$(13.5 - 10.5)$.

$$\therefore Q_3 = L + \frac{\frac{3N}{4} - c.f}{f} \times i$$

$$= 13.5 + \frac{81 - 76}{20} \times 3$$

$$= 14.25$$

Here,

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

$$= \frac{14.25 - 9.125}{2}$$

$$= 2.5625$$

Again,

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

$$= \frac{14.25 - 9.125}{14.25 + 9.125}$$

$$= 0.21925$$

Exercise - 11.2

1. Calculate the mean deviation from mean. Also find coefficient.

a.

class	0-10	10-20	20-30	30-40	40-50
Frequency	9	6	4	12	9

Solution:

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Class	mid-value(x)	frequency(f)	Fx	$\|x-\bar{x}\|$	$f\|x-\bar{x}\|$
0-10	5	9	45	21.5	193.5
10-20	15	6	90	11.5	69
20-30	25	4	100	1.5	6
30-40	35	12	420	8.5	102
40-50	45	9	405	18.5	166.5
		N = Ef = 40	Efx = 1060		$\Sigma f\|x-\bar{x}\|$ = 537

We know,

$$\text{mean}(\bar{x}) = \frac{\Sigma fx}{N}$$

$$= \frac{1060}{40}$$

$$= 26.5$$

Now,

$$\text{M.D from mean} = \frac{\Sigma f|x-\bar{x}|}{N}$$

$$= \frac{387}{40} \quad \frac{537}{40}$$

$$= 9.67 \quad 13.425$$

Again,

$$\text{Coefficient of M.D} = \frac{\text{M.D}}{\bar{x}}$$

$$= \frac{13.425}{26.5}$$

$$= 0.50$$

b.

Class	$0 \le x \le 10$	$10 \le x \le 20$	$20 \le x \le 30$	$30 \le x \le 40$
frequency	15	12	7	8

Solution:

Class	x	Frequency(f)	fx	$\lvert x-\bar{x}\rvert$	$f\lvert x-\bar{x}\rvert$
0-10	5	15	75	11.9	178.5
10-20	15	12	180	1.9	22.8
20-30	25	7	175	8.1	56.7
30-40	35	8	280	18.1	144.8
~~40-50~~		N = 42	Σfx = ~~605~~		$\Sigma f\lvert x-\bar{x}\rvert$
			710		= 402.8

We know,

$$\text{Mean}(\bar{x}) = \frac{\Sigma fx}{N}$$

$$= \frac{710}{42}$$

$$= 16.9047$$

Here,

$$\text{M.D from mean} = \frac{\Sigma f\lvert x-\bar{x}\rvert}{N}$$

$$= \frac{402.8}{42}$$

$$= 9.60$$

Also,

$$\text{Coefficient of MD} = \frac{\Sigma f\lvert x-\bar{x}\rvert}{\bar{x}}$$

$$= \frac{9.60}{16.90}$$

$$= 0.56$$

2. Calculate the mean deviation from median. Also calculate its coefficient.

	Age in yrs	20-30	30-40	40-50	50-60	60-70
a.	No. of ppl	5	6	7	10	12

Age	x	f	cf	$\lvert x - md \rvert$	$f \lvert x - md \rvert$
20-30	25	5	5	18.75	93.75
30-40	35	7	12	8.75	61.25
40-50	45	8	20	1.25	10.
50-60	55	6	26	11.25	67.5
60-70	65	4	30	21.25	85
		$N = 30$			$\Sigma f \lvert x - md \rvert = 317.5$

Here,

Median lies in $\left(\frac{N}{2}\right)^{th}$ class

$$= \frac{30}{2}$$

$$= 15$$

c.f greater than 15 is 20. So, median lies in (40-50) class

Now,

$$md = L + \frac{\frac{N}{2} - cf}{F} \times i$$

$$= 40 + \frac{15 - 12}{8} \times 10$$

$$= 43.75$$

Now,

$$\text{M.D from median} = \frac{\Sigma f \lvert x - md \rvert}{N}$$

$$= \frac{317.5}{30}$$

$$= 10.58$$

Also, Coefficient of $M.D = \frac{M.D}{m.d}$

$$= \frac{10.58}{43.75} = 0.24$$

b.

