

5) Rural Urban Distribution

33.92% of Nepalese population resides in rural area and 66.08% resides in urban area.

Measures of Dispersion

Absolute Measure

1) Range = $L - S$

2) Quartile Deviation = $\frac{Q_3 - Q_1}{2}$

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

4) Variance = σ^2

Relative Measure

1) Coeff of Range = $\frac{L - S}{L + S}$

2) Coeff of QD = $\frac{Q_3 - Q_1}{Q_3 + Q_1}$

3) Coefficient of SP = $\frac{\sigma}{\bar{x}}$

4) Coeff of variance = $\frac{\sigma}{\bar{x}} \times 100\%$

Exercise

Find the standard deviation and variance. Also interpret the results.

Class	0-10	10-20	20-30	30-40	40-50
Frequency	9	12	13	11	8

Solution

Calculation for Standard Deviation

Marks	x	f	fx	fx^2
0-10	5	9	45	225
10-20	15	12	180	2700
20-30	25	13	325	8125
30-40	35	11	385	13275
40-50	45	8	360	16200
$N = 53, \sum fx = 1295, \sum fx^2 = 40725$				

Now,

$$\bar{x} = \frac{\sum fx}{N} = \frac{1295}{53} = 24.43$$

$$\begin{aligned} \therefore SD(\sigma) &= \sqrt{\frac{\sum fx^2}{N} - \left(\frac{\sum fx}{N}\right)^2} \\ &= \sqrt{\frac{40725}{53} - \left(\frac{1295}{53}\right)^2} \\ &= 13.09 \end{aligned}$$

$$\begin{aligned} \text{Variance} &= \sigma^2 \\ &= (13.09)^2 \\ &= 171.37 \end{aligned}$$

Interpretation: Here, $\sigma = 13.09$. This means that the average deviation from the mean (24.43) is 13.09

- 3) Calculate the standard deviation and variance from the following data and interpret the result.

a)

x:	5	7	8	10	12
f:	7	8	10	11	9

Solution

Calculation of Standard Deviation

x	f	fx	fx ²
5	7	35	175
7	8	56	392
8	10	80	640
10	11	110	1100
12	9	108	1296
N = 45, $\Sigma fx = 389$, $\Sigma fx^2 = 3603$			

Now,

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{389}{45} = 8.64$$

Now,

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{\Sigma fx^2}{N} - \left(\frac{\Sigma fx}{N}\right)^2}$$

$$= \sqrt{\frac{3603}{45} - (8.64)^2}$$

$$= 2.32$$

$$\text{Variance} = \sigma^2 = (2.32)^2 = 5.38$$

Interpretation: Here, $\sigma = 2.32$. This means that the average deviation from the mean (8.64) is 2.32

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x:	40	44	50	55	60	65
f:	12	14	16	20	18	15

Solution

Calculation of standard deviation

x	f	fx	fx ²
40	12	480	19200
44	14	616	27104
50	16	800	40000
55	20	1100	60500
60	18	1080	64800
65	15	975	63375
N = 95, $\Sigma fx = 5051$, $\Sigma fx^2 = 274979$			

Now,

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{5051}{95} = 53.16$$

$$\text{standard deviation } (\sigma) = \sqrt{\frac{\Sigma fx^2}{N} - (\bar{x})^2}$$

$$= \sqrt{\frac{274979}{95} - (53.16)^2}$$

$$= 8.27$$

$$\text{variance } (\sigma^2) = (8.27)^2 = 68.3929$$

Interpretation: Here, $\sigma = 8.27$. This means that average deviation from the mean (53.16) is 8.27

7. Find the SD from the following distribution.

weight (kg)	40-45	40-50	40-55	40-60	40-65
No. of players	2	7	13	26	40

40-70	40-75
45	55

Solution

Calculation of standard Deviation

weight	X	f	fx	fx ²
40-45	42.5	2	85	3612.5
45-50	47.5	5	237.5	11281.25
50-55	52.5	6	315	16637.5
55-60	57.5	13	747.5	42981.5
60-70	62.5	14	875	54687.5
65-70	67.5	65	337.5	32781.25
70-75	72.5	10	725	52562.5
N = 55, $\Sigma fx = 3322.5$, $\Sigma fx^2 = 204443.8$				

Now,

$$\sigma = \sqrt{\frac{\Sigma fx^2}{N} - \left(\frac{\Sigma fx}{N}\right)^2}$$

$$= \sqrt{\frac{204443.8}{55} - \left(\frac{3322.5}{55}\right)^2}$$

$$= 8.24$$

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{3322.5}{55} = 60.4$$

Interpretation: Here, $\sigma = 8.24$. This means that average deviation from the mean 60.4 is 8.24

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40-65
40

calculate the standard deviation.

