

# UNIT 2

## MEASURES OF DISPERSION

QUARTILES

DECILES

PERCENTILES

**PARTITION VALUE** - There are the values of the variable which divide the total frequency into a number of equal parts

They are – (1) Quartiles  
(2) Deciles  
(3) Percentiles

**QUARTILES** :- Quartiles are those values of the variable which divide the total frequency into four equal parts i.e.  $Q_1$ ,  $Q_2$ ,  $Q_3$ ,  $Q_4$

**Median** is that value of the variable which divide the total frequency into two equal parts

When the lower half before the median is divided into two equal parts the value of the dividing variable is called **LOWER QUARTILE** and is denoted by  $Q_1$

The value of the variable dividing the upper half is called the **UPPER QUARTILE** and is denoted by  $Q_3$

$Q_1$  - FIRST QUARTILE  
( lower quartile)(25%)

$Q_2$  - SECOND QUARTILE  
(middle quartile)(50%)

$Q_3$  - THIRD QUARTILE (75%)  
(upper quartile)

$Q_4$  - LAST QUARTILE

Individual / ungrouped data –

$$Q_i = i ( N+1)/4,$$

Where  $i = 1, 2, 3, \dots$

Grouped frequency distribution –

$$Q_1 = L_1 + \frac{(N/4 - f_c) * i}{f}$$

$$Q_2 = L_1 + \frac{(2N/4 - f_c) * i}{f}$$

$$Q_3 = L_1 + \frac{(3N/4 - f_c) * i}{f}$$

where  $L_1$  = lower limit of quartile class  
 $f$  = frequency of quartile class  
 $f_c$  = proceeding c f of quartile class  
 $i$  = length of quartile class  
 $N$  = total frequency

Qu :- determine the quartiles for the following data-

Class interval	Frequency
10-15	4
15-20	12
20-25	16
25-30	22
30-40	10
40-50	8
50-60	6
60-70	4

**solution -**

Class interval	f	C f
10-15	4	4
15-20	12	16
20-25	16	32
25-30	22	54
30-40	10	64
40-50	8	72
50-60	6	78
60-70	4	82
	$\Sigma f = 82$	

$$Q_1 = (N + 1)/4 \text{ th term}$$

$$(82 + 1) / 4 \text{ th term}$$

$$83/4 = 20.75 \text{ th term , which is included in 20-25}$$

$$Q_1 = L_1 + \frac{(N/4 - f_c)}{f} * i$$

$$= 20 + \frac{(82/4 - 16)}{16} * 5$$

$$= 20 + \frac{(20.5-16)* 5}{16}$$

$$= 20 + 4.5*5/16$$

$$= 20 + 225/160$$

$$= 20 + 1.41$$

$$Q_1 = 21.41$$

$$Q_2 = \frac{2(N+1)}{(N+1)/2} \text{ TH TERM} = \frac{(82+1)}{2}$$

$$83/2 = 41.5$$

which is included in 25-30

$$Q_2 = L_1 + \frac{(2N/4 - f_c)}{f} * i$$

$$= 25 + \frac{(41-32)*5}{22}$$

$$= 25 + 45/22$$

$$= 25 + 2.05$$

$$Q_2 = 27.05$$

$$Q_3 = 3(N+1) / 4 \text{ th term}$$

$$= 3*83/4 \text{ th term}$$

$$= 249/4 = 62.25$$

which is included in 30-40

$$Q_3 = L_1 + \frac{(3N/4 - f_c)}{f} * i$$

$$= 30 + \frac{(3*82 /4 - 54)}{10} * 10$$

$$= 30 + (246/4 - 54$$

$$= 30 + (61.5 - 54 )$$

$$= 30 + 7.5$$

$$Q_3 = 37.5$$

QU – find quartiles -

**solution**

Amount of tax (Rs)	NO. OF traders	X	f	Cf
25	135	25	135	135
50	120	50	120	255
75	90	75	90	345
100	60	100	60	405
200	55	200	55	459
300	40	300	40	499
			$\sum f = 499$	

$$Q_1 = (N+1)/4$$

$$= 500/4 = 125 \text{ th term}$$

$$Q_1 = 25$$

$$Q_2 = 2(N+1)/4$$

$$= (2*500)/4 = 250 \text{ th term}$$

$$Q_2 = 50$$

$$Q_3 = 3(N+1)/4 = 3(500)/4 = 1500/4 = 375$$

$$Q_3 = 100$$

# DECILES

- The nine quantities that divide a distribution in ascending order into ten equal parts are called the **deciles** . They are denoted by

$$D_1, D_2, D_3 \dots\dots\dots D_9$$

Ungrouped data -  $D_i = i ( N + 1 ) / 10$  th term

Grouped data -  $D_i = L_1 + \frac{i N / 10 - f_c}{f} * i$

where  $i = 1, 2, 3 \dots 9$



Qu – calculate the deciles –  $D_2$ ,  $D_5$ ,  $D_7$  &  $D_9$



Solution-

CLASS INTERVAL	FREQUENCY
0-10	3
10-20	10
20-30	17
30-40	7
40-50	6
50-60	4
60-70	2
70-80	1

CLASS INTERVAL	FREQUENCY	C f
0-10	3	3
10-20	10	13
20-30	17	30
30-40	7	37
40-50	6	43
50-60	4	47
60-70	2	49
70-80	1	50
	$\Sigma f = 50$	

