

Unit III
Measures of Central Tendency
CHAPTER 7



MEAN

a) Arithmetic Mean

IMPORTANT FORMULAE

For Arithmetic Mean

Individual Series ; $\bar{X} = \frac{\sum X}{N}$ (Direct Method)
 $= A + \frac{\sum dx}{N}$ (Short Cut method)
 $= A + \frac{\sum dx'}{N} \times i$ (Step Deviation Method)

Discrete and Continuous Series ; $\bar{X} = \frac{\sum fm}{N} = \frac{\sum fX}{N}$ (Direct Method)
 $= A + \frac{\sum fdx}{N}$ (Short cut Method)
 $= A + \frac{\sum fdx'}{N} \times i$ (Step Deviation Method)

Weighted A.M; $\bar{X}_w = \frac{\sum WX}{\sum W}$ And ; Combined $\bar{X}_{123} = \frac{N_1 \bar{X}_1 + N_2 \bar{X}_2 + N_3 \bar{X}_3 \dots}{N_1 + N_2 + N_3 \dots}$

1. ARITHMETIC MEAN (A.M.)

Meaning

It is the most widely used measure to represent the entire data. To a layman, it is an average but for a statistician, it is 'Arithmetic Mean'. Arithmetic mean is obtained by adding all the items and by dividing the total by the total number of items. If the marks of 6 students are 4, 8, 12, 16, 20, 30, then to find average marks of the students, we will add these six values and divide the total by the total number of items. The total of the 6 items in this case is 90, dividing it by 6, we get 15. It is the Arithmetic Average or Mean ($\bar{X}$).



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$$\bar{X} = \frac{4 + 8 + 12 + 16 + 20 + 30}{6} = \frac{90}{6} = 15.$$

✓ 10. **MERITS AND DEMERITS OF ARITHMETIC MEAN**

(A) Merits

1. It can be **easily calculated**; and can be easily understood. It is the reason that it is the **most used** measure of central tendency.
2. As every item is taken in calculation, it is **effected by every item**.
3. As the mathematical formula is **rigid one**, therefore the result remains the same.
4. **Fluctuations are minimum** for this measure of central tendency when samples are taken from one and the same population.
5. It can further be subjected to **algebraic treatment** unlike other measures like mode and median.

6. A.M. has also a plus point being a **calculated quantity** and is **not based on position** of terms in a series.
7. As it is rigidly defined, it is **mostly used** for comparing the various issues.

(B) Demerits or Limitations

1. It cannot be located graphically.
2. A single item can bring big change in the result. For example if there are three terms 4, 7, 10 ; $\bar{X}$ is 7 in this case. If we add a new term 95, the new $\bar{X}$ is $\frac{4+7+10+95}{4} = \frac{116}{4} = 29$. This is a big change as compared to the size of first three terms' $\bar{X}$.
3. Its value will be effective only if the frequency is **normally distributed**. Otherwise in case skewness is more, the results become ineffective.
4. In case of **open end class intervals** we have to **assume the limits of such intervals** and a little variation in $\bar{X}$ can take place. Such is not the case with median and mode, and there is no use of the open end intervals in its calculations.
5. **Qualitative forms** such as Cleverness, Riches etc. cannot give $\bar{X}$ as data can't be expressed numerically.
6. $\bar{X}$ cannot be located by inspection as in the case of mode and median.
7. Some times it gives **impossible or laughable conclusions**. e.g. if there are 60, 50 and 12 students in three classes then average number of students is $\frac{60+50+42}{3} = 50.67$, which is impossible as number of students can't be in fractions.

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7. It should have sampling stability.

A. Arithmetic Mean

its value is obtained by adding together all the items and by dividing this total by the number of items.

- I Simple A. Mean.
- II Weighted A. Mean.

