.09$

Coefficient of variation = $\frac{\sigma}{\overline{x}} \times 100$

C.V.(A) = $\frac{15.09}{44.6} \times 100 = 33.83$

Similarly,

For Group B

Marks	Group A f_i	Midpoint x_i	$y_i = \frac{x_i - A}{h} = \frac{x_i - 45}{10}$	y_i^2	$f_i y_i$	$f_i y_i^2$
10-20	10	15	-3	9	-30	90
20-30	20	25	-2	4	-40	80
30-40	30	35	-1	1	-30	30
40-50	25	45	0	0	0	0
50-60	43	55	1	1	43	43
60-70	15	65	2	4	30	60
70-80	7	75	3	9	21	72

	$\sum f_i$ =N = 150				$\sum f_i y_i$ = -6	$\sum f_i y_i^2$ =375

Mean,

$$\overline{x} = A + \frac{1}{N}\sum_{i=1}^{n} f_i y_i \times h = 45 + \frac{-6}{150} \times 10 = 44.6$$

We know, Variance, $\sigma^2 = \frac{1}{N^2}\left[N\sum f_i y_i^2 - (\sum f_i y_i)^2\right] \times h^2$

We know, Standard Deviation = $\sigma = \sqrt{Variance}$

$\therefore \sigma = \sqrt{249.84} = 15.80$

Coefficient of variation = $\frac{\sigma}{\overline{x}} \times 100$

C.V.(B) = $\frac{15.80}{44.6} \times 100 = 35.42$

Since C.V.(B) > C.V.(A)

Therefore, Group B is more variable.

Question:2 From the prices of shares X and Y below, find out which is more stable in value:

X	35	54	52	53	56	58	52	50	51	49

Y	108	107	105	105	106	107	104	103	104	101

Answer:

X(x_i)	Y(y_i)	x_i^2	y_i^2
35	108	1225	1166
54	107	2916	1144
52	105	2704	1102
53	105	2809	1102
56	106	8136	1123
58	107	3364	1144
52	104	2704	1081
50	103	2500	1060
51	104	2601	1081

49	101	2401	1020
=510	= 1050	=26360	=110

For X,

Mean , $\overline{x}=\frac{1}{n}\sum_{i=1}^{n}x_i=\frac{510}{10}=51$

Variance, $\sigma^2=\frac{1}{n^2}\left[n\sum x_i^2-(\sum x_i)^2\right]$

We know, Standard Deviation = $\sigma=\sqrt{Variance}=\sqrt{35}=5.91$

C.V.(X) = $\frac{\sigma}{\overline{x}}\times 100=\frac{5.91}{51}\times 100=11.58$

Similarly, For Y,

Mean , $\overline{y}=\frac{1}{n}\sum_{i=1}^{n}y_i=\frac{1050}{10}=105$

Variance, $\sigma^2=\frac{1}{n^2}\left[n\sum y_i^2-(\sum y_i)^2\right]$

We know, Standard Deviation = $\sigma=\sqrt{Variance}=\sqrt{4}=2$

C.V.(Y) = $\frac{\sigma}{\overline{y}}\times 100=\frac{2}{105}\times 100=1.904$

Since C.V.(Y) < C.V.(X)

Hence Y is more stable.

Question:3(i) An analysis of monthly wages paid to workers in two firms A and B, belonging to the same industry, gives the following results:

	Firm A	Firm B
No. of wage earners	586	648
Mean of monthly wages	$Rs\ 5253$	$Rs\ 5253$
Variance of the distribution of wages	100	121

Which firm A or B pays larger amount as monthly wages?

Answer:

Given, Mean of monthly wages of firm A = 5253

Number of wage earners = 586

Total amount paid = 586 x 5253 = 30,78,258

Again, Mean of monthly wages of firm B = 5253

Number of wage earners = 648

Total amount paid = 648 x 5253 = 34,03,944

Hence firm B pays larger amount as monthly wages.

Question:3(ii) An analysis of monthly wages paid to workers in two firms A and B, belonging to the same industry, gives the following results:

	Firm A	Firm B
No. of wage earners	586	648
Mean of monthly wages	$Rs\ 5253$	$Rs\ 5253$
Variance of the distribution of wages	100	121

Which firm, A or B, shows greater variability in individual wages?

Answer:

Given, Variance of firm A = 100

Standard Deviation = $\sigma_A = \sqrt{Variance} = \sqrt{100} = 10$

Again, Variance of firm B = 121

Standard Deviation = $\sigma_B = \sqrt{Variance} = \sqrt{121} = 11$

Since $\sigma_B > \sigma_A$, firm B has greater variability in individual wages.

