



Exercise – 14.1

Question 1:

A survey was conducted by a group of students as a part of their environment awareness programme, in which they collected the following data regarding the number of plants in 20 houses in a locality. Find the mean number of plants per house.

| Number of plants | 0 – 2 | 2 – 4 | 4 – 6 | 6 – 8 | 8 – 10 | 10 – 12 | 12 – 14 |
|------------------|-------|-------|-------|-------|--------|---------|---------|
| Number of houses | 1 | 2 | 1 | 5 | 6 | 2 | 3 |

Which method did you use for finding the mean, and why?

To find the class mark (x_i) for each interval, the following relation is used.

$$\text{Class mark } (x_i) = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

x_i and $f_i x_i$ can be calculated as follows.

| Number of plants | Number of houses (f_i) | x_i | $f_i x_i$ |
|------------------|-------------------------------|-------|--------------------|
| 0 – 2 | 1 | 1 | $1 \times 1 = 1$ |
| 2 – 4 | 2 | 3 | $2 \times 3 = 6$ |
| 4 – 6 | 1 | 5 | $1 \times 5 = 5$ |
| 6 – 8 | 5 | 7 | $5 \times 7 = 35$ |
| 8 – 10 | 6 | 9 | $6 \times 9 = 54$ |
| 10 – 12 | 2 | 11 | $2 \times 11 = 22$ |
| 12 – 14 | 3 | 13 | $3 \times 13 = 39$ |
| Total | 20 | | 162 |



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From the table, it can be observed that

$$\sum f_i = 20$$

$$\sum f_i x_i = 162$$

$$\text{Mean, } \bar{x} = \frac{\sum f_i x_i}{\sum f_i}$$

$$= \frac{162}{20} = 8.1$$

Therefore, mean number of plants per house is 8.1.

Here, direct method has been used as the values of class marks (x_i) and f_i are small.

Question 2:

Consider the following distribution of daily wages of 50 worker of a factory.

| | | | | | |
|----------------------------|-----------|-----------|------------|-----------|-----------|
| Daily wages (in Rs) | 100 – 120 | 120 – 140 | 140 – 1 60 | 160 – 180 | 180 – 200 |
| Number of workers | 12 | 14 | 8 | 6 | 10 |

Find the mean daily wages of the workers of the factory by using an appropriate method.

To find the class mark for each interval, the following relation is used.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Class size (h) of this data = 20

Taking 150 as assured mean (a), d_i , u_i , and $f_i u_i$ can be calculated as follows.

| Daily wages (in Rs) | Number of workers (f_i) | x_i | $d_i = x_i - 150$ | $u_i = \frac{d_i}{20}$ | $f_i u_i$ |
|--------------------------------|---------------------------------------------|-------|-------------------|------------------------|-----------|
| 100 – 120 | 12 | 110 | – 40 | – 2 | – 24 |



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|-----------|----|-----|------|-----|------|
| 120 – 140 | 14 | 130 | – 20 | – 1 | – 14 |
| 140 – 160 | 8 | 150 | 0 | 0 | 0 |
| 160 – 180 | 6 | 170 | 20 | 1 | 6 |
| 180 – 200 | 10 | 190 | 40 | 2 | 20 |
| Total | 50 | | | | – 12 |

From the table, it can be observed that

$$\sum f_i = 50$$

$$\sum f_i u_i = -12$$

$$\begin{aligned}\text{Mean } \bar{x} &= a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) h \\ &= 150 + \left(\frac{-12}{50} \right) 20 \\ &= 150 - \frac{24}{5} \\ &= 150 - 4.8 \\ &= 145.2\end{aligned}$$

Therefore, the mean daily wage of the workers of the factory is Rs 145.20.