$$D_2 = 2(50+1)/10 = 105/10 = 10.5 \text{ th term}$$

Then deciles class = 10-20

$$D_2 = 10 + \frac{2(50)/10 - 3}{10} * 10$$
$$= 10 + 7 = 17, \quad D_2 = 17$$

$$D_5 = 5(50+1)/10 = 51/2 = 25.5 \text{ th term}$$

Deciles class = 20-30

$$D_5 = 20 + \frac{5(50)/10 - 13}{17} * 10$$
$$= 20 + 120/17 = 20 + 7.05 = 27.05$$

$$D_5 = 27.05$$

$$\text{Similarly } D_7 = 37.14 \quad \& \quad D_9 = 55$$

# PERCENTILE

The 99 quantities which divide a distribution in ascending order in 100 equal parts are called the **percentiles**. It is denoted by  $P_1 P_2 P_3 \dots P_{99}$

**UNGROUPED DATA –**  $P_i = i(N+1)/100$  th term

**GROUPED DATA -** 
$$P_i = L_1 + \frac{i N/100 - f_c}{f} * i$$
  
where  $i = 1, 2, 3, \dots, 99$

## RELATION AMONG QUARTILES, DECILES & PERCENTILES

$$P_{25} = Q_1, \quad P_{50} = D_5 = Q_2, \quad P_{75} = Q_3, \quad D_1 = P_{10}, \\ D_2 = P_{20} \dots$$

Qu – calculate  $P_{15}$ ,  $P_{42}$ ,  $P_{63}$ ,  $P_{84}$

CLASS INTERVAL	FREQUENCY	C f
0-10	3	3
10-20	10	13
20-30	17	30
30-40	7	37
40-50	6	43
50-60	4	47
60-70	2	49
70-80	1	50
	$\Sigma f = 50$	

$$P_{15} = 15(50+1)/100 = 7.65$$

Percentile class = 10-20

$$P_{15} = 10 + \frac{15(50)/100 - 3}{10} * 10$$

$$= 10 + 4.5 = \mathbf{14.5}$$

$$P_{42} = 42*51/100 = 21.42$$

Class = 20-30

$$P_{42} = 20 + \frac{42*50/100 - 13}{17} * 10$$

$$= 20 + 80/17$$

$$= 20 + 4.7 = \mathbf{24.7}$$

Similarly  $P_{63} = \mathbf{32.14}$  &  $P_{84} = \mathbf{48.3}$

**CALCULATE median ,the two quartiles ,3<sup>rd</sup> deciles and the 80<sup>th</sup> percentiles**

**solution -**

Credit balance	no. of accounts
0-1000	7
1000-2000	16
2000-3000	23
3000-4000	40
4000-5000	9
5000-6000	4
6000-7000	1

Credit balance	no. of accounts (f)	C f
0-1000	7	7
1000-2000	16	23
2000-3000	23	46
3000-4000	40	86
4000-5000	9	95
5000-6000	4	99
6000-7000	1	100
	$\Sigma f = 100$	

**Median =  $Q_2$ , AND  $Q_1$  ,  $Q_3$  ,  $D_3$  ,  $P_{80}$**

# MEASURES Of DISPERSION

- **WHAT IS DISPERSION** - Dispersion means spread of data or variation of data from the central tendency . It helps to understand the distribution of data
- Scatteredness of data about an average is known as dispersion.

Illustration – Subject	student 1	student 2
Hindi	20	48
Maths	55	52
English	60	55
science	50	50
mean	=53	

# OBJECTIVES OF DISPERSION

- To find the average distance of the items from an average.
- To know the structure of the series.
- To study of the reliability of average.
- To know the limits of the items.
- to make further statistical analysis.
- to compare between two or more series.
- to control variation.
- to find range of value.

# ESSENTIALS OF GOOD MEASURE

- It should be rigidly defined.
- It should be easy to calculate & understand.
- It should be based on all items.
- It should be capable of further algebraic treatment.
- It should be least affected by sample fluctuations.



# MEASURES OF DISPERSION

```
graph TD; A[MEASURES OF DISPERSION] --> B[ABSOLUTE MEASURE]; A --> C[RELATIVE MEASURE];
```

## ABSOLUTE MEASURE

Expressed in original units

original units

( rupees, kg)

### TYPES

Range

Interquartile deviation

Quartile deviation

Mean deviation

Standard deviation

Variance

## RELATIVE MEASURE

Compare two or more  
distribution

Ratio ,percentage

### TYPES

Coefficient of range

Coefficient of Q.D

Coefficient of M.D.

Coefficient of S.D.