Question:4 The following is the record of goals scored by team A in a football session:

No. of goals scored	0	1	2	3	4
No. of matches	1	9	7	5	3

For the team B, mean number of goals scored per match was 2 with a standard deviation 1.25 goals. Find which team may be considered more consistent?

Answer:

No. of goals scored x_i	Frequency f_i	x_i^2	$f_i x_i$	$f_i x_i^2$
0	1	0	0	0
1	9	1	9	9
2	7	4	14	28
3	5	9	15	45
4	3	16	12	48
	$\sum f_i$ =N = 25		$\sum f_i x_i$ = 50	$\sum f_i x_i^2$ =130

For Team A,

Mean,

$$\overline{x} = \frac{1}{N}\sum_{i=1}^{n} f_i x_i = \frac{50}{25} = 2$$

We know, Variance, $\sigma^2 = \frac{1}{N^2}\left[N\sum f_i x_i^2 - (\sum f_i x_i)^2\right]$

$$\implies \sigma^2 = \frac{1}{(25)^2}\left[25(130) - (50)^2\right]$$

$$= \frac{750}{625} = 1.2$$

We know, Standard Deviation = $\sigma = \sqrt{Variance}$

$$\therefore \sigma = \sqrt{1.2} = 1.09$$

C.V.(A) = $\frac{\sigma}{\overline{x}} \times 100 = \frac{1.09}{2} \times 100 = 54.5$

For Team B,

Mean = 2

Standard deviation, σ = 1.25

C.V.(B) = $\frac{\sigma}{\overline{x}} \times 100 = \frac{1.25}{2} \times 100 = 62.5$

Since C.V. of firm B is more than C.V. of A.

Therefore, Team A is more consistent.

Question:5 The sum and sum of squares corresponding to length x (in cm) and weight y (in gm) of 50 plant products are given below:

$$\sum_{i=1}^{50} x_i = 212, \sum_{i=1}^{50} x_i^2 = 902.8, \sum_{i=1}^{50} y_i = 261, \sum_{i=1}^{50} y_i^2 = 1457.6$$

Which is more varying, the length or weight?

Answer:

For lenght x,

Mean, $\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i = \frac{212}{50} = 4.24$

We know, Variance, $\sigma^2 = \frac{1}{n^2}\left[n\sum f_i x_i^2 - (\sum f_i x_i)^2\right]$

$$\implies \sigma^2 = \frac{1}{(50)^2}\left[50(902.8) - (212)^2\right]$$
$$= \frac{196}{2500} = 0.0784$$

We know, Standard Deviation = $\sigma = \sqrt{Variance} = \sqrt{0.0784} = 0.28$

C.V.(x) = $\frac{\sigma}{\overline{x}} \times 100 = \frac{0.28}{4.24} \times 100 = 6.603$

For weight y,

Mean,

Mean, $\overline{y} = \frac{1}{n}\sum_{i=1}^{n} y_i = \frac{261}{50} = 5.22$

We know, Variance, $\sigma^2 = \frac{1}{n^2}\left[n\sum f_i y_i^2 - (\sum f_i y_i)^2\right]$

$$\implies \sigma^2 = \frac{1}{(50)^2}\left[50(1457.6) - (261)^2\right]$$
$$= \frac{4759}{2500} = 1.9036$$

We know, Standard Deviation = $\sigma = \sqrt{Variance} = \sqrt{1.9036} = 1.37$

C.V.(y) = $\frac{\sigma}{\overline{y}} \times 100 = \frac{1.37}{5.22} \times 100 = 26.24$

Since C.V.(y) > C.V.(x)

Therefore, weight is more varying.

NCERT solutions for class 11 maths chapter 15 statistics-Miscellaneous Exercise

Question:1 The mean and variance of eight observations are 9 and 9.25 , respectively. If six of the observations are $6, 7, 10, 12, 12$ and 13 , find the remaining two observations.

Answer:

Given,

The mean and variance of 8 observations are 9 and 9.25, respectively

Let the remaining two observations be x and y,

Observations: 6, 7, 10, 12, 12, 13, x, y.

∴ Mean, $\overline{X} = \frac{6+7+10+12+12+13+x+y}{8} = 9$

60 + x + y = 72

x + y = 12 -(i)

Now, Variance

$$= \frac{1}{n}\sum_{i=1}^{8}(x_i - x)^2 = 9.25$$

$$\implies 9.25 = \frac{1}{8}\left[(-3)^2 + (-2)^2 + 1^2 + 3^2 + 4^2 + x^2 + y^2 - 18(x+y) + 2.9^2\right]$$

$$\implies 9.25 = \frac{1}{8}\left[(-3)^2 + (-2)^2 + 1^2 + 3^2 + 4^2 + x^2 + y^2 + -18(12) + 2.9^2\right]$$ (Using (i))

$$\implies 9.25 = \frac{1}{8}\left[48 + x^2 + y^2 - 216 + 162\right] = \frac{1}{8}\left[x^2 + y^2 - 6\right]$$