Simple A.M

I In a series of individual observations

a) Direct Method $\bar{X} = \frac{\sum X}{N}$

b) Short-cut Method $\bar{X} = A + \frac{\sum d}{N}$

In case of discrete series

a) Direct Method $\bar{X} = \frac{\sum fX}{N}$

b) Short-cut Method $\bar{X} = A + \frac{\sum fd}{N}$



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3. a) Direct method $\bar{x} = \frac{\sum fm}{N}$

✓ b) short-cut method $\bar{x} = A + \frac{\sum fd}{N}$

✓ c) step deviation method $\bar{X} = A + \frac{\sum fd'}{N} \times h$

$$\bar{x} = \frac{\sum Wx}{\sum W}$$

solution:- H.no.

Sl. No.	M. Income (X)	(X-A) A=
1	780	-20
2	760	-40
3	690	-110
4	750	-50
5	840	40

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6	920	120
7	1100	300
8	810	10
9	1050	250
10	950	150
10	86,50	650

Direct Method $\bar{x} = \frac{\sum x}{N} = \frac{8650}{10} = 865$ Ans.

Short-cut method $\bar{x} = A + \frac{\sum d}{N}$

$$= 800 + \frac{650}{10}$$

$$= 800 + 65 = 865 \text{ Ans.}$$

The following table gives the marks obtained by B. Com. students with Roll nos. 1 to 10 at an examination. Calculate the A.M. by using direct method and short-cut method.



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marks
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R no.	X	d = (X - A)
1	43	-7
2	48	-2
3	65	15
4	67	17
5	31	-19
6	60	10
7	37	-13
8	48	-2
9	78	28
10	59	9
<u>10</u>	<u>536</u>	<u>36</u>

D. Method $\bar{X} = \frac{\sum X}{N} = \frac{536}{10} = 53.6$ marks
Ans.

C. Method $\bar{X} = A + \frac{\sum d}{N}$
 $= 50 + \frac{36}{10} = 50 + 3.6 = 53.6$ marks
 Ans.



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Discrete Series

1. From the following data of the marks obtained by 60 students of a class, calculate the A.M. by using D.M. & S.C. method.

Solution:-

Marks (x)	No. of Students (f)	f(x)	d(x-A)	f(d)
20	8	160	-20	-160
30	12	360	-10	-120
40	20	800	0	0
50	10	500	10	100
60	6	360	20	120
70	4	280	30	120
	<u>60</u>	<u>2460</u>		<u>60</u>

Direct Method $\bar{x} = \frac{\sum f(x)}{N} = \frac{2460}{60} = 41 \text{ mark}$

S.C. Method $\bar{x} = A + \frac{\sum fd}{N} = 40 + \frac{60}{60} = 41 \text{ mark}$

S.A.M $\bar{x} = A + \frac{\sum fd'}{N} \times C$

$$= 40 + \frac{60}{60} \times 10 = 41$$

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2. From the following frequency distribution, find out mean height of the students by using direct method and S.C. method.

Solution

Height (in inches)	No of students (f)	f(x)	d = (x - A)	f(d)
64	1	64	-6	-6
65	6	390	-5	-30
66	10	660	-4	-40
67	22	1474	-3	-66
68	21	1428	-2	-42
69	17	1173	-1	-17
70	14	980	0	0
71	5	355	1	5
72	3	216	2	6
73	1	73	3	3
	<u>100</u>	<u>6813</u>		<u>-187</u>

$$D.M = \bar{X} = \frac{\sum f(x)}{N} = \frac{6813}{100} = 68.13 \text{ inches}$$

$$C.M = \bar{X} = A + \frac{\sum fd}{N} = 70 + \left(\frac{-187}{100} \right) = 68.13 \text{ inches}$$

= 70 - 1.87 = 68.13 inches

Ans.



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Continuous Series

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I From the following data, compute A.M. by direct method, S.C. method and step deviation method.