Question 3:

The following distribution shows the daily pocket allowance of children of a locality. The mean pocket allowance is Rs.18. Find the missing frequency f .

| | | | | | | | |
|-------------------------------------------|------------|------------|-----------|------------|------------|------------|------------|
| Daily pocket allowance (in Rs) | 11 – 13 | 13 – 15 | 15 –17 | 17 – 19 | 19 – 21 | 21 – 23 | 23 – 25 |
| Number of workers | 7 | 6 | 9 | 13 | f | 5 | 4 |

To find the class mark (x_i) for each interval, the following relation is used.



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$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Given that, mean pocket allowance, $\bar{x} = \text{Rs } 18$

Taking 18 as assured mean (a), d_i and $f_i d_i$ are calculated as follows.

| Daily pocket allowance (in Rs) | Number of children f_i | Class mark x_i | $d_i = x_i - 18$ | $f_i d_i$ |
|-----------------------------------|-----------------------------|------------------|------------------|-----------|
| 11 – 13 | 7 | 12 | – 6 | – 42 |
| 13 – 15 | 6 | 14 | – 4 | – 24 |
| 15 – 17 | 9 | 16 | – 2 | – 18 |
| 17 – 19 | 13 | 18 | 0 | 0 |
| 19 – 21 | f | 20 | 2 | $2f$ |
| 21 – 23 | 5 | 22 | 4 | 20 |
| 23 – 25 | 4 | 24 | 6 | 24 |
| Total | $\sum f_i = 44 + f$ | | | $2f - 40$ |

From the table, we obtain

$$\sum f_i = 44 + f$$

$$\sum f_i d_i = 2f - 40$$

$$\bar{x} = a + \frac{\sum f_i d_i}{\sum f_i}$$

$$18 = 18 + \left(\frac{2f - 40}{44 + f} \right)$$



$$0 = \left(\frac{2f - 40}{44 + f} \right)$$

$$2f - 40 = 0$$

$$2f = 40$$

$$f = 20$$

Hence, the missing frequency, f , is 20.

Question 4:

Thirty women were examined in a hospital by a doctor and the number of heart beats per minute were recorded and summarized as follows. Find the mean heart beats per minute for these women, choosing a suitable method.

| | | | | | | | |
|-----------------------------------------|---------|---------|---------|---------|---------|---------|---------|
| Number of heart beats per minute | 65 – 68 | 68 – 71 | 71 – 74 | 74 – 77 | 77 – 80 | 80 – 83 | 83 – 86 |
| Number of women | 2 | 4 | 3 | 8 | 7 | 4 | 2 |

To find the class mark of each interval (x_i), the following relation is used.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Class size, h , of this data = 3

Taking 75.5 as assumed mean (a), d_i , u_i , $f_i u_i$ are calculated as follows.

| Number of heart beats per minute | Number of women f_i | x_i | $d_i = x_i - 75.5$ | $u_i = \frac{d_i}{3}$ | $f_i u_i$ |
|-----------------------------------------|---------------------------------|-------|--------------------|-----------------------|-----------|
| 65 – 68 | 2 | 66.5 | -9 | -3 | -6 |
| 68 – 71 | 4 | 69.5 | -6 | -2 | -8 |



| | | | | | |
|---------|----|------|-----|-----|-----|
| 71 – 74 | 3 | 72.5 | – 3 | – 1 | – 3 |
| 74 – 77 | 8 | 75.5 | 0 | 0 | 0 |
| 77 – 80 | 7 | 78.5 | 3 | 1 | 7 |
| 80 – 83 | 4 | 81.5 | 6 | 2 | 8 |
| 83 – 86 | 2 | 84.5 | 9 | 3 | 6 |
| Total | 30 | | | | 4 |

From the table, we obtain

$$\sum f_i = 30$$

$$\sum f_i u_i = 4$$

$$\begin{aligned}\text{Mean } \bar{x} &= a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) \times h \\ &= 75.5 + \left(\frac{4}{30} \right) \times 3 \\ &= 75.5 + 0.4 = 75.9\end{aligned}$$

Therefore, mean hear beats per minute for these women are 75.9 beats per minute.

