UNIT :DISPERSION

DISPERSION-It is extent to which values in a distribution differ from the average of the distribution.

Objective of dispersion -:
(1) Know the limitation of average
(2) Encourage students to know the need of measures of dispersion
(3) Find the measures and then compare them
(4) Differentiate the absolute and relative measures of dispersion

Importance of dispersion-: We know that the per capita income gives only the average income. A measure of dispersion can tell you about income inequalities. There are two measures of dispersion -:

Absolute measures-: When dispersion of the series is expressed in terms of original unit of the series, it is called absolute measure of dispersion. Ex: Data in the in the form of rupees, kilograms, meters etc.

Relative measures -: The relative measure of dispersion express the variability of data in term of some relative value or percentage. Relative measure of dispersion is known as coefficient of dispersion.

Absolute measurement	**Relative measurement**
Range	Coefficient of range
Quartile deviation	Coefficient of quartile deviation
Mean deviation	Coefficient of mean deviation
Standard deviation	Coefficient of standard deviation
Lorenz curve	

Range - Range is the difference between the largest value and the smallest value in a distribution.

IMPORTANCE OF RANGE: We see the maximum and minimum temperature of different cities almost daily on our TV screen and form judgments about temperature.

Coefficient of Range: It is ratio of the difference between the highest and lowest values of the series and the sum of the lowest and highest values of the series .It is calculated given below formula. H = highest value L = lowest value Coefficient of range (CR)=$\frac{H-L}{H+L}$ **Calculation Coefficient of range**:

(1) Individual series and range

Wages ₹	50	60	80	90	200	225	250	300	340	360	400

Range = H-L H= 400, L = 50

Range is 400-50 =350 CR = $\frac{H-L}{H+L}$

CR = $\frac{400-50}{400+50}$ = $\frac{350}{450}$ =o.78

Discrete series:

Size	10	11	12	13	14	15	16	18
Frequency	1	13	24	14	15	13	16	20

Here, H = 18; L =10

Range = H –L = 18 -10 =8

C R = $\frac{H-L}{H+L}$ = $\frac{18-10}{18+10}$ =$\frac{8}{28}$ =0.29

Distribution series and range -:

Marks	Number of student
20-29	8
30-39	12
40-49	20
50-59	7
60-69	3

The above inclusive series must be converted into exclusive series to calculate range, the conversion is as given below:

Marks	Number of student
19.5-29.5	8
29.5-39.5	12
39.5-49.5	20
49.5-59.5	7
59.5-69.5	3

Range = Upper limit of the last class **-** Lower limit of the first class

L = 19.5; H = 69.5 Range = 69.5 -19.5 =50

Coefficient of range = $\frac{69.5-19.5}{69.5+19.5} = \frac{50}{89}$ =0.562

Merits:

(1)**Simple:** It is very simple to measure the dispersion

(2)**Wide Application**: Range is widely used in statistical series relating to quality control in production.

Demerits-:(1) Unstable

(2)Not based on all values

(3)Irrelevant for open ended frequency distribution

Quartile: It is the half of inter quartile range. It is also called semi-inter quartile range.

Inter quartile range: It is the difference between third quartile (Q_3) and first quartile (Q_1) of a series.

Coefficient Quartile deviation: Coefficient of quartile deviation is calculated using the different formula:

Coefficient of QD = $\frac{Q_3 - Q_1}{Q_3 + Q_1}$

(1)Individual series and coefficient of quartile deviation

Wages ₹	50	60	80	90	200	225	250	300	340	360	400

Q_1 = ($\frac{N+1}{4}$) = $\frac{11+1}{4}$ = $\frac{12}{4}$ = 3 , size of 3rd item = 80

Q_3 =3 ($\frac{N+1}{4}$) = 3($\frac{11+1}{4}$) = 3($\frac{12}{4}$) = 3 X 3 = 9 th item

size of 9th item =340

QD= Q3-Q1 = 340-80 = 260.