Solution

Direct method

Marks	m. point	no. of students	
x	m	f	f(m)
0-10	5	5	25
10-20	15	10	150
20-30	25	25	625
30-40	35	30	1050
40-50	45	20	900
50-60	55	10	550
		<u>100</u>	<u>3300</u>

$$D.M \bar{x} = \frac{\sum f(m)}{N} = \frac{3300}{100} = 33 \text{ marks}$$

✓ S. C. Method

x	m.p	f	d(x-A)	f(d)
0-10	5	5	-30	-150
10-20	15	10	-20	-200
20-30	25	25	-10	-250
30-40	<u>35</u>	30	0	0
40-50	45	20	10	200
50-60	55	10	20	200

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$$S.C.M \bar{X} = A + \frac{\sum f(d)}{N}$$

$$= 35 + \frac{-200}{100}$$

$$= 35 - 2 = 33 \text{ Marks}$$

Step deviation Method

X	m.p	f	d(x-A)	f(d) = $\frac{d}{10}$	f(d)'	✓
0-10	5	5	-30	-3	-15	
10-20	15	10	-20	-2	-20	
20-30	25	25	-10	-1	-25	
30-40	35	30	0	0	0	
40-50	45	20	10	1	20	
50-60	55	10	20	2	20	
		<u>100</u>			<u>-20</u>	

$$S.D.M \bar{X} = A + \frac{\sum f(d)'}{N} \times C$$

$$= 35 + \left(\frac{-20}{100} \right) \times 10$$

$$= 35 + (-2) = 33 \text{ Marks}$$

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Saturday

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2. Calculate date by using short cut method.

Solution:

Age x	M.P (m)	f	d	f(d)
10-21	19.5	8	-11	-88
22-25	23.5	32	-7	-224
26-35	30.5	54	0	0
36-45	40.5	36	10	360
46-55	50.5	20	20	400
		<u>150</u>		<u>448</u>

S.C. Method $\bar{X} = A + \frac{\sum f(d)}{N}$

$$= 30.5 + \frac{448}{150}$$

$$= 30.5 + 2.9$$

$$= 33.4$$

Ans.

SUNDAY

3. Obtain the mean from the following series by using S.C. method and step deviation method.

Solution

S. C. Method

Class Interval m. P

X	(m)	f	d(x-A)	f(d)	
10-25	17.5	6	-45	-270	-1530
25-40	32.5	20	-30	-600	
40-55	47.5	44	-15	-660	
55-70	62.5	26	0	0	
70-85	77.5	3	15	45	75
85-100	92.5	1	30	30	
	<u>100</u>			<u>-1455</u>	

$$\text{S.C. Method } \bar{x} = A + \frac{\sum fd}{N}$$

$$= 62.5 + \frac{-1455}{100}$$

$$= 62.50 - 14.55 = 47.95 \text{ Ans}$$



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S. D. method

X.O. (x)	m.p (m)	f	d	$d' = \frac{d}{15}$	$f(d')$
10-25	17.5	6	-45	-3	-18
25-40	32.5	20	-30	-2	-40
40-55	47.5	44	-15	-1	-44
55-70	62.5	26	0	0	0
70-85	77.5	3	15	1	3
85-100	92.5	1	30	2	2
		<u>100</u>			<u>-97</u>

$$\text{S.D. Method } \bar{x} = A + \frac{\sum fd'}{N} \times C$$

$$= 62.5 + \left(\frac{-97}{100} \right) \times 15$$

$$= 62.5 + \frac{1455}{100}$$

$$= 62.50 - 14.55 = 47.95 \text{ Ans}$$

Find the mean from the following figures by using S.C. method and step-deviation method.