Question 5:

In a retail market, fruit vendors were selling mangoes kept in packing boxes. These boxes contained varying number of mangoes. The following was the distribution of mangoes according to the number of boxes.

| | | | | | |
|--------------------------|---------|---------|---------|---------|---------|
| Number of mangoes | 50 – 52 | 53 – 55 | 56 – 58 | 59 – 61 | 62 – 64 |
| Number of boxes | 15 | 110 | 135 | 115 | 25 |

Find the mean number of mangoes kept in a packing box. Which method of finding the mean did you choose?



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| Number of mangoes | Number of boxes f_i |
|-------------------|-----------------------|
| 50 – 52 | 15 |
| 53 – 55 | 110 |
| 56 – 58 | 135 |
| 59 – 61 | 115 |
| 62 – 64 | 25 |

It can be observed that class intervals are not continuous. There is a gap of 1 between two class intervals. Therefore, $\frac{1}{2}$ has to be added to the upper class limit and $\frac{1}{2}$ has to be subtracted from the lower class limit of each interval.

Class mark (x_i) can be obtained by using the following relation.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Class size (h) of this data = 3

Taking 57 as assumed mean (a), d_i , u_i , $f_i u_i$ are calculated as follows.

| Class interval | f_i | x_i | $d_i = x_i - 57$ | $u_i = \frac{d_i}{3}$ | $f_i u_i$ |
|----------------|-------|-------|------------------|-----------------------|-----------|
| 49.5 – 52.5 | 15 | 51 | -6 | -2 | -30 |
| 52.5 – 55.5 | 110 | 54 | -3 | -1 | -110 |
| 55.5 – 58.5 | 135 | 57 | 0 | 0 | 0 |
| 58.5 – 61.5 | 115 | 60 | 3 | 1 | 115 |
| 61.5 – 64.5 | 25 | 63 | 6 | 2 | 50 |
| Total | 400 | | | | 25 |



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It can be observed that

$$\sum f_i = 400$$

$$\sum f_i u_i = 25$$

$$\begin{aligned} \text{Mean, } \bar{x} &= a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) \times h \\ &= 57 + \left(\frac{25}{400} \right) \times 3 \\ &= 57 + \frac{3}{16} = 57 + 0.1875 \\ &= 57.1875 \\ &\approx 57.19 \end{aligned}$$

Mean number of mangoes kept in a packing box is 57.19.

Step deviation method is used here as the values of $f_i d_i$ are big and also, there is a common multiple between all d_i .

Question 6:

The table below shows the daily expenditure on food of 25 households in a locality.

| | | | | | |
|----------------------------------|-----------|-----------|-----------|-----------|-----------|
| Daily expenditure (in Rs) | 100 – 150 | 150 – 200 | 200 – 250 | 250 – 300 | 300 – 350 |
| Number of households | 4 | 5 | 12 | 2 | 2 |

Find the mean daily expenditure on food by a suitable method.

To find the class mark (x_i) for each interval, the following relation is used.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Class size = 50

Taking 225 as assumed mean (a), d_i , u_i , $f_i u_i$ are calculated as follows.

| | | | | | |
|----------------------------------|-------|-------|-------------------|------------------------|-----------|
| Daily expenditure (in Rs) | f_i | x_i | $d_i = x_i - 225$ | $u_i = \frac{d_i}{50}$ | $f_i u_i$ |
|----------------------------------|-------|-------|-------------------|------------------------|-----------|



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|-----------|----|-----|-------|-----|-----|
| 100 – 150 | 4 | 125 | – 100 | – 2 | – 8 |
| 150 – 200 | 5 | 175 | – 50 | – 1 | – 5 |
| 200 – 250 | 12 | 225 | 0 | 0 | 0 |
| 250 – 300 | 2 | 275 | 50 | 1 | 2 |
| 300 – 350 | 2 | 325 | 100 | 2 | 4 |
| Total | 25 | | | | – 7 |

From the table, we obtain

$$\sum f_i = 25$$

$$\sum f_i u_i = -7$$

$$\begin{aligned}\text{Mean, } \bar{x} &= a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) \times h \\ &= 225 + \left(\frac{-7}{25} \right) \times (50) \\ &= 225 - 14 \\ &= 211\end{aligned}$$

Therefore, mean daily expenditure on food is Rs 211.