IQD = Q3-Q1/2 = 260/2 = 130

Coefficient of QD = $\frac{340-80}{340+80}$ = $\frac{260}{420}$ = 1.47

Discrete series:

Size	10	11	12	13	14	15	16	18
Frequency	1	13	24	14	15	13	16	20
CF	1	14	38	52	67	80	96	116

Q_1 =$\frac{N}{4}$=$\frac{116}{4}$=$\frac{116}{4}$=29th item is 12

Q_3=3($\frac{N}{4}$) =3($\frac{116}{4}$)=3($\frac{116}{4}$)=$\frac{348}{4}$=87 th items is 16

$QD = Q3 - Q1$ = 16-12 = 4

$IQD = Q3 - Q1/2$ 16-12/2 = 4/2 = 2

Coefficient of QD =$\frac{Q_3 - Q_1}{Q_3 + Q_1}$ =$\frac{16-12}{16+12}$ = $\frac{4}{28}$ =0.14

Coefficient of quartile deviation from continuation series-:

Illustration

Age (years)	0-20	20-40	40-60	60-80	**80-100**
Numbers of person	**4**	10	15	20	11

Solution -:

Age (years)	Number of person (f)	Cumulative frequency
0-20	4	4
20-40	10	14
40-60	15	29
60-80	20	49
80-100	11	60

Q_1 = Size of ($\frac{N}{4}$)th item = size of ($\frac{60}{4}$) th items = size of 15 th items

15th items lies in group 40-60 and falls within 29th cumulative frequency of the series

$Q_1 = l_1 + \frac{\frac{N}{4} - c.f}{f} \text{ X i}$

l_1= Lower limit of the class interval

N= Sum total of frequencies

c.f =Cumulative frequencies

f = Frequency of the quartile class

i= Class interval

Thus, $Q_1 = 40 + \frac{\frac{60}{4} - 14}{15} \text{ x } 20$

$= 40 + \frac{15-14}{15} \text{ X } 20$

$= 40 + \frac{1}{15} \text{ X } 20$

= 40 +1.33 = 41.33

Q_3 = Size of 3 ($\frac{N}{4}$) th item = size of 3($\frac{60}{4}$) th item

= Size of 45 th item

45 th item fall within 49 th cumulative frequency of the series

$Q_3 = l_1 + \frac{3\left(\frac{N}{4}\right) - C.f}{f} \text{ X i}$

$= 60 + \frac{3\left(\frac{60}{4}\right) - 29}{20} \text{ X } 20$

$= 60 + \frac{45-29}{20} \text{ X } 20$

$= 60 + \frac{16}{20} \text{ X } 20$

= 60 + 16 = 76

Now we have values of Q_1 and Q_3

Coefficient of QD = $\frac{Q_3 - Q_1}{Q_3 + Q_1} = \frac{76-41.33}{76+41.33} = \frac{34.67}{117.33} = 0.30$

Coefficient of QD = 0.30

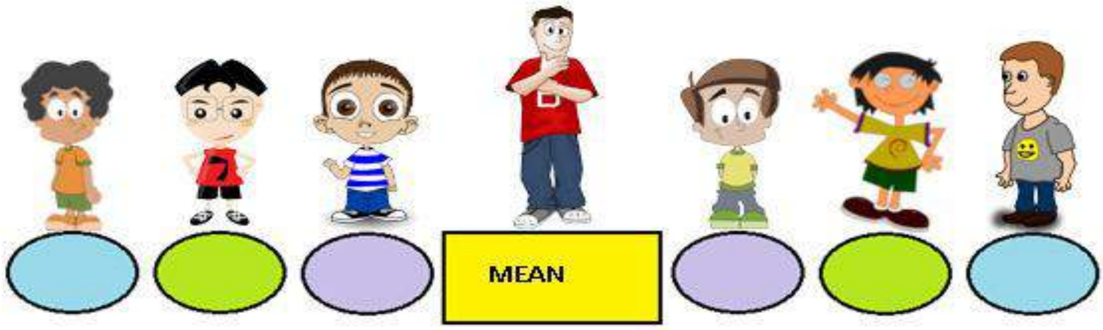
Merits: (1) It is very simple to calculate.

(2) Less effect of extreme value

Demerits: (1) Not based on all values

(2) Formation of series not known
(3) Instability

<u>Mean Deviation</u>: It is the arithmetic average of deviations of all the values taken from a statistical average (mean, median or mode) of series. In taking deviations of values, algebraic signs + and – are not taken into consideration,



that is negative deviations are also treated as positive deviations.

<u>Coefficient of mean deviation</u>: We can find out coefficient of mean deviation, mean deviation of series is divided by the central tendency of the series.