Marks	0-5	5-10	10-15	15-20	20-25
Frequency	10	5	12	5	8

Solution

Calculation of Standard Deviation

Marks	X	f	fx	fx ²
0-5	2.5	10	25	62.5
5-10	7.5	5	37.5	281.25
10-15	12.5	12	150	1875
15-20	17.5	5	87.5	1531.25
20-25	22.5	8	180	4050
N = 40, $\Sigma fx = 480$, $\Sigma fx^2 = 7800$				

Now,

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{480}{40} = 12$$

$$\text{Standard Deviation } (\sigma) = \sqrt{\frac{\Sigma fx^2}{N} - (\bar{x})^2}$$

$$= \sqrt{\frac{7800}{40} - 144}$$

$$= 7.14$$

Interpretation: Here, $\sigma = 7.14$. This means that the average deviation from the mean value (12) is 7.14.

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9. A study of 100 engineering companies give the following information.

Price (Rs. in crore)	0-10	10-20	20-30	30-40	40-50	50-60
No. of companies	8	12	20	30	20	10

Find the standard deviation and interpret the result.

Solution

Calculation of standard Deviation

Price (Rs in crore)	x	f	fx	fx ²
0-10	5	8	40	200
10-20	15	12	180	2700
20-30	25	20	500	12500
30-40	35	30	1050	36750
40-50	45	20	900	40500
50-60	55	10	550	30250
$N = 100, \sum fx = 3220, \sum fx^2 = 122900$				

$$\bar{x} = \frac{\sum fx}{N} = \frac{3220}{100} = 32.2$$

$$\begin{aligned} \text{Standard Deviation } (\sigma) &= \sqrt{\frac{\sum fx^2}{N} - \left(\frac{\sum fx}{N}\right)^2} \\ &= \sqrt{\frac{122900}{100} - \left(\frac{3220}{100}\right)^2} \\ &= 13.86 \end{aligned}$$

Interpretation: Here, $\sigma = 13.86$. It means that the ^{average} deviation from the mean (32.2) is 13.86

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0-40	41-50	51-60
30	20	10

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Following are the marks obtained by A and B in five examinations out of 100.

MARKS OF A	45	60	65	70	80
MARKS OF B	30	70	80	85	90

Solution

Calculation of Standard Deviation

For A

X	X ²
45	2025
60	3600
65	4225
70	4900
80	6400
$\Sigma x = 320$	$\Sigma x^2 = 21150$

Now,

$$S.D(\sigma) = \sqrt{\frac{\Sigma x^2}{N} - \left(\frac{\Sigma x}{N}\right)^2}$$

$$= \sqrt{\frac{21150}{5} - \left(\frac{320}{5}\right)^2}$$

$$= 11.57$$

$$C.V = \frac{\sigma}{\bar{x}} \times 100$$

$$= \frac{11.57}{64} \times 100$$

$$= 18.07\%$$

For B

x	x^2
30	900
70	4900
80	6400
85	7225
90	8100
$\Sigma x = 355$	$\Sigma x^2 = 27525$

$$\begin{aligned}
 SD(\sigma) &= \sqrt{\frac{\Sigma x^2}{N} - \left(\frac{\Sigma x}{N}\right)^2} \\
 &= \sqrt{\frac{27525}{5} - \left(\frac{355}{5}\right)^2} \\
 &= 21.54
 \end{aligned}$$

$$\begin{aligned}
 C.V &= \frac{\sigma}{\bar{x}} \times 100\% \\
 &= \frac{21.54}{71} \times 100\% \\
 &= 30.33\%
 \end{aligned}$$

Since $CV(A) < CV(B)$, marks of A is more consistent than marks of B.

The average wages and standard deviation of two factories are as follows:

	Factory A	Factory B
Average wages	586	575
Standard Deviation	9	10

In which factory is the greater variability in wages?

Solution

$$CV \text{ of A} = \frac{\sigma}{\bar{x}} \times 100\% = 1.53$$

$$CV \text{ of B} = \frac{\sigma}{\bar{x}} \times 100\% = 1.73$$

Factory B has greater variability in wages.