Question 7:

To find out the concentration of SO_2 in the air (in parts per million, i.e., ppm), the data was collected for 30 localities in a certain city and is presented below:

| concentration of SO_2 (in ppm) | Frequency |
|-----------------------------------------|-----------|
| 0.00 – 0.04 | 4 |
| 0.04 – 0.08 | 9 |
| 0.08 – 0.12 | 9 |
| 0.12 – 0.16 | 2 |



| | |
|-------------|---|
| 0.16 – 0.20 | 4 |
| 0.20 – 0.24 | 2 |

Find the mean concentration of SO₂ in the air.

To find the class marks for each interval, the following relation is used.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Class size of this data = 0.04

Taking 0.14 as assumed mean (a), d_i , u_i , $f_i u_i$ are calculated as follows.

| Concentration of SO ₂ (in ppm) | Frequency f_i | Class mark x_i | $d_i = x_i - 0.14$ | $u_i = \frac{d_i}{0.04}$ | $f_i u_i$ |
|-------------------------------------------|--------------------|---------------------|--------------------|--------------------------|-----------|
| 0.00 – 0.04 | 4 | 0.02 | – 0.12 | – 3 | – 12 |
| 0.04 – 0.08 | 9 | 0.06 | – 0.08 | – 2 | – 18 |
| 0.08 – 0.12 | 9 | 0.10 | – 0.04 | – 1 | – 9 |
| 0.12 – 0.16 | 2 | 0.14 | 0 | 0 | 0 |
| 0.16 – 0.20 | 4 | 0.18 | 0.04 | 1 | 4 |
| 0.20 – 0.24 | 2 | 0.22 | 0.08 | 2 | 4 |
| Total | 30 | | | | – 31 |

From the table, we obtain



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$$\sum f_i = 30$$

$$\sum f_i u_i = -31$$

$$\text{Mean, } \bar{x} = a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) \times h$$

$$= 0.14 + \left(\frac{-31}{30} \right) (0.04)$$

$$= 0.14 - 0.04133$$

$$= 0.09867$$

$$= 0.099 \text{ ppm}$$

Therefore, mean concentration of SO₂ in the air is 0.099 ppm.

Question 8:

A class teacher has the following absentee record of 40 students of a class for the whole term. Find the mean number of days a student was absent.

| | | | | | | | |
|---------------------------|-------|--------|---------|---------|---------|---------|---------|
| Number of days | 0 – 6 | 6 – 10 | 10 – 14 | 14 – 20 | 20 – 28 | 28 – 38 | 38 – 40 |
| Number of students | 11 | 10 | 7 | 4 | 4 | 3 | 1 |

To find the class mark of each interval, the following relation is used.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Taking 17 as assumed mean (a), d_i and $f_i d_i$ are calculated as follows.

| Number of days | Number of students | x_i | $d_i = x_i - 17$ | $f_i d_i$ |
|-----------------------|---------------------------|-------|------------------|-----------|
| | f_i | | | |
| 0 – 6 | 11 | 3 | -14 | -154 |
| 6 – 10 | 10 | 8 | -9 | -90 |
| 10 – 14 | 7 | 12 | -5 | -35 |
| 14 – 20 | 4 | 17 | 0 | 0 |



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|---------|----|----|----|-------|
| 20 – 28 | 4 | 24 | 7 | 28 |
| 28 – 38 | 3 | 33 | 16 | 48 |
| 38 – 40 | 1 | 39 | 22 | 22 |
| Total | 40 | | | - 181 |

From the table, we obtain

$$\sum f_i = 40$$

$$\sum f_i d_i = -181$$

$$\begin{aligned}\text{Mean, } \bar{x} &= a + \left(\frac{\sum f_i d_i}{\sum f_i} \right) \\ &= 17 + \left(\frac{-181}{40} \right) \\ &= 17 - 4.525 \\ &= 12.475 \\ &\approx 12.48\end{aligned}$$

Therefore, the mean number of days is 12.48 days for which a student was absent.