Coefficient of MD from mean $=\frac{MD\bar{x}}{\bar{X}} = \frac{Mean\ deviation}{Arithmetic\ mean}$

Coefficient of MD from median$=\frac{MDm}{M} = \frac{Mean\ deviation}{Median}$

<u>Individual series and mean deviation</u>:

<u>Illustration</u>:

S.No.	1	2	3	4	5	6	7	8	9
Wages(₹)	40	42	45	47	50	51	54	55	57

<u>Solution</u>: Coefficient of mean deviation and coefficient of mean deviation using median.

S. No.	Wages (₹)	Deviation from median $\lvert dm\rvert=\lvert X-M\rvert$, M = 50
1	40	10
2	42	8
3	45	5
4	47	3
5	50 (M)	0
6	51	1
7	54	4

8 9	55 57	5 7
N =9		$\sum\|dm\|$ =43

M = Size of ($\frac{N+1}{2}$)th item

M = Size of ($\frac{9+1}{2}$) th item

M = 5th item = 50₹

MD_m = $\frac{\sum|dm|}{N}$ = $\frac{43}{9}$ = 4.78₹

Coefficient of MD_m

= $\frac{MD_m}{M}$ = $\frac{4.78}{50}$ = 0.096

Mean deviation using arithmetic mean -:

Illustration -:

S. No.	1	2	3	4	**5**	6	7	8	9
Wages(₹)	40	42	45	47	50	51	54	55	57

Solution -: Calculation of mean deviation and coefficient of mean deviation using arithmetic mean.

S.No.	Wages (₹)	Deviation from arithmetic mean $\|d\bar{x}\|$= $\|x-\bar{x}\|$ $\bar{x}$ =49
1 2 3 4 5 6 7 8 9	40 42 45 47 50 51 54 55 57	9 7 4 2 1 2 5 6 8
N = 9	∑ X =441	$\sum\|d\bar{x}\|$ =44

$\bar{X}$ = $\frac{\sum X}{N}$ = $\frac{441}{9}$ = ₹ 49

$MD_{\bar{X}}$ = $\frac{\sum|d_{\bar{X}}|}{N}$ = $\frac{44}{9}$ = ₹ 4.89

Coefficient of $MD_{\bar{X}}$ = $\frac{MD_{\bar{X}}}{\bar{X}}$ = $\frac{4.89}{49}$ = 0.10

Merits: (1) It is very simple and easy measure of dispersion.

(2) Mean deviation is based on all the items of the series.

(3) Mean deviation is less affected by extreme values than the range.

Demerits:

1)Calculation of mean deviation suffers from inaccuracy.

2)Mean deviation is not capable of any further algebraic treatment.

3) Unreliable.

Standard deviation: It is a measure that is used to quantify the amount of variation or dispersion of a set of data value.

Calculation of standard deviation -:

Individual series -:

Direct Method -: This method involves the following step:

- Find the mean value from the given series $\bar{X} = \frac{\sum X}{N}$.
- Find the deviation of each item from $\bar{X}$.x = X - $\bar{X}$
- Each value of deviation is squared x^2
- The sum total of the square of the deviation is = $\sum x^2$
- $\sum x^2$ is divided by the number of items (N) in the series .Square root of $\frac{\sum x^2}{N}$ will be the standard deviation.
- Calculate the value of $\sqrt{\frac{\sum x^2}{N}}$.

Formula : SD or σ = $\sqrt{\frac{\sum x^2}{N}}$ or $\sqrt{\frac{\sum (X-\bar{X})^2}{N}}$

Illustration -:

Marks	12	8	17	13	15	9	18	11	6	1

Solution -:

S . No.	Marks	Deviation	Square of

		$(x = x - \bar{x})$ $\bar{x} = 11$	deviation $x^2 = (X - \overline{X})^2$
1 2 3 4 5 6 7 8 9 10	12 8 17 13 15 9 18 11 6 1	12-11 =1 8 – 11 = -3 17 -11 = 6 13 -11 = 2 15 – 11 = 4 9 – 11 = -2 18 -11 = 7 11 – 11 =0 6 – 11 = -5 1 – 11= -10	1 9 36 4 16 4 49 0 25 100
N =10	∑ X =110	∑x =0	$\sum x^2$ =244