$\implies x^2 + y^2 = 80$ -(ii)

Squaring (i), we get

$x^2 + y^2 + 2xy = 144$ (iii)

(iii) - (ii) :

2xy = 64 (iv)

Now, (ii) - (iv):

$$x^2 + y^2 - 2xy = 80 - 64$$
$$\implies (x - y)^2 = 16$$
$$\implies x - y = \pm 4$$ -(v)

Hence, From (i) and (v):

x – y = 4 $\implies$ x = 8 and y = 4

x – y = -4 $\Longrightarrow$ x = 4 and y = 8

Therefore, The remaining observations are 4 and 8. (in no order)

Question:2 The mean and variance of 7 observations are 8 and 16 , respectively. If five of the observations are $2, 4, 10, 12, 14$. Find the remaining two observations.

Answer:

Given,

The mean and variance of 7 observations are 8 and 16, respectively

Let the remaining two observations be x and y,

Observations: 2, 4, 10, 12, 14, x, y

∴ Mean, $\overline{X} = \frac{2+4+10+12+14+x+y}{7} = 8$

42 + x + y = 56

x + y = 14 -(i)

Now, Variance

$$= \frac{1}{n}\sum_{i=1}^{8}(x_i - \overline{x})^2 = 16$$

$$\Longrightarrow \; 16 = \frac{1}{7}\left[(-6)^2 + (-4)^2 + 2^2 + 4^2 + 6^2 + x^2 + y^2 - 16(x+y) + 2.8^2\right]$$

$$\Longrightarrow \; 16 = \frac{1}{7}\left[36 + 16 + 4 + 16 + 36 + x^2 + y^2 - 16(14) + 2(64)\right]$$ (Using (i))

$\implies 16 = \frac{1}{7}\left[108 + x^2 + y^2 - 96\right] = \frac{1}{7}\left[x^2 + y^2 + 12\right]$

$\implies x^2 + y^2 = 112 - 12 = 100$ -(ii)

Squaring (i), we get

$x^2 + y^2 + 2xy = 196$ (iii)

(iii) - (ii) :

2xy = 96 (iv)

Now, (ii) - (iv):

$x^2 + y^2 - 2xy = 100 - 96$
$\implies (x - y)^2 = 4$
$\implies x - y = \pm 2$ -(v)

Hence, From (i) and (v):

x – y = 2 $\implies$ x = 8 and y = 6

x – y = -2 $\implies$ x = 6 and y = 8

Therefore, The remaining observations are 6 and 8. (in no order)

Question:3 The mean and standard deviation of six observations are 8 and 4 , respectively. If each observation is multiplied by 3 , find the new mean and new standard deviation of the resulting observations.

Answer:

Given,

Mean = 8 and Standard deviation = 4

Let the observations be $x_1, x_2, x_3, x_4, x_5 \ and \ x_6$

Mean, $\overline{x} = \frac{x_1 + x_2 + x_3 + x_4 + x_5 + x_6}{6} = 8$

Now, Let y_i be the the resulting observations if each observation is multiplied by 3:

$$\overline{y}_i = 3\overline{x}_i$$
$$\implies \overline{x}_i = \frac{\overline{y}_i}{3}$$

New mean, $\overline{y} = \frac{y_1 + y_2 + y_3 + y_4 + y_5 + y_6}{6}$

$$= 3\left[\frac{x_1 + x_2 + x_3 + x_4 + x_5 + x_6}{6}\right] = 3 \times 8$$

= 24

We know that,

Standard Deviation = $\sigma = \sqrt{Variance}$

$$= \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2}$$

-(i)

Now, Substituting the values of $x_i \ and \ \overline{x}$ in (i):

Hence, the variance of the new observations = $\frac{1}{6} \times 864 = 144$

Therefore, Standard Deviation = $\sigma = \sqrt{Variance}$ = $\sqrt{144}$ = 12

Question:4 Given that $\bar{x}$ is the mean and σ^2 is the variance of n observations .Prove that the mean and variance of the observations $ax_1, ax_2, ax_3, ..., ax_n$,
are $a\bar{x}$ and $a^2\sigma^2$ respectively, $(a \neq 0)$.