Question 9:

The following table gives the literacy rate (in percentage) of 35 cities. Find the mean literacy rate.

| | | | | | |
|-----------------------------|---------|---------|---------|---------|---------|
| Literacy rate (in %) | 45 – 55 | 55 – 65 | 65 – 75 | 75 – 85 | 85 – 95 |
| Number of cities | 3 | 10 | 11 | 8 | 3 |

To find the class marks, the following relation is used.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Class size (h) for this data = 10

Taking 70 as assumed mean (a), d_i , u_i , and $f_i u_i$ are calculated as follows.



| Literacy rate (in %) | Number of cities f_i | x_i | $d_i = x_i - 70$ | $u_i = \frac{d_i}{10}$ | $f_i u_i$ |
|----------------------|---------------------------|-------|------------------|------------------------|-----------|
| 45 – 55 | 3 | 50 | – 20 | – 2 | – 6 |
| 55 – 65 | 10 | 60 | – 10 | – 1 | – 10 |
| 65 – 75 | 11 | 70 | 0 | 0 | 0 |
| 75 – 85 | 8 | 80 | 10 | 1 | 8 |
| 85 – 95 | 3 | 90 | 20 | 2 | 6 |
| Total | 35 | | | | – 2 |

From the table, we obtain

$$\sum f_i = 35$$

$$\sum f_i u_i = -2$$

$$\begin{aligned}\text{Mean, } \bar{x} &= a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) \times h \\ &= 70 + \left(\frac{-2}{35} \right) \times (10) \\ &= 70 - \frac{20}{35} \\ &= 70 - \frac{4}{7} \\ &= 70 - 0.57 \\ &= 69.43\end{aligned}$$

Therefore, mean literacy rate is 69.43%.

Exercise – 14.2

Question 1:

The following table shows the ages of the patients admitted in a hospital during a year:



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| age (in years) | 5 – 15 | 15 – 25 | 25 – 35 | 35 – 45 | 45 – 55 | 55 – 65 |
|--------------------|--------|---------|---------|---------|---------|---------|
| Number of patients | 6 | 11 | 21 | 23 | 14 | 5 |

Find the mode and the mean of the data given above. Compare and interpret the two measures of central tendency.

To find the class marks (x_i), the following relation is used.

$$x_i = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Taking 30 as assumed mean (a), d_i and $f_i d_i$ are calculated as follows.

| Age (in years) | Number of patients | Class mark | $d_i = x_i - 30$ | $f_i d_i$ |
|----------------|--------------------|------------|------------------|-----------|
| | f_i | x_i | | |
| 5 – 15 | 6 | 10 | - 20 | - 120 |
| 15 – 25 | 11 | 20 | - 10 | - 110 |
| 25 – 35 | 21 | 30 | 0 | 0 |
| 35 – 45 | 23 | 40 | 10 | 230 |
| 45 – 55 | 14 | 50 | 20 | 280 |
| 55 – 65 | 5 | 60 | 30 | 150 |
| Total | 80 | | | 430 |

From the table, we obtain



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$$\sum f_i = 80$$

$$\sum f_i d_i = 430$$

$$\begin{aligned}\text{Mean, } \bar{x} &= a + \frac{\sum f_i d_i}{\sum f_i} \\ &= 30 + \left(\frac{430}{80} \right) \\ &= 30 + 5.375 \\ &= 35.375 \\ &\approx 35.38\end{aligned}$$

Mean of this data is 35.38. It represents that on an average, the age of a patient admitted to hospital was 35.38 years.