Coefficient of variance

**RANGE** – a range of a distribution is the difference between the highest and the lowest observation of the distribution.

$$R = H - L \quad \text{where } H = \text{highest value} \\ L = \text{lowest value}$$

Coefficient of range  $\rightarrow \frac{H - L}{H + L}$

### **Merits of range –**

- it is easy to calculate
- it is not affected by frequencies
- it is used in the application of control charts

### **Demerits of range-**

- It is not suitable for open ended distribution
- It cannot be used in algebraic calculations
- It shows too much variation in different samples

## Individual distribution - find Range and coefficient of R-

3,8,2,5,6,9,10

Soln-  $R = H - L$

$$= 10 - 2 = 8$$

Coefficient of R =  $H - L / H + L$

$$= 10 - 2 / 10 + 2 = 8 / 12 = 2/3$$

## Discrete series -

X	10	20	30	40	50
f	3	5	2	6	3

Soln - we do not see frequency for highest & lowest value

$$R = 50 - 10 = 40$$

$$\text{Coefficient of R} = 50 - 10 / 50 + 10 = 40 / 60 = 2/3$$

## Continuous series –

Classes	10-20	20-30	30-40	40-50	50-60
f	6	3	8	5	4

**Soln** – There are two method to solve this series-

(1) range =  $R = H - L = 60 - 10 = 50$

COEFFICIENT of R =  $60 - 10 / 60 + 10 = 50 / 70 = 5/7$

(2) **Mid value** -

Class interval	Mid value	F
10-20	15	6
20-30	25	3
30-40	35	8
40-50	45	5
50-60	55	4

$$\text{Range} = R = 55 - 15 = 40$$

$$\begin{aligned}\text{Coefficient of R} &= \\ &= 55 - 15 / 55 + 15 \\ &= 40 / 70 \\ &= 4/7\end{aligned}$$

## INTERQUARTILE RANGE

- The interquartile range of a distribution is the difference between the third quartile  $Q_3$  and the first quartile  $Q_1$ .

$$\text{IQR} = (Q_3 - Q_1)$$

**QUARTILE DEVIATION** - It is the half of the interquartile range

$$\text{Q.D.} = (Q_3 - Q_1) / 2$$

- COEFFICIENT OF QUARTILE DEVIATION-**

$$\text{Coefficient of Q.D.} = \frac{(Q_3 - Q_1) / 2}{(Q_3 + Q_1) / 2}$$

$$= (Q_3 - Q_1) / (Q_3 + Q_1)$$

Determine Q.D. and coefficient of Q.D. for the following distribution-

Weight (kg)	30-34	35-39	40-44	45-49	50-54
No. of boys	5	11	26	10	8

Soln-

Class interval	f	C f
29.5-34.5	5	5
34.5-39.5	11	16
39.5-44.5	26	42
44.5-49.5	10	52
49.5-54.5	8	60
	$\sum f = 60$	