CI	0-20	20-40	40-60	60-80	80-100
F	5	6	7	16	12

Solution:

CI	x	f	c.f	|x-md|	f|x-md|
0-20	10	5	5	54	270
20-40	30	6	11	34	204
40-60	50	7	18	14	98
60-80	70	10	28	6	60
80-100	90	12	40	26	312
		N = 40			$\Sigma f\|x-md\|$ = 944

Here,

median lies in class $\left(\frac{N}{2}\right)$

$= \frac{40}{2} = 20$

c.f greater than 20 is 28. So, it lies in class (60-80)

Now,

$$md = L + \frac{\frac{N}{2} - cf}{f} \times i$$

$$= 60 + \frac{20 - 18}{10} \times 20$$

$$= 64$$

Here,

MD from median $= \frac{\Sigma f|x-md|}{N}$

$= \frac{944}{40} = 23.6$

Also, Coefficient of MD $= \frac{MD}{md}$

$= 23.6 / 64 = 0.36$

3. Calculate the mean deviation from median. Also find its coefficient.

a.

CI	0-5	5-10	10-15	15-20	20-25	25-30
f	8	7	11	14	18	12

Solution.

CI	x	f	c.f	$\|x-md\|$	$f\|x-md\|$
0-5	2.5	8	8	15.7142	125.7136
5-10	7.5	7	15	10.7142	74.9994
10-15	12.5	11	26	5.7142	62.8562
15-20	17.5	14	40	0.7142	9.9988
20-25	22.5	18	58	4.2858	77.1444
25-30	27.5	12	70	9.2858	111.4296
		N=70			$\Sigma f\|x-md\| = 392.142$

Here,

median lies in $\left(\frac{N}{2}\right) = \frac{70}{2} = 35$

C.f greater than 35 is 40. It lies in class (15-20)

Now,

$$M.d = L + \frac{\frac{N}{2} - Cf}{f} xi$$

$$= 15 + \frac{35-26}{14} \times 5$$

$$= 18.2142$$

Also,

$$M.D \text{ from median} = \frac{\Sigma F|x-md|}{N}$$

$$= \frac{392.142}{70}$$

$$= 5.60$$

Also,

Coefficient of MD = $\frac{MD}{m_d}$

$= \frac{5.60}{18.21}$

$= 0.30$

b.

CI	x	f	c.f	$\lvert x - m_d \rvert$	$f \lvert x - m_d \rvert$
0-4	2	7	7	8	56
4-8	6	13	20	4	52
8-12	10	10	30	0	0
12-16	14	5	35	4	20
16-20	18	8	43	8	64
20-24	22	4	47	12	48
24-28	26	3	50	16	48
		$N = 50$			$\Sigma \lvert x - m_d \rvert$
					$= 288$

Here,

median lies in $\left(\frac{N}{2}\right) = \frac{50}{2} = 25$

c.f greater than 25 is 30. It lies in class (8-12)

Now

$m.d = L + \frac{\frac{N}{2} - Cf}{f} \times i$

$= 8 + \frac{25 - 20}{10} \times 4$

$= 10$

Also,

m.D from median $= \frac{\Sigma f \lvert x - m_d \rvert}{N}$

$= \frac{288}{50}$

$= 5.76$

Also,

Coefficient of M.D $= \frac{MD}{Md}$

$= \frac{5.76}{10}$

$= 0.576$

4. Construct a frequency distribution table taking the class interval of 10 and calculate the mean deviation from mean.

5, 18, 14, 24, 7, 38, 46, 30, 21, 16, 31, 45, 27, 10, 4, 17, 29, 37, 49, 28

Solution:

CI	x	f	fx	$\lvert x-\bar{x}\rvert$	$f\lvert x-\bar{x}\rvert$
0-10	5	3	15	19.5	58.5
10-20	15	5	75	9.5	47.5
20-30	25	5	125	0.5	2.5
30-40	35	4	140	10.5	42.5
40-50	45	3	135	20.5	6.5
		N=20	Σfx =		$\Sigma f\lvert x-\bar{x}\rvert$ =
			490		212.5

Now,

$\text{mean}(\bar{x}) = \frac{\Sigma fx}{N} = \frac{490}{20} = 24.5$

Also,

M.D from mean $= \frac{\Sigma f\lvert x-\bar{x}\rvert}{N}$

$= 212.5 / 20 = 10.45$

Also, Coefficient of M.D = $\frac{M.D}{Md}$

$= \frac{10.625}{24.5}$

$= 0.43$

Exercise - 11.3

1. Find the standard deviation from the following ~~table~~ data. Also its coefficient.

a.