$\bar{X} = \frac{\sum X}{N} = \frac{110}{10} = 11$

$\sigma = \sqrt{\frac{\sum x^2}{N}} = \sqrt{\frac{244}{10}} = \sqrt{24.4} = 4.94$

Coefficient of SD = $\frac{\boldsymbol{\sigma}}{\boldsymbol{x}}$

$= \frac{4.94}{11}$

= 0.45

Short cut method -:

(a) A=Assumed mean
(b) Deviation of all the items are obtained from the assumed mean.
(c) Sum total of these deviation is obtained as ∑(X –A) or ∑dx.
(d) Square up the deviation and obtain their sum total of as $\sum dx^2$.
(e) The following formula is applied to calculate the value of standard deviation.

FORMULA -: $\sigma = \sqrt{\frac{\sum dx^2}{N} - (\frac{\sum dx}{N})^2}$

Illustration -: Find out SD from the data given below:

8,10,12,14,16,18,20,22,24,26

SOLUTION -:

S.No.	Size	Deviation from Assumed average (dx =X – A) A =20	Square of deviation (dx^2)
1	8	8-20=-12	144
2	10	10 -20 = -10	100
3	12	12 – 20 = -8	64
4	14	14 -20 = -6	36
5	16	16 – 20 = -4	16
6	18	18 – 20 = -2	4
7	20 (A)	20 -20 = 0	0
8	22	22 -20 =+ 2	4
9	24	24 – 20 = +4	16
10	26	26 -20 = +6	36
N =10		∑dx = -30	$\sum dx^2$= 420

$$\sigma = \sqrt{\frac{\sum dx^2}{N} - (\frac{\sum dx}{N})^2} = \sqrt{\frac{420}{10} - (\frac{-30}{10})^2}$$

$$= \sqrt{42 - (-3)^2} = \sqrt{33} = 5.74$$

<u>Step deviation method</u>:

Steps:

(a) Take any value of the series as assumed mean (A).

(b) Deviation are taken from the assumed mean (dx) = (X –A).

(c) The deviation are divided by the common factor as (dx') = $\frac{dx}{c}$

(d) Here C is the common factor.

(e) dx' are squared and obtained as sum of= $\sum dx'^2$.

(f) The following formula is applied to calculate the value of standard deviation.

FORMULA -: $\sigma = \sqrt{\frac{\sum dx'^2}{N} - (\frac{\sum dx'}{N})^2} \times C$

ILLUSTRATION -: Find out SD of the monthly income of 5 person, as stated below:

S. No. of persons	Monthly Income (in ₹)
1	500
2	700
3	1000

4 5	1500 1300

SOLUTION -:

S.No.	Monthly income	Deviation from assumed average (dx = X – A) A =1000	dx' = $\frac{dx}{c}$ C =100	dx'^2
1 2 3 4 5	500 700 1000 1500 1300	-500 -300 0 +500 +300	-5 -3 0 +5 +3	25 9 0 25 9
N =5			$\sum dx'$ =0	$\sum dx'^2$ =68

$$\sigma = \sqrt{\frac{\sum dx'^2}{N} - \left(\frac{\sum dx'}{N}\right)^2} \text{ X C}$$

$$= \sqrt{\frac{68}{5} - \left(\frac{0}{5}\right)^2} \text{ X 100}$$

$$= \sqrt{13.6} \text{ X 100 = 368.78}$$

2. Discrete series and standard deviation: There are two method of calculating SD.

- Direct method
- Short – cut method.

<u>Direct method</u>:

Steps:

- Find out mean value from the given series as $\bar{X} = \frac{\sum fX}{N}$
- Deviation of various items are obtained from the mean value as x = X -$\bar{X}$
- Deviations are squared to obtainx^2 .

- Squared deviation are multiplied by their corresponding frequencies to obtain $\sum fx^2$.
- The following formula is applied to calculate the value of SD.