$$Q_1 = 60 + 1/4 = 61/4 = 15.25$$

$$\text{CLASS} = 34.5 - 39.5$$

$$Q_1 = 34.5 + \frac{60/4 - 5}{11} * 5$$

$$34.5 + 50/11 = 39$$

$$Q_3 = 3(61)/4 = 45.75$$

$$\text{CLASS} = 44.5 - 49.5$$

$$Q_3 = 44.5 + \frac{3(60)/4 - 42 * 5}{10}$$

$$= 44.5 + 15/10$$

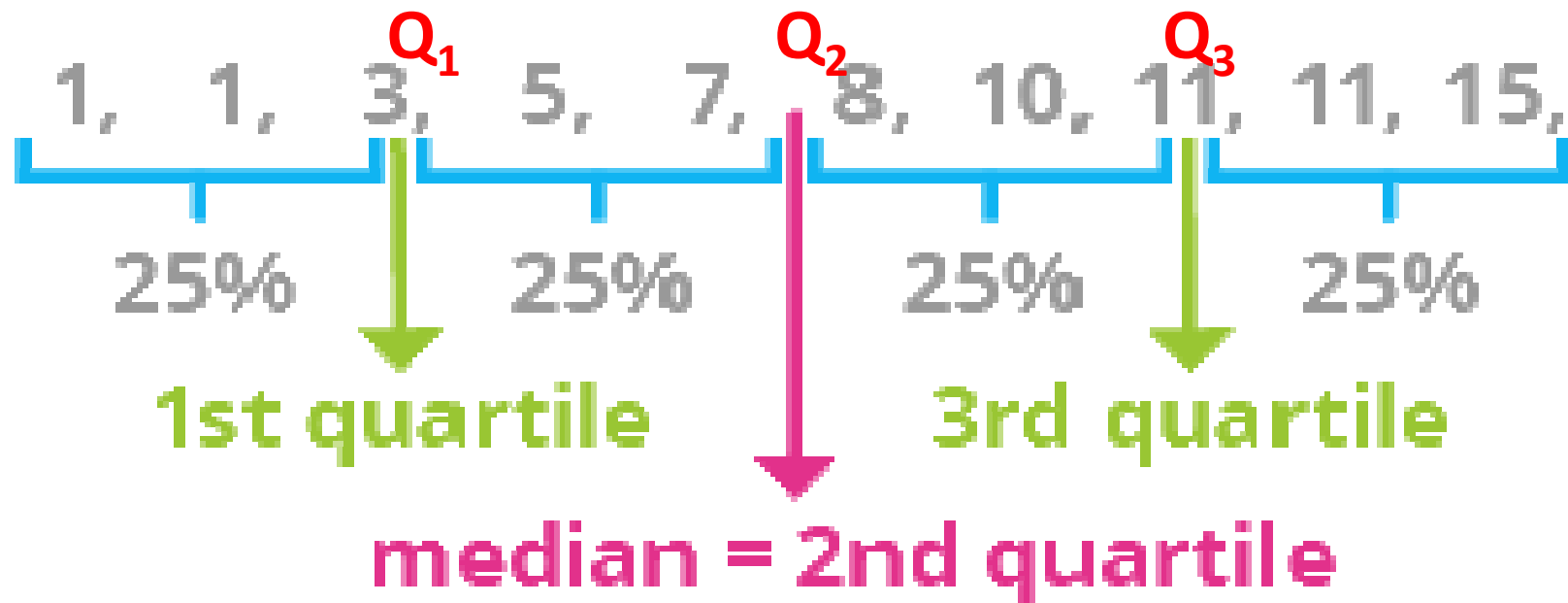
$$= 44.5 + 1.5$$

$$= 46$$

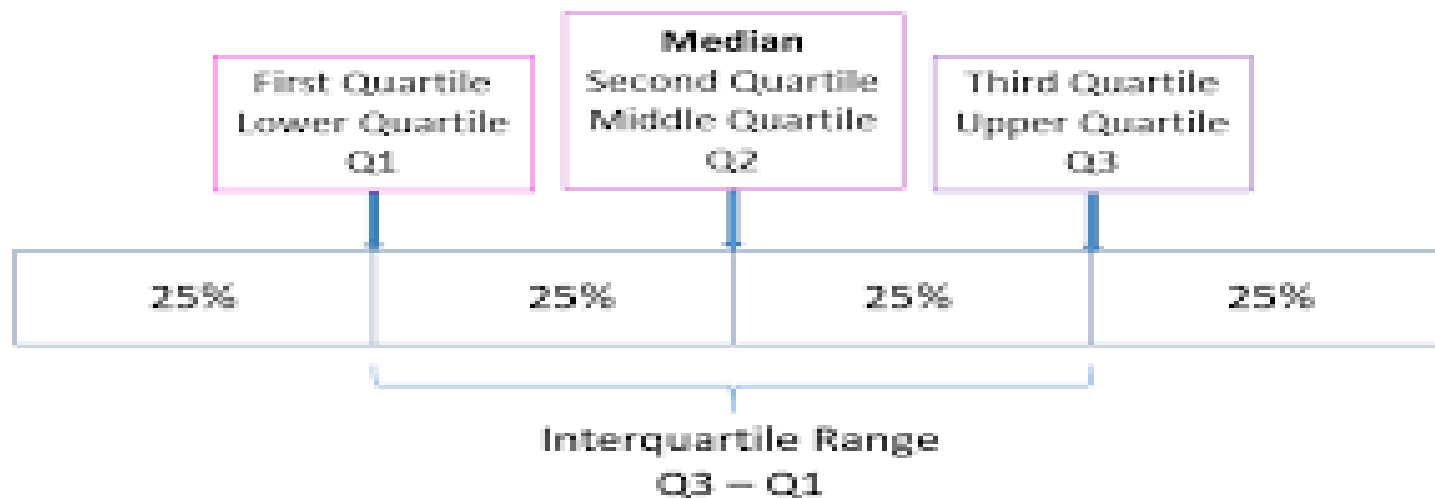
$$\begin{aligned} \text{Q.D.} &= Q_3 - Q_1 / 2 \\ &= 46 - 39 = 7 / 2 = 3.5 \end{aligned}$$

$$\text{Q.D.} = 3.5$$

$$\begin{aligned} \text{Coefficient of Q.D.} &= Q_3 - Q_1 / Q_3 + Q_1 \\ &= 46 - 39 / 46 + 39 \\ &= 7 / 85 = 0.082 \end{aligned}$$



#### Median and Quartiles





## MEAN DEVIATION ( M.D.)

The arithmetic mean of the absolute deviation of the observations of a distribution from its mean ,median & mode is known as

### MEAN DEVIATION.

Individual series -  $M.D. = \frac{\sum |D|}{N}$  where  $D = |X - \bar{X}|$   
 $D = |X - M_d|$

Discrete series -  $M.D. = \frac{\sum f |D|}{N}$

Continuous series  $M.D. = \frac{\sum f |D|}{N}$

Coefficient of M.D. =  $\frac{M.D}{MEAN}$  OR  $\frac{M.D.}{MEDIAN}$  OR  $\frac{M.D.}{MODE}$