Answer:

Given, Mean = $\bar{x}$ and variance = σ^2

Now, Let y_i be the the resulting observations if each observation is multiplied by a:

$$\overline{y}_i = a\overline{x}_i$$
$$\implies \overline{x}_i = \frac{\overline{y}_i}{a}$$

$$\overline{y} = \frac{1}{n}\sum_{i=1}^{n} y_i = \frac{1}{n}\sum_{i=1}^{n} ax_i$$

$$\overline{y} = a\left[\frac{1}{n}\sum_{i=1}^{n} x_i\right] = a\overline{x}$$

Hence the mean of the new observations $ax_1, ax_2, ax_3, ..., ax_n$ is $a\bar{x}$

We know,

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \overline{x})^2$$

Now, Substituting the values of $x_i \ and \ \overline{x}$:

Hence the variance of the new observations $ax_1, ax_2, ax_3, ..., ax_n$ is $a^2\sigma^2$

Hence proved.

Question:5(i) The mean and standard deviation of 20 observations are found to be 10 and 2 , respectively. On rechecking, it was found that an observation 8 was incorrect. Calculate the correct mean and standard deviation in each of the following cases:

If wrong item is omitted.

Answer:

Given,

Number of observations, n = 20

Also, Incorrect mean = 10

And, Incorrect standard deviation = 2

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$\implies 10 = \frac{1}{20}\sum_{i=1}^{20} x_i \implies \sum_{i=1}^{20} x_i = 200$$

Thus, incorrect sum = 200

Hence, correct sum of observations = 200 – 8 = 192

Therefore, Correct Mean = (Correct Sum)/19

$$= \frac{192}{19}$$

= 10.1

Now, Standard Deviation,

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2 - (\frac{1}{n}\sum_{i=1}^{n} x)^2}$$

,which is the incorrect sum.

Thus, New sum = Old sum - (8x8)

= 2080 – 64

= 2016

Hence, Correct Standard Deviation =

$$= \sqrt{106.1 - 102.01} = \sqrt{4.09}$$

=2.02

Question:5(ii) The mean and standard deviation of 20 observations are found to be 10 and 2 , respectively. On rechecking, it was found that an observation 8 was incorrect. Calculate the correct mean and standard deviation in each of the following cases:

If it is replaced by $12.$

Answer:

Given,

Number of observations, n = 20

Also, Incorrect mean = 10

And, Incorrect standard deviation = 2

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$\implies 10 = \frac{1}{20}\sum_{i=1}^{20} x_i \implies \sum_{i=1}^{20} x_i = 200$$

Thus, incorrect sum = 200

Hence, correct sum of observations = 200 – 8 + 12 = 204

Therefore, Correct Mean = (Correct Sum)/20

$$= \frac{204}{20}$$

= 10.2

Now, Standard Deviation,

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2 - (\frac{1}{n}\sum_{i=1}^{n} x)^2}$$

,which is the incorrect sum.

Thus, New sum = Old sum - (8x8) + (12x12)

= 2080 – 64 + 144

= 2160

Hence, Correct Standard Deviation =

$= \sqrt{108 - 104.04} = \sqrt{3.96}$

= 1.98

Question:6 The mean and standard deviation of marks obtained by 50 students of a class in three subjects, Mathematics, Physics and Chemistry are given below:

Subject	**Mathematics**	**Physics**	**Chemistry**
Mean	42	32	40.9
Standard deviation	12	15	20

Which of the three subjects shows highest variability in marks and which shows the lowest?

Answer:

Given,

Standard deviation of physics = 15

Standard deviation of chemistry = 20

Standard deviation of mathematics = 12

We know ,

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

The subject with greater C.V will be more variable than others.

$$C.V._P = \frac{15}{32} \times 100 = 46.87$$

$$C.V._C = \frac{20}{40.9} \times 100 = 48.89$$

$$C.V._M = \frac{12}{42} \times 100 = 28.57$$

Hence, Mathematics has lowest variability and Chemistry has highest variability.

Question:7 The mean and standard deviation of a group of 100 observations were found to be 20 and 3 , respectively. Later on it was found that three observations were incorrect, which were recorded as $21, 21$ and 18 . Find the mean and standard deviation if the incorrect observations are omitted.

Answer:

Given,

Initial Number of observations, n = 100

$$\overline{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$\implies 20 = \frac{1}{100}\sum_{i=1}^{100} x_i \implies \sum_{i=1}^{100} x_i = 2000$$

Thus, incorrect sum = 2000

Hence, New sum of observations = 2000 - 21-21-18 = 1940

New number of observation, n' = 100-3 =97

Therefore, New Mean = New Sum)/100

$$= \frac{1940}{97}$$

= 20

Now, Standard Deviation,

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=1}^{n} x_i^2 - (\frac{1}{n}\sum_{i=1}^{n} x)^2}$$

,which is the incorrect sum.

Thus, New sum = Old (Incorrect) sum - (21x21) - (21x21) - (18x18)

= 40900 - 441 - 441 - 324

= 39694

Hence, Correct Standard Deviation =

$$= \sqrt{108 - 104.04} = \sqrt{3.96}$$

= 3.036