FORMULA -: σ = $\sqrt{\frac{\sum fx^2}{N}}$ or σ = $\sqrt{\frac{\sum f(X-\overline{X})^2}{N}}$

Illustration: Compute standard deviation from the following data. Use direct method:

Size	4	6	8	10	12	14	16
Frequency	1	2	3	5	3	2	1

Solution-:

Size (X)	Frequency (f)	Multiple of size and frequency (fx)	Deviation from Mean (x = x - $\bar{x}$) $\bar{X}$ =10	Square of deviation (x^2)	fx^2
4	1	4	-6	36	36
6	2	12	-4	16	32
8	3	24	-2	4	12
10	5	50	0	0	0
12	3	36	+2	4	12
14	2	28	+4	16	32
16	1	16	+6	36	36
	N =17	∑fx= 170			$\sum fx^2$ =160

$\bar{X} = \frac{\sum fX}{N} = \frac{170}{17} = 10$

σ = $\sqrt{\frac{\sum fx^2}{N}} = \sqrt{\frac{160}{17}} = \sqrt{9.41} = 3.07$

Short –cut method :

Steps :

(a) Assume any item value as assumed mean (A).
(b) Deviate different item values from assumed mean to obtain d=(X-A).
(c) Deviations multiply with corresponding frequencies to obtain ∑fd
(d) Deviation are squared to obtain ∑fd^2
(e) The following formula is applied to calculate the value of SD.

Formula -: σ = $\sqrt{\frac{\sum fd^2}{N} - (\frac{\sum fd}{N})^2}$

Illustration -: Find out SD of the following data:

Size	1	2	3	4	5	6	7	8
Frequency	5	10	15	20	15	10	10	15

Solution-:

Size (X)	Frequency (f)	Deviation from assumed average (dx=X –A) A =5	Square of deviation (dx^2)	Multiple of deviation And the frequency (fdx)	fdx^2
1	5	-4	16	-20	80
2	10	-3	9	-30	90
3	15	-2	4	-30	60
4	20	-1	1	-20	20
5	15	0	0	0	0
6	10	+1	1	+10	10
7	10	+2	4	+20	40
8	15	+3	9	+45	135
	∑f=100			∑fdx = -25	∑fdx^2=435

$$\sigma = \sqrt{\frac{\sum fdx^2}{N} - (\frac{\sum fdx}{N})^2}$$

$$= \sqrt{\frac{435}{100} - (\frac{-25}{100})^2}$$

$$= \sqrt{\frac{435}{100} - (\frac{-1}{4})^2} \quad = \sqrt{\frac{435}{100} - \frac{1}{16}}$$

$= \sqrt{4.29}$ = 2.07

<u>Continues series and standard deviation</u> -:

Three method are available for the calculation of SD in case continues series.

(a) Direct method (b) Short –cut method (c) Step- deviation method

<u>Direct method</u>: This method involves the following step;

(a) Find the mean value from the given series ($\bar{X}$)

(b) Deviation of various mid- values are taken from the mean value x =m -$\bar{X}$

(c) Deviation are squared (x^2) and then multiple by their corresponding frequencies to get ∑fx^2 .

(d) Following formula is used to calculate the value of standard deviation.

Formula: σ = $\sqrt{\frac{\sum fx^2}{N}}$ or σ = $\sqrt{\frac{\sum f(X-\overline{X})^2}{N}}$

Illustration:

From the following series, calculate SD by using direct method:

Size	0-2	2-4	4-6	6-8	8-10	10-12
Frequency	2	4	6	4	2	6

Solution -:

Size (x)	Mid-value (m)	Frequency (f)	Multiple of mid value and frequencies (fm)	Deviation from mean value (X=m -$\bar{x}$) $\bar{X}$ =6.5	Square of deviation (x^2)	fx^2
0-2	1	2	2	-5.5	30.25	60.50
2-4	3	4	12	-3.5	12.25	49.00
4-6	5	6	30	-1.5	2.25	13.50
6-8	7	4	28	+0.5	0.25	1.00
8-10	9	2	18	+2.5	6.25	12.50
10-12	11	6	66	+4.5	20.25	121.50
		N =24	∑fm =156			∑ fx^2=258

$\bar{X}$=$\frac{\sum fm}{N}$ =$\frac{156}{24}$= 6.5

σ = $\sqrt{\frac{\sum fx^2}{N}}$

= $\sqrt{\frac{258}{24}}$

=$\sqrt{10.75}$ =3.28

Short cut method:

SD = $\sqrt{\frac{\sum fdx^2}{N} - (\frac{\sum fdx}{N})^2}$

Illustration:

Size	0-2	2-4	4-6	6-8	8-10	10-12
Frequency	2	4	6	4	2	6

Solution:

Size (x)	Mid-value (m)	Frequency (f)	Deviation from assumed mean (dx=m - A), A=5 $\bar{X}$ =6.5	Square of deviation (dx^2)	Multiple of deviation And the frequency (fdx)	fdx^2
0-2 2-4 4-6 6-8 8-10 10-12	1 3 5 7 9 11	2 4 6 4 2 6	-4 -2 0 +2 +4 +6	16 4 0 4 16 36	-8 -8 0 +8 +8 +36	32 16 0 16 32 216
		N =24			∑fdx=36	∑fdx^2=312

SD = $\sqrt{\frac{\sum fdx^2}{N} - (\frac{\sum fdx}{N})^2}$ = $\sqrt{\frac{312}{24} - (\frac{36}{24})^2}$ =$\sqrt{13 - 2.25}$ =$\sqrt{10.75}$ = 3.28

Standard deviation = 3.28

Step deviation method:

This is the most popular method of calculating standard deviation in case of grouped data

Steps:

- Assume any one item value as assumed mean(A)
- Find out mid value for each class
- Find out deviation from mid values(dx=m -$\bar{x}$)
- Divide the deviation by their common factor to get ($\frac{dx}{c}$) , expressed as dx'
- Multiply dx' with the corresponding frequencies and find their sum total of as $\sum f dx'$.Also take square of (dx'^2), and multiply them by the corresponding frequencies to get ∑fdx'^2 .
- Calculate the value of SD, using the following formula.

Formula -: SD = $\sqrt{\frac{\sum f dx'^2}{N} - (\frac{\sum f dx'}{N})^2}$ X C

Illustration -:

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
No of students	5	10	20	40	30	20	10	4

Solution -:

Marks (X)	Mid values (M)	Frequency	Deviation from assumed average (dx=M-A) A=35	$dx'=\frac{dx}{c}$ C=10	fdx'	f dx'^2
0-10 10-20 20-30 30-40 40-50 50-60 60-70 70-80	5 15 25 35(A) 45 55 65 75	5 10 20 40 30 20 10 4	-30 -20 -10 0 +10 +20 +30 +40	-3 -2 -1 0 +1 +2 +3 +4	-15 -20 -20 0 +30 +40 +30 +16	45 40 20 0 30 80 90 64
		N=139			∑f dx'=61	∑f dx'^2=369

SD = $\sqrt{\frac{\sum f dx'^2}{N} - (\frac{\sum f dx'}{N})^2}$ XC = $\sqrt{\frac{369}{139} - (\frac{61}{139})^2}$ X 10

==$\sqrt{2.655 - 0.193}$X 10

=$\sqrt{2.462}$ x 10

=15.69

Standard deviation =15.69

Step- deviation method-:

Find out standard deviation from the following data. Use step – deviation method:

Marks	20-40	40-60	60-80	80-100	100-120	120-140
Number of student	6	9	8	10	11	6

Solution-:

Marks	Mid values (M)	Frequency	Deviation from assumed average (dx=M-A) A=90	$dx' = \frac{dx}{c}$ C=20	fdx'	f dx'^2
20-40	30	6	-60	-3	-18	54
40-60	50	9	-40	-2	-18	36
60-80	70	8	-20	-1	-8	8
80-100	90	10	0	0	0	0
100-120	110	11	+20	+1	11	11
120-140	130	6	+40	+2	12	24
		N=50			∑fdx'=-21	∑f $dx'^2 = 133$

SD = $\sqrt{\frac{\sum f dx'^2}{N} - (\frac{\sum f dx'}{N})^2}$ x C = $\sqrt{\frac{133}{50} - (\frac{-21}{50})^2}$x 20

= $\sqrt{2.66 - 0.1764}$ x 20 =$\sqrt{2.4836}$ x 20 = 31.52

Standard deviation = 31.52

Coefficient of standard deviation-: It is generally used whenever variation in different series is compared. It is estimated by dividing the value of standard deviation by the mean of the series.

Coefficient of standard deviation = $\frac{\sigma}{\bar{x}}$

Merits -:(1) The calculation of standard deviation is based on all the value of a series.(2) Standard deviation is a clear and certain measure of dispersion.(3) Change in sample causes little effect on standard deviation.(4) It is capable of further algebraic treatment.

Demerits-:(1) It is difficult to calculate and make use of standard deviation as a measure of dispersion.(2) More important to extreme value.