# DISCRETE SERIES-

QU – calculate mean deviation from mean and its coefficient

X	10	11	12	13	14
F	3	12	18	12	3

Soln - -

X	f	f x	D  =   X - $\bar{X}$	f  D
10	3	30	2	6
11	12	132	1	12
12	18	216	0	0
13	12	156	1	12
14	3	42	2	6
	$\sum f = 48$	$\sum fx = 576$		$\sum f  D  = 36$

$$\bar{X} = \sum fx / \sum f$$

$$= 576 / 48$$

$$\bar{X} = 12$$

$$\text{M..D.} = \frac{\sum F |D|}{N}$$

$$= 36 / 48$$

$$= 0.75$$

$$\text{COEFFICIENT OF M.D.} = \text{M.D.} / \text{Mean}$$

$$= 0.75 / 12$$

$$= 0.0625$$

Calculate M.D. and its COEFFICIENT from median

X	f	C f	D  =  X- M <sub>d</sub>	f   D
10	3	3	2	6
11	12	15	1	12
12	18	33	0	0
13	12	45	1	12
14	3	48	2	6
	$\Sigma f = 48$			$\Sigma F  D  = 36$

$$\text{M.D.} = 36 / 48$$

$$\text{M.D.} = 0.75$$

Coefficient of M.D.

$$= \text{M.D.} / M_d$$

$$= 0.75 / 12$$

$$= 0.062$$

$$N = 48 \text{ (Even)}$$

$$M_d = 24 \text{ th term} + 25 \text{ th term} / 2$$

$$M_d = 12 + 12 / 2$$

$$M_d = 12$$

## Individual series –

Calculate mean deviation & its coefficient from median

6.7,10,12,13,4,8,12

Soln – arrange in ascending order 4,6,7,8,10,12,12,13

N = 8 (EVEN)

$$M = \frac{(N/2) \text{ th term} + (N/2 + 1) \text{ th term}}{2}$$

$$M_d = \frac{4^{\text{th}} \text{ term} + 5^{\text{th}} \text{ term}}{2} \\ = \frac{8 + 10}{2}$$

$$M_d = 9$$

$$M.D. = 22 / 8 \\ = 2.75$$

$$\text{COEFFICIENT OF M.D.} = 2.75 / 9 \\ = 0.304$$

Similarly mean =  $72/8 = 9$ , then

$$M.D. = 2.75 \text{ \& Coeff. } = 0.304$$

X	D   =   X - M <sub>d</sub>
4	5
6	3
7	2
8	1
10	1
12	3
12	3
13	4
	$\Sigma  D  = 22$

## CONTINUOUS SERIES-

Calculate M.D. & its coefficient from median

classes	f	C f	Midpoint X	D  =  X-M <sub>d</sub>	f D
0-5	5	5	2.5	11.5	57.5
5-10	8	13	7.5	6.5	52.0
10-15	15	28	12.5	1.5	22.5
15-20	16	44	17.5	3.5	56.0
20-25	6	50	22.5	8.5	51.0
	$\Sigma f$ =50				$\Sigma f D $ =239

N = 50 (EVEN)

$M_d = 25 \text{ th term} + 26 \text{ th term} / 2$

then median class = 10-15

$$M_d = 10 + \frac{25 - 13 * 5}{15} = 10 + 4 = 14$$

$$\text{M.D.} = 239 / 50$$

$$= 4.78$$

Coefficient of M.D. =

$$4.78 / 14$$

$$= 0.341$$

Calculate the mean deviation from the mean-

Weight in grams	0-5	5-10	10-15	15-20	20-25
no,. Of items	5	8	15	16	6

Soln –

classes	Mid value X	f	d= x-A/i	f d	D  (X- X )	f  D
0-5	2.5	5	-2	-10	11	55
5-10	7.5	8	-1	-8	6	48
10-15	<b>12.5 A</b>	15	0	0	1	15
15-20	17.5	16	+1	+16	4	64
20-25	22.5	6	+2	+12	9	54
		$\sum f = 50$		$\sum fd = 10$		$\sum f D  = 236$

$$\begin{aligned}
 \bar{X} &= A + \frac{\sum fd}{\sum f} * i \\
 &= 12.5 + \frac{10}{50} * 5 \\
 &= 12.5 + 1 \\
 &= \mathbf{13.5}
 \end{aligned}$$

$$\begin{aligned}
 \text{M.D.} &= 236/50 = \mathbf{4.72} \\
 \text{coefficient of M.D.} &= 4.72 / 13.5 \\
 &= \mathbf{0.349}
 \end{aligned}$$

### ➤ ADVANTAGES OF Q.D. :-

1. It is not affected by extreme value.
2. It is based on middle 50% value ,so it is better measure than range.
3. it is suitable for open ended data.

### ➤ DISADVANTAGES OF Q.D.:-

1. it is affected by sampling fluctuations.
2. it is unfit for further mathematical treatment.
3. it is not based on all observation.

### **ADVANTAGES OF M.D. :-**

1. It is based on all observation.
2. it is better than range & Q.D.
3. it is easy to calculate & understand .
4. it is not affected by extreme value.
5. it is a good measure for comparing two or more data.

### **DISADVANTAGES OF M.D.:-**

1. it is not suitable for open ended data set .
2. it cannot be used for further algebraic calculation.
3. it is based on absolute deviation.
4. mean deviation is not considered from mode.