It can be observed that the maximum class frequency is 23 belonging to class interval 35 – 45.

Modal class = 35 – 45

Lower limit (l) of modal class = 35

Frequency (f_1) of modal class = 23

Class size (h) = 10

Frequency (f_0) of class preceding the modal class = 21

Frequency (f_2) of class succeeding the modal class = 14

$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 35 + \left(\frac{23 - 21}{2(23) - 21 - 14} \right) \times 10 \\ &= 35 + \left[\frac{2}{46 - 35} \right] \times 10 \\ &= 35 + \frac{20}{11} \\ &= 35 + 1.81 \\ &= 36.8\end{aligned}$$



Mode is 36.8. It represents that the age of maximum number of patients admitted in hospital was 36.8 years.

Question 2:

The following data gives the information on the observed lifetimes (in hours) of 225 electrical components:

| Lifetimes (in hours) | 0 – 20 | 20 – 40 | 40 – 60 | 60 – 80 | 80 – 100 | 100 – 120 |
|----------------------|--------|---------|---------|---------|----------|-----------|
| Frequency | 10 | 35 | 52 | 61 | 38 | 29 |

Determine the modal lifetimes of the components.

From the data given above, it can be observed that the maximum class frequency is 61, belonging to class interval 60 – 80.

Therefore, modal class = 60 – 80

Lower class limit (l) of modal class = 60

Frequency (f_1) of modal class = 61

Frequency (f_0) of class preceding the modal class = 52

Frequency (f_2) of class succeeding the modal class = 38

Class size (h) = 20

$$\begin{aligned} \text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 60 + \left(\frac{61 - 52}{2(61) - 52 - 38} \right) (20) \end{aligned}$$



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$$\begin{aligned} &= 60 + \left(\frac{9}{122 - 90} \right) (20) \\ &= 60 + \left(\frac{9 \times 20}{32} \right) \\ &= 60 + \frac{90}{16} = 60 + 5.625 \\ &= 65.625 \end{aligned}$$

Therefore, modal lifetime of electrical components is 65.625 hours.

Question 3:

The following data gives the distribution of total monthly household expenditure of 200 families of a village. Find the modal monthly expenditure of the families. Also, find the mean monthly expenditure.

| Expenditure (in Rs) | Number of families |
|---------------------|--------------------|
| 1000 – 1500 | 24 |
| 1500 – 2000 | 40 |
| 2000 – 2500 | 33 |
| 2500 – 3000 | 28 |
| 3000 – 3500 | 30 |
| 3500 – 4000 | 22 |
| 4000 – 4500 | 16 |
| 4500 – 5000 | 7 |

It can be observed from the given data that the maximum class frequency is 40, belonging to 1500 – 2000 intervals.

Therefore, modal class = 1500 – 2000

Lower limit (l) of modal class = 1500



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Frequency (f_1) of modal class = 40

Frequency (f_0) of class preceding modal class = 24

Frequency (f_2) of class succeeding modal class = 33

Class size (h) = 500

$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 1500 + \left(\frac{40 - 24}{2(40) - 24 - 33} \right) \times 500 \\ &= 1500 + \left(\frac{16}{80 - 57} \right) \times 500 \\ &= 1500 + \frac{8000}{23} \\ &= 1500 + 347.826 \\ &= 1847.826 = 1847.83\end{aligned}$$

Therefore, modal monthly expenditure was Rs 1847.83.