18. Find the Quartile deviation and its coefficient from the following data:

a) Marks: 9, 11, 7, 13, 17, 6, 19, 21, 24, 26, 30

Solution

Arranging in ascending order

6, 7, 9, 11, 13, 17, 19, 21, 24, 26, 30

$N = 11$

We know:

$$Q_1 = \left(\frac{N+1}{4} \right)^{\text{th}} \text{ item}$$

$$= \left(\frac{11+1}{4} \right)^{\text{th}} \text{ item}$$

$$= 3^{\text{rd}} \text{ item}$$

$$= 9$$

$$Q_3 = 3\left(\frac{N+1}{4}\right)^{\text{th}} \text{ item}$$

$$= (3 \times 3)^{\text{th}} \text{ item}$$

$$= 9^{\text{th}} \text{ item}$$

$$= 24$$

$$\therefore QD = \frac{Q_3 - Q_1}{2}$$

$$= \frac{24 - 9}{2}$$

$$= 7.5$$

$$\therefore \text{Coeff of } QD = \frac{Q_3 - Q_1}{Q_3 + Q_1} = \frac{24 - 9}{24 + 9} = \frac{15}{33} = 0.45$$

c)

Marks	20	22	24	26	28	30
Frequency	8	4	5	6	15	12

Solution

Calculation for QD and its coefficient

Marks	f	cf
20	8	8
22	4	12
24	5	17
26	6	23
28	15	38
30	12	50
N = 50		

Now,

$$Q_1 = \left(\frac{N+1}{4}\right)^{\text{th}} \text{ term} = \left(\frac{51}{4}\right)^{\text{th}} \text{ term} = 12.75^{\text{th}} \text{ term}$$

The cf just greater than 12.75 is 37, $Q_1 = 24$

$$Q_3 = 3\left(\frac{N+1}{4}\right)^{\text{th}} \text{ item} = \left(\frac{153}{4}\right)^{\text{th}} \text{ term} = 38.25^{\text{th}} \text{ term}$$

The cf just greater than 38.25 is 50. So, $Q_3 = 30$

$$\therefore Q.D = \frac{Q_3 - Q_1}{2} = \frac{30 - 24}{2} = 3$$

$$\text{Coeff of QD} = \frac{30 - 24}{30 + 24} = 0.11$$

10. Find the quartile deviation and coefficient of QD from the data given below:

a)

class	0-10	10-20	20-30	30-40	40-50	50-60
Frequency	10	15	25	30	20	10

Solution

Calculation for QD and its coefficient

class	f	cf
0-10	10	10
10-20	15	25
20-30	25	50
30-40	30	80
40-50	20	100
50-60	10	110
$N = 110$		

Now,

$$Q_1 = \frac{N}{4} = \frac{110}{4} = 27.5$$

The cf just greater than 27.5 is 50.
 $\therefore Q_1$ class is 20-30

$$\therefore Q_1 = L + \frac{\frac{N}{4} - cf}{f} \times h$$

$$= 20 + \frac{27.5 - 25}{25} \times 10$$

$$= 21$$

Now,

$$Q_3 = 3\left(\frac{N}{4}\right)$$

$$= 3 \times \left(\frac{110}{4}\right)$$

$$= 82.5^{\text{th}} \text{ term}$$

The cf just greater than 82.5 is 100. So,
 Q_3 lies in class 40-50

$$Q_3 = L + \frac{3\frac{N}{4} - cf}{f} \times h$$

$$= 40 + \frac{82.5 - 80}{20} \times 10$$

$$= 41.25$$

$$Q.D = \frac{Q_3 - Q_1}{2} = \frac{41.25 - 21}{2} = 10.12$$

$$\text{Coeff of } Q.D = \frac{Q_3 - Q_1}{Q_3 + Q_1} = \frac{41.25 - 21}{41.25 + 21} = 0.325$$

19. The marks of students are given below. Find the absolute and relative measure of range.

a) 5, 1

b) 7, 8, 10, 12, 15, 16, 15, 14, 13, 17, 18, 19

Here;

Largest value (L) = 19

Smallest value (S) = 7

$$\text{Range (R)} = L - S = 19 - 7 = 12$$

$$\text{Coeff of Range (CR)} = \frac{L - S}{L + S} = \frac{19 - 7}{19 + 7} = 0.46$$

20. Find the range and coefficient of range of the following wage rates

a)

Wage rate (Rs)	200	250	300	350	400	450
No of employees	7	16	20	13	12	10

Here,

Largest value (L) = 450

Smallest value (S) = 200

$$\therefore \text{Range} = L - S = 450 - 200 = 250$$

$$\text{Coeff of Range} = \frac{L - S}{L + S} = \frac{450 - 200}{450 + 200} = 0.38$$

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