## STANDERD DEVIATION ( S.D.)

**STANDERD DEVIATION** is the **positive square root of the arithmetic mean of the squares of sums of the derivations taken from mean**

it is denoted by 'σ' (sigma)

Individual series

$$\sigma = \sqrt{\frac{\sum (X - \bar{X})^2}{N}} \quad \text{where } \bar{X} = \sum x / n$$

Discrete series-  $\sigma = \sqrt{\sum f (x - \bar{x})^2 / N}$

$$\text{Where } \bar{x} = \sum f x / \sum f$$

$$\sigma = \sqrt{\sum d^2 / N} \quad \text{where } d = (x - \bar{x})$$

**VARIANCE**- IT is the square of standard deviation  
OR

standard deviation is the positive square root of  
variance .

So **VARIANCE =  $\sigma^2$  OR  $\sigma = \sqrt{\text{VARIANCE}}$**

$$\text{COEFFICIENT OF VARIATION} = \text{C.V.} = \frac{\sigma}{X} * 100 \quad \%$$

## Individual series -

qu .- determine standard deviation and its coefficient

7,8,6,8,9,7,5,6

Soln -

$$\bar{x} = (7+8+6+8+9+7+5+6) / 8 = 56 / 8 = 7$$

X	( X - $\bar{X}$ )	(X - $\bar{X}$ ) <sup>2</sup>
7	7-7=0	0
8	1	1
6	-1	1
8	1	1
9	2	4
7	0	0
5	-2	4
6	-1	1
		$\sum (X-\bar{X})^2 =$ 12

$$\sigma = \sqrt{\sum (X-\bar{X})^2 / N}$$

$$= \sqrt{12 / 8}$$

$$= \sqrt{1.5}$$

$$\sigma = 1.22$$

$$\text{Coefficient of S.D.} = 1.22/7$$

$$= 0.174$$

$$\text{Variance} = 1.5$$

$$\text{coefficient of variance} = \text{C.V.}$$

$$= 1.22 * 100 / 7 = 17.4\%$$

**DIRECT METHOD** - Find S.D. By direct method –

18, 11, 16, 9, 15, 13, 17, 8

Soln -

$$\bar{X} = 107 / 8 = 13.37$$

$$\sigma = \sqrt{\frac{\sum x^2}{n} - \frac{(\sum x)^2}{n}}$$

x	x <sup>2</sup>
18	324
11	121
16	256
9	81
15	225
13	169
17	289
8	64
$\sum x = 107$	$\sum x^2 = 1529$

$$\sigma = \sqrt{(1529/8) - (107/8)^2}$$

$$= \sqrt{191.12 - 178.89}$$

$$= \sqrt{12.234} = 3.5$$

$$\sigma = 3.5$$

$$\text{coefficient of S.D.} = 3.5/13.37 \\ = 0.261$$

$$\text{variance} = 12.23$$

$$\text{C.V.} = 3.5 * 100 / 13.37 \\ = 26.17\%$$

## SHORT CUT METHOD – Calculate S.D.

11,14,22,25,28,35,40,42,50

Soln -

$$\begin{aligned}\bar{X} &= 28 + 15/9 \\ &= 28 + 16.6 = 44.6\end{aligned}\quad \text{where } d = (x - A)$$

x	d=(x-A)	d <sup>2</sup>
11	-17	289
14	-14	196
22	-6	36
25	-3	9
<b>28</b> <u><b>A</b></u>	0	0
35	7	49
40	12	144
42	14	196
50	22	484
n=9	∑ d = 15	∑ d <sup>2</sup> = 1403

$$\begin{aligned}\sigma &= \sqrt{(1403/9) - (15/9)^2} \\ &= \sqrt{155.89 - 2.78} \\ &= \sqrt{153.11} \\ &= 12.37\end{aligned}$$

$$\begin{aligned}\text{Coeff. Of M.D.} &= 12.37/44.6 \\ &= 0.277\end{aligned}$$

$$\text{variance} = 153.11$$

$$\text{C.V.} = 12.37 * 100 / 44.6 = 27.73\%$$

## DISCRETE SERIES -

QU .-1

Calculate S. D. From the following distribution –

Tariff	4	7	10	15	25	50
no Of booking	80	75	40	32	15	8

Soln -

class	f	f x	$(x - \bar{x})$	$(x - \bar{x})^2$	$f (x - \bar{x})^2$
4	80	320	4-10=-6	36	2880
7	75	525	-3	9	675
10	40	400	0	0	0
15	32	480	5	25	800
25	15	375	15	225	3375
50	8	400	40	1600	12800
	$\sum f =$ 250	$\sum f x =$ 2500			$\sum f (x - \bar{x})^2 =$ 20530