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S.C. Method

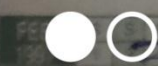
Solution					
C. Interval	m.p	f	d	f(d)	
X	(m)				
0-5	2.5	5	-15	-75	248
5-10	7.5	10	-10	-100	
10-15	12.5	14	-5	-70	
15-20	17.5	20	0	0	
20-25	22.5	35	5	175	348
25-30	27.5	15	10	150	
30-35	32.5	1	15	15	
		<u>100</u>		<u>95</u>	

S.C. Method $\bar{X} = A + \frac{\sum fd}{N} \times C$ $\therefore 17.5 + \frac{95}{100} \times 5 = 17.5 + 4.75 = 22.25$ Ans

Step-deviation Method

X	m.p	f	d	$d' = \frac{d}{5}$	f(d')	
	(m)					
0-5	2.5	5	-15	-3	-15	-49
5-10	7.5	10	-10	-2	-20	
10-15	12.5	14	-5	-1	-14	
15-20	17.5	20	0	0	0	
20-25	22.5	35	5	1	35	68
25-30	27.5	15	10	2	30	
30-35	32.5	1	15	3	3	
		<u>100</u>			<u>19</u>	

S.D.M = $A + \frac{\sum fd'}{N} \times C = 17.5 + \left(\frac{19}{100}\right) \times 5 = 17.5 + 0.95 = 18.45$ Ans



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12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

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$$= 25 + \frac{380}{50}$$

$$= 25 + 7.6 = 32.6 \text{ Ans.}$$

Step D Method

Step 2: Melhoro

x	m.p	f	d	d'	$\frac{d}{10}$	f(d')
0-10	5	4	-20	-2		-8
10-20	15	6	-10	-1		-6
20-30	25	10	0	0		0
30-40	35	15	10	1		15
40-50	45	8	20	2		16
50-60	55	7	30	3		21
		<u>50</u>				<u>30</u>

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$$S.D.M = A + \frac{\sum f(x)'}{N} \times C$$

$$= 25 + \frac{30}{50} \times 10$$

$$= 25 + 7 \cdot 6 = 32.6 \text{ Ans.}$$

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Saturday

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Weighted A.M

I A contractor employs three types of workers 20 males, 15 females and 5 children. To a male worker he pays Rs. 40 per day, to a female worker Rs. 32 per day and to a child worker Rs. 15 per day. What is the average wage per day paid by the contractor

Wage per day Rs.	no. of workers	WX
X	W	WX
40	20	800
32	15	480
15	5	75
	<u>40</u>	<u>1355</u>

$$\bar{X}_w = \frac{\sum WX}{\sum W} = \frac{1355}{40} = 33.88 \text{ Am}$$

Comment on the performance of the students of the ~~three~~ university using simple & weighted average



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Mumbai Monday + Calcutta Unit

University - Course of study	Pass %	No. of students (in hundreds)	Pass %	No. of students (in hundreds)
MA	71	3	82	2
M. Com.	83	4	76	3
B.A.	73	5	73	6
B. Com.	74	2	76	7
B. Sc.	65	3	65	3
M. Sc.	66	3	60	7

Solution

Mumbai University

	X	W	W(X)
M.A	71	3	213
M. Comm.	83	4	332
B. A.	73	5	365
B. Comm.	74	2	148
B. Sc.	65	3	195
M. Sc.	66	3	198

432 20 1451

S. A. M $\bar{X} = \frac{\sum X}{N} = \frac{432}{6} = 72$ marks

W.A.M $\bar{x}_w = \frac{\sum wx_i}{\sum w} = \frac{1451}{20} = 72.55 \text{ m}$

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Calcutta University

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	X	w	w(x)
M.A	82	2	164
M.Com	76	3	228
B.A	73	6	438
B.Com	76	7	532
B.Sc.	65	3	195
M.Sc.	60	7	420
	<u>432</u>	<u>28</u>	<u>1977</u>

S.A.M $\bar{X} = \frac{\sum X}{N} = \frac{432}{6} = 72 \text{ marks}$

W.A.M. $\bar{X}_w = \frac{\sum w(x)}{\sum w} = \frac{1977}{28} = 70.61 \text{ marks}$

72 marks + 70.61 marks Ar



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