Class	0-10	10-20	20-30	30-40	40-50
frequency	2	9	10	7	1

Solution:

C.I	x	f	fx	$(x-\bar{x})^2$	$f(x-\bar{x})^2$
0-10	5	2	10	345.96	691.9
10-20	15	9	135	73.96	665.64
20-30	25	10	250	1.96	19.6
30-40	35	7	245	129.96	909.7
40-50	45	1	45	457.96	457.96
		N=29	Σfx		$\Sigma f(x-\bar{x})^2$
			685		= 2744.5

Mean

mean $(\bar{x}) = \frac{\Sigma fx}{N}$

$= \frac{685}{29}$

$= 23.6$

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

$$= \sqrt{\frac{2744.8}{29}}$$

$$= 9.72$$

Also,

$$\text{Coefficient of } S.D = \frac{S.D}{\text{Mean}}$$

$$= \frac{\sigma}{\bar{x}}$$

$$= \frac{9.72}{23.6}$$

$$= 0.411$$

Short-cut method

C.I	x	f	$d = (x-A)/c$	fd	fd^2
0-10	5	2	-20	-40	800
10-20	15	9	-10	-90	900
20-30	25	10	0	0	0
30-40	35	7	10	70	700
40-50	45	1	20	20	400
		$N = 29$		$\Sigma fd = -40$	Σfd^2
					$= 2800$

Here,

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

$$= \sqrt{\frac{2800}{29} - \left(\frac{-40}{29}\right)^2}$$

$$= \sqrt{96.55 - 1.90}$$

$$= \sqrt{94.65}$$

$$= 9.72$$

b

Mark secured	0-20	20-40	40-60	60-80	80-100
No of students	2	8	16	10	4

Solution:

C.I	x	f	fx	$(x-\bar{x})^2$	$f(x-\bar{x})^2$
0-20	10	2	20	1849	3698
20-40	30	8	240	529	4232
40-60	50	16	800	9	144
60-80	70	10	700	289	2890
80-100	90	4	360	1369	5476
		N=40	Σfx =		$\Sigma f(x-\bar{x})^2$
			2120		= 16440

Here,

$$\text{Mean}(\bar{x}) = \frac{\Sigma fx}{N}$$

$$= \frac{2120}{40} = 53$$

we know

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

$$= \sqrt{\frac{16440}{40}}$$

$$= \sqrt{410.11}$$

$$= 20.27$$

$$\text{Coefficient of } S.D = \frac{S.D}{\bar{x}}$$

$$= \frac{20.27}{53}$$

$$= 0.38$$

c.

Height in cm	0-8	8-16	16-24	24-32	32-40
No. of plants	6	7	16	8	9

Soln:

C.I	x	f	d(x-A)	fd	fd^2	fx
0-8	4	6	-16	-96	1536	24
8-16	12	7	-8	-56	448	84
16-24	20	10	0	0	0	200
24-32	28	8	8	64	512	224
32-40	36	9	16	144	2304	324
		N=40		$\Sigma fd = 56$	$\Sigma fd^2 = 4800$	$\Sigma fx = 856$

Here,

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

$$= \sqrt{\frac{4800}{40} - \left(\frac{56}{40}\right)^2}$$

$$= \sqrt{120 - 1.96}$$

$$= 10.86$$

$$\bar{x} = \frac{\Sigma fx}{N}$$

$$= \frac{856}{40}$$

$$= 21.4$$

Also,

Coefficient of $S.D = \frac{S.D}{\bar{x}}$

$$= \frac{10.86}{21.4}$$

$$= 0.50$$

2.0. Calculate the variance and the coefficient of variance from the following data.

9.	x	$0 \leq x \leq 10$	$10 \leq x \leq 20$	$20 \leq x \leq 30$	$30 \leq x \leq 40$	$40 \leq x \leq 50$
	f	7	10	14	12	6

Solution:

C.I	x	f	fx	d(x-A)	fd	fd^2
0-10	5	7	35	-20	-140	2800
10-20	15	10	150	-10	-100	1000
20-30	25	14	350	0	0	0
30-40	35	12	420	10	120	1200
40-50	45	6	270	20	120	2400
		$N=49$	Σfx		Σfd	Σfd^2
			1225		0	7400

Here,

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

$$= \sqrt{\quad}$$

$$\text{Mean}(\bar{x}) = \frac{\Sigma fx}{N}$$

$$= \frac{1225}{49} = \cancel{25}\ 25$$

Now

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

$$= \sqrt{\frac{7400}{49} - \left(\frac{0}{49}\right)^2}$$

$$= \sqrt{\quad}\ 12.28$$

Also,

$$\text{Coefficient of S.D} = \frac{\sigma}{\bar{x}}$$

$$= \frac{12.28}{25}$$

$$= 0.49$$

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

$$= \frac{12.28}{25} \times 100$$

$$= 49.12$$

b.