**QU. 2**--Calculate S.D. by DIRECT METHOD –

Amount	4	8	10	13	18	24	30
No. of Bills	18	22	45	60	52	36	17

Soln -

x	f	f x	x <sup>2</sup>	f x <sup>2</sup>
4	18	72	16	288
8	22	176	64	1408
10	45	450	100	4500
13	60	780	169	10140
18	52	936	324	16848
24	36	864	576	20736
30	17	510	900	15300
	$\Sigma f = 250$	$\Sigma fx = 3788$		$\Sigma f x^2 = 69220$

$$\text{Qu-①} \quad \bar{X} = \frac{\sum f x}{\sum f} = \frac{2500}{250} = 10$$

$$\begin{aligned} \therefore \text{S.D.} &= \sqrt{\frac{\sum f(x - \bar{x})^2}{N}} \\ &= \sqrt{\frac{20530}{250}} = 9.062 \end{aligned}$$

$$\begin{aligned} \text{Coefficient of S.D.} &= 9.062/10 = \\ &= 0.9062 \end{aligned}$$

$$\text{VARIANCE} = 82.12$$

$$\begin{aligned} \text{C.V.} &= 9.062 * 100 / 10 \\ &= 90.62\% \end{aligned}$$

$$\begin{aligned} \text{Qu-②} \quad \sigma &= \sqrt{\frac{\sum f x^2}{N} - \left(\frac{\sum f x}{N}\right)^2} \\ &= \sqrt{\frac{69220}{250} - \left(\frac{3788}{250}\right)^2} \\ &= \sqrt{276.88 - 229.58} \\ &= \sqrt{47.3} = 6.88 \end{aligned}$$

$$\begin{aligned} \bar{X} &= \sum f x / \sum f = 3788/250 \\ &= 15.15 \end{aligned}$$

$$\begin{aligned} \text{Coefficient of S.D.} &= 6.88/15.15 \\ &= 0.454 \end{aligned}$$

$$\text{VARIANCE} = 47.3$$

$$\begin{aligned} \text{C.V.} &= 6.88 * 100 / 15.15 \\ &= 45.41\% \end{aligned}$$



## SHORT CUT METHOD –

QU. – 3 Calculate S.D. by shortcut method

Farm size	5	8	10	12	15	25	50	75
No. of farms	24	35	42	58	63	16	9	3

Soln -

x	f	d= (x – A)	f d	d <sup>2</sup>	f d <sup>2</sup>
5	24	5-25=-20	-480	400	9600
8	35	-17	-595	289	10115
10	42	-15	-630	225	9450
12	58	-13	-754	169	9802
15	63	-10	-630	100	6300
25 A	16	0	0	0	0
50	9	25	225	625	5625
75	3	50	150	2500	7500
	$\Sigma f =$ 250		$\Sigma f d =$ -2714		$\Sigma f d^2 =$ 58392

Soln-③

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

$$= \sqrt{\frac{58392}{250} - \left(\frac{-2714}{250}\right)^2}$$

$$= \sqrt{233.57 - 117.85}$$

$$= \sqrt{115.72}$$

$$= \boxed{10.76}$$

Continuous Series

$$\sigma = \sqrt{\frac{\sum fd^2}{N} - \left(\frac{\sum fd}{N}\right)^2} \times i$$

$$\bar{X} = A + \sum fd / \sum f$$

$$= 25 + (-2714) / 250$$

$$= 25 - 10.856 = 14.144$$

$$\text{Coefficient of S.D.} = 10.76 / 14.14$$

$$= 0.76$$

$$\text{VARIANCE} = \sigma^2 = 115.72$$

$$\text{C.V.} = \sigma * 100 / \bar{X}$$

$$= 10.76 * 100 / 14.14$$

$$= 76.07 \%$$

# CONTINUOUS SERIES –

## QU – 1. calculate S.D.

Class	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90
f	8	15	17	28	25	24	18	9	6

**Soln -**

Class	f	Midpo int (x)	d = ( x-A )/i	d <sup>2</sup>	fd	fd <sup>2</sup>
0-10	8	5	-4	16	-32	128
10-20	15	15	-3	9	-45	135
20-30	17	25	-2	4	-34	68
30-40	28	35	-1	1	-28	28
40-50	25	45 A	0	0	0	0
50-60	24	55	1	1	24	24
60-70	18	65	2	4	36	72
70-80	9	75	3	9	27	81
80-90	6	85	4	16	24	96
	$\sum f$ =150				$\sum fd = -$ 28	$\sum fd^2 =$ 632

Soln-1

$$\bar{X} = A + \frac{\sum fd}{N} \times i$$

$$= 45 + \frac{-28}{150} \times 10$$

$$= 45 - \frac{28}{15}$$

$$= 45 -$$

$$= \boxed{43.13}$$

### STEP DEVIATION METHOD

$$\sigma = \sqrt{\frac{\sum fd^2}{N} - \left(\frac{\sum fd}{N}\right)^2 \times i}$$

$$= \sqrt{\frac{632}{150} - \left(\frac{-28}{150}\right)^2 \times 10}$$

$$= \sqrt{4.213 - 0.035 \times 10}$$

$$= \boxed{20.44}$$

$$\text{coefficient of S.D.} = 20.44 / 43.13$$

$$= \mathbf{0.473}$$

$$\text{VARIANCE} = \mathbf{417.79}$$

$$\text{C.V.} = 20.44 \times 100 / 43.13$$

$$= \mathbf{47.39 \%}$$

QU - calculate standard deviation and coefficient of variation from the following data-