Coefficient of variation-: Standard deviation of the given series divided by mean of the given series and multiplied with base 100.

Coefficient of variation or CV =$\frac{\sigma}{\bar{X}}$ x 100

Individual series and coefficient of variation -:

Illustration -: Calculate coefficient of variation of the following series:

S.No.	1	2	3	4	5	6	7	8	9	10
Marks	53	58	25	30	54	42	32	48	46	52

Solution-:

S.No.	Marks (X)	Deviation from mean(X=X -$\bar{x}$) $\bar{x}$ =44	Square of deviation (X-$\overline{X})^2$
1	53	9	81
2	58	14	196
3	25	-19	361
4	30	-14	196
5	54	10	100
6	42	-2	4
7	32	-12	144
8	48	4	16
9	46	2	4
10	52	8	64
N=10	∑X=440		$\sum x^2$=∑(X-$\overline{X})^2$=1166

$\bar{X}$= $\frac{\sum X}{N}$ =$\frac{440}{10}$ =44

SD =$\sqrt{\frac{\sum x^2}{N}}$ =$\sqrt{\frac{1166}{10}}$ =$\sqrt{116.6}$ = 10.8

CV = $\frac{\sigma}{\bar{X}}$ **x 100 =**$\frac{10.8}{44}$ x 100 = 24.55

Coefficient of variation =24.55

Discrete series and coefficient of variation -:

Illustration-: Calculate coefficient of variation of the following data:

Items	10	12	14	16	18	20	22

Frequency	4	6	10	15	9	4	2

Solution:

Items	Frequency (f)	Deviation from assumed average (dx=X-A) A=16	Fdx	fdx^2
10	4	-6	-24	144
12	6	-4	-24	96
14	10	-2	-20	40
16	15	0	0	0
18	9	+2	+18	36
20	4	+4	+16	64
22	2	+6	+12	72
			∑fdx = -22	∑fdx^2=452

$\bar{X}$= A + $\frac{\sum \text{fdX}}{N}$ = 16 +$\frac{-22}{50}$ = 15.56

SD =$\sqrt{\frac{\sum f dx'^2}{N} - (\frac{\sum f dx'}{N})^2}$ = $\sqrt{\frac{452}{50} - (\frac{-22}{50})^2}$ == $\sqrt{9.04 - (-0.44)^2}$

= $\sqrt{9.04 - 0.1936}$= $\sqrt{8.8464}$ =2.97

CV = $\frac{\sigma}{\bar{X}}$ **x 100 =**$\frac{2.97}{15.56}$ x 100 = 19.09

Coefficient of variation = 19.09

Continues series and coefficient of variation-:

Illustration: Calculate coefficient of variation, given the following data-set.

Marks	0-10	10-20	20-30	30-40	40-50	50-60	60-70
No of student	2	4	5	9	10	5	15

Solution -:

Marks	Mid – value(M)	Frequency(f)	Deviation from assumed average (dx=m-A)	dx'=$\frac{dx}{c}$ C=10	dx'^2	fdx'	fdx'^2

			A=35				
0-10 10-20 20-30 30-40 40-50 50-60 60-70	5 15 25 35(A) 45 55 65	2 4 5 9 10 5 15	-30 -20 -10 0 +10 +20 +30	-3 -2 -1 0 +1 +2 +3	9 4 1 0 1 4 9	-6 -8 -5 0 +10 +10 +45	18 16 5 0 10 20 135
		N= 50				∑fdx'=46	∑f $dx'^2 =$ 204

$\bar{X}$= A + $\frac{\sum \mathrm{f} dx'}{N}$ x C =35+$\frac{46}{50}$ x 10 =44.2 SD

=$\sqrt{\frac{\sum f dx'^2}{N} - (\frac{\sum f dx'}{N})^2}$X C

= $\sqrt{\frac{204}{50} - (\frac{-46}{50})^2}$ x 10

=$\sqrt{4.08 - (-0.92)^2}$ x 10

= $\sqrt{4.08 - 0.8464}$ x 10 =$\sqrt{3.2336}$ x 10

= 1.798 x 10

= 17.98

CV = $\frac{\sigma}{\bar{X}}$ **x 100**

= $\frac{17.98}{44.2}$ x 100 = 40.68

Coefficient of variation =40.68