Mid-value	4	8	12	16	20	24
frequency	10	15	11	16	14	8

Soln:

x	f	fx	d(x-A)	fd	fd²	fd²
4	10	40	-8 -12	-80 -120	640	1440
8	15	120	-4 -8	-60 -120	240	960
12	11	132	0 -4	0 -44	0	176
16	16	256	4 0	64 0	256	0
20	14	280	8 4	112 56	896	224
24	8	192	12 8	96 64	1152	512
	N=74	Σfx=		Σfd=	Σfd²=	Σfd²=3312
		~~768~~ 1020		132 -164	3184	

We know,

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{\cancel{768} = \cancel{10.37}\ 1020}{\cancel{74}} = 13.78$$

Now,

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

$$= \sqrt{\frac{3184}{10.37} - \left(\frac{132}{10.37}\right)^2} = \sqrt{\frac{3312}{\cancel{138}74} - \left(\frac{-164}{\cancel{10}74}\right)^2}$$

$$= \sqrt{307.039 - 162.028} = \sqrt{\cancel{240.34 - 141.64}}$$

$$= 12.04 = \sqrt{\cancel{43.02 - 3.18}}$$

$$= 6.31$$

Also,

$$\text{Coefficient of S.D} = \frac{\sigma}{\bar{x}} = \frac{\cancel{12.04}}{\cancel{10.37}} =$$

$$= \frac{6.31}{13.78} = 0.45$$

Also,

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

$$= \frac{6.31}{13.78} \times 100 = \cancel{47.87}\ 45.79$$

c.

x	less than 10	less than 20	less than 30	less than 40	less than 50
f	12	19	24	33	40

Soln:

c.I	x	f	d (x-A)	fd	fd^2	fx
0-10	5	12	-20	-240	4800	60
10-20	15	19-12 = 7	-10	-70	700	105
20-30	25	24-19 = 5	0	0	0	125
30-40	35	33-24 = 9	10	90	900	135
40-50	45	40-33 = 7	20	140	2800	135
		N = 40		Σfd = 920	Σfd^2 = 9200	Σfx = 920
				-80		

Here,

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{920}{40} = 23$$

Also,

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

$$= \sqrt{\frac{9200}{40} - \left(\frac{-80}{40}\right)^2}$$

$$= \sqrt{230 - 4}$$

$$= 15.03$$

Also,

$$\text{Coefficient of S.D} = \frac{\sigma}{\bar{x}} = \frac{15.03}{23}$$

$$= 0.65$$

Again,

$$\text{Coefficient of variation (C.V)} = \frac{S.D}{\bar{x}} \times 100$$

$$= \frac{15.03}{23} \times 100$$

$$= 65.34$$

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d.	x	above 20	above 40	above 60	above 80	above 100
	f	50	42	30	18	7

Solution:

Cl.	x	f	fx	d(x-A)	fd	fd^2	
20-40	30	50-42=8	240	-40	-320	12800	
40-60	50	42-30=12	600	-20	-240	4800	
60-80	70	30-18=12	840	0	0	0	
80-100	90	18-7=11	990	20	220	4400	
100-120	110	7	770	40	280	11200	
		N=50	Σfx=		Σfd=	Σfd^2=	
			3440		-60	33200	

Here,

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{3340}{50}$$

$$= 66.8$$

Now

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

$$= \sqrt{\frac{33206}{50} - \left(\frac{-66}{50}\right)^2}$$

$$= \sqrt{664 - 1.44}$$

$$= 25.74$$

Also,

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

$$= \frac{25.74}{66.8} = 0.38$$

Again,

Coefficient of variation $= \frac{S.D}{\bar{x}} \times 100$

$$= 38.53$$

3.a. Prepare a frequency distribution taking 0-4 as one of the class intervals and hence find the standard deviation.
7, 3, 10, 4, 2, 1, 9, 11, 18, 8, 5, 6, 4, 13, 17, 6, 8, 12, 17, 19, 5, 3
17, 16, 3, 2, 14, 13, 4, 10

Solution:

C.I.	x	f	fx	d(x-A)	fd	fd^2	
0-4	2	6	12	-8	-48	384	
4-8	6	8	48	-4	-32	128	
8-12	10	6	60	0	0	0	
12-16	14	4	56	4	16	64	
16-20	18	6	108	8	48	384	
		N=30	Σfx_2		Σfd_2	Σfd^2_2	
			284		-16	960	

Here,

$$\bar{x} = \frac{\Sigma fx}{N} = \frac{284}{30} = 9.46$$

Also,

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

$$= \sqrt{\frac{960}{30} - \left(\frac{-16}{30}\right)^2}$$

$$= \sqrt{32 - 0.28}$$

$$= 5.63$$

Also,

$$\text{Coefficient of } S.D = \frac{S.D}{\bar{x}} = \frac{5.63}{9.46} = 0.59$$

Again,

$$\text{coefficient of variation } (C.V) = \frac{\sigma}{\bar{x}} \times 100$$

$$= \frac{5.63}{9.46} \times 100 = 59.51$$