Value	90-99	80-89	70-79	60-69	50-59	40-49	30-39
frequency	2	12	22	20	14	4	1

Soln -

Class interval	Midpoint(x)	f	$d = x - A / i$	$d^2$	fd	$fd^2$
90-99	94.5	2	3	9	6	18
80-89	84.5	12	2	4	24	48
70-79	74.5	22	1	1	22	22
60-69	64.5 A	20	0	0	0	0
50-59	54.5	14	-1	1	-14	14
40-46	44.5	4	-2	4	-8	16
30-39	34.5	1	-3	9	-3	9
		$\sum f = 75$			$\sum fd = 27$	$\sum fd^2 = 127$

$$\bar{X} = A + \frac{\sum f d}{\sum f} * i$$

$$= 64.5 + \frac{27}{75} * 10$$

$$= 64.5 + 3.6 = 68.10$$

**The required A.M. = 68.10**

$$S.D. = \sigma = \sqrt{\frac{\sum f d^2}{N} - \left(\frac{\sum f d}{N}\right)^2} * i$$

$$= \sqrt{\frac{127}{75} - \left(\frac{27}{75}\right)^2} * 10$$

$$= \sqrt{1.6933 - 0.1296} * 10$$

$$= 1.2505 * 10$$

$$= 12.51$$

**The required S.D. = 12.51**

$$C.V. = \frac{\sigma}{\bar{X}} * 100$$

$$= 12.51 * 100 / 68.10 = 18.37\%$$

**The required coefficient of variation = 18.37**

## RELATION AMONG S.D ,Q.D.& M.D. -

$$\text{Q.D.} = \frac{5}{6} \text{ M.D.} = \frac{2}{3} \text{ S.D.}$$

$$6 \text{ Q.D.} = 5 \text{ M.D.} = 4 \text{ S.D.}$$

**QU -** for a series the value of mean deviation is 15 . Find the most likely value of its quartile deviation .

**Soln -**

$$\begin{aligned} \text{Q.D.} &= \frac{5}{6} \text{ M.D} \\ &= \frac{5}{6} * 15 \\ &= \frac{75}{6} \\ &= 12.5 \end{aligned}$$

Qu – c.v. of two series are 76% and 90 % but their S.D. are 15 and 18 respectively . Find their means .

Qu – The mean and standard deviation of a normal distribution are Rs. 60 and Rs. 5 respectively . Find the Interquartile range and the mean deviation of the distribution

Qu - for a distribution the coefficient of variation is 22.5 % and the value of mean is 7.5 . Find out the value of standard deviation

Qu – standard deviations of the two series are 18.6 and 13.8 their coefficients of variation are 52% and 63% . Find their arithmetic mean



## ❖ ADVANTAGES OF S.D. –

1. it is based on all items
2. it is most widely used measure of dispersion.
3. it is rigidly defined.
4. it is least affected by sampling fluctuations.
5. it is capable of further algebraic treatment.
6. it is the best of all measures of dispersions.

## DISADVANTAGES OF S.D. –

1. It is difficult and time consuming to calculate.
2. it is more affected by extremely large values.
3. it is not suitable for open ended series.

### ASSIGNMENT NO - 1

Qu -1. Calculate Q.D. & Coefficient of quartile deviation .also find interquartile range

Daily wages	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110-120
No. of workers	13	33	46	35	19	18	18	18

Qu – 2- find range and interquartile range-

Marks	5	10	15	20	25	30
no,. Of students	3	7	18	12	8	2

Qu .- 3.- find 1<sup>st</sup> quartile and 25<sup>th</sup> percentile from the following data-  
91,75,61,101,43,104

Qu -4.- calculate Range ,Q.D.and coefficient of Q.D.--

Class	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50
frequency	2	7	10	28	20	18	10	4	1

Qu .- 5.- calculate  $Q_3$  AND  $D_7$  for the following data-

marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
No. of students	3	10	17	7	6	4	2	1

Qu .- 6.- find M.D. from median & its coefficient

Mar ks	20	18	16	14	12	10	8	6
f	2	4	9	18	27	25	14	1

Qu .- 7.-calculate S.D. & coefficient of variation - (STEP DEVIATION METHOD)

class	20-40	40-60	60-80	80-100	100-120	120-140	140-160	160-180	180-200
f	6	9	11	14	20	15	10	8	7

QU .-8 .-For some distribution of data ,coefficient of variance is 20.5% and the value of the airthmetic mean is 5.5,then find S.D.

Qu .-9.- if S.D. of two series are 10 and 20 and their C.V. are 50% and 80% respectively then find arithmetic mean of these two series

Qu .-10 .-two brands of tyres are tested for the following –

NO. OF TYRES BRAND		
Life	X	Y
0-10	1	0
10-20	24	21
20-30	55	62
30-40	12	14
40-50	8	3

- (a) Which brand of tyres have greater average life?
- (b) compare the variability and state which brand of tyres would you use on your car?