To find the class mark, the following relation is used.

$$\text{Class mark} = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Class size (h) of the given data = 500

Taking 2750 as assumed mean (a), d_i , u_i , and $f_i u_i$ are calculated as follows.

| Expenditure (in Rs) | Number of families f_i | x_i | $d_i = x_i - 2750$ | $u_i = \frac{d_i}{500}$ | $f_i u_i$ |
|---------------------|-----------------------------|-------|--------------------|-------------------------|-----------|
| 1000 – 1500 | 24 | 1250 | – 1500 | – 3 | – 72 |
| 1500 – 2000 | 40 | 1750 | – 1000 | – 2 | – 80 |
| 2000 – 2500 | 33 | 2250 | – 500 | – 1 | – 33 |



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|-------------|-----|------|------|---|------|
| 2500 – 3000 | 28 | 2750 | 0 | 0 | 0 |
| 3000 – 3500 | 30 | 3250 | 500 | 1 | 30 |
| 3500 – 4000 | 22 | 3750 | 1000 | 2 | 44 |
| 4000 – 4500 | 16 | 4250 | 1500 | 3 | 48 |
| 4500 – 5000 | 7 | 4750 | 2000 | 4 | 28 |
| Total | 200 | | | | – 35 |

From the table, we obtain

$$\sum f_i = 200$$

$$\sum f_i u_i = -35$$

$$\bar{x}(\text{mean}) = a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) \times h$$

$$\begin{aligned}\bar{x} &= 2750 + \left(\frac{-35}{200} \right) \times 500 \\ &= 2750 - 87.5 \\ &= 2662.5\end{aligned}$$

Therefore, mean monthly expenditure was Rs 2662.50.

Question 4:

The following distribution gives the state-wise teacher-student ratio in higher secondary schools of India. Find the mode and mean of this data. Interpret the two measures.

| Number of students per teacher | Number of states/U.T |
|--------------------------------|----------------------|
| 15 – 20 | 3 |
| 20 – 25 | 8 |
| 25 – 30 | 9 |
| 30 – 35 | 10 |



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|---------|---|
| 35 – 40 | 3 |
| 40 – 45 | 0 |
| 45 – 50 | 0 |
| 50 – 55 | 2 |

It can be observed from the given data that the maximum class frequency is 10 belonging to class interval 30 – 35.

Therefore, modal class = 30 – 35

Class size (h) = 5

Lower limit (l) of modal class = 30

Frequency (f_1) of modal class = 10

Frequency (f_0) of class preceding modal class = 9

Frequency (f_2) of class succeeding modal class = 3

$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 30 + \left(\frac{10 - 9}{2(10) - 9 - 3} \right) \times (5) \\ &= 30 + \left(\frac{1}{20 - 12} \right) 5 \\ &= 30 + \frac{5}{8} = 30.625\end{aligned}$$

Mode = 30.6

It represents that most of the states/U.T have a teacher-student ratio as 30.6.

To find the class marks, the following relation is used.

$$\text{Class mark} = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$



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Taking 32.5 as assumed mean (a), d_i , u_i , and $f_i u_i$ are calculated as follows.

| Number of students per teacher | Number of states/U.T (f_i) | x_i | $d_i = x_i - 32.5$ | $u_i = \frac{d_i}{5}$ | $f_i u_i$ |
|--------------------------------|-----------------------------------|-------|--------------------|-----------------------|-----------|
| 15 – 20 | 3 | 17.5 | – 15 | – 3 | – 9 |
| 20 – 25 | 8 | 22.5 | – 10 | – 2 | – 16 |
| 25 – 30 | 9 | 27.5 | – 5 | – 1 | – 9 |
| 30 – 35 | 10 | 32.5 | 0 | 0 | 0 |
| 35 – 40 | 3 | 37.5 | 5 | 1 | 3 |
| 40 – 45 | 0 | 42.5 | 10 | 2 | 0 |
| 45 – 50 | 0 | 47.5 | 15 | 3 | 0 |
| 50 – 55 | 2 | 52.5 | 20 | 4 | 8 |
| Total | 35 | | | | – 23 |

$$\begin{aligned}\text{Mean, } \bar{x} &= a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) h \\ &= 32.5 + \left(\frac{-23}{35} \right) \times 5 \\ &= 32.5 - \frac{23}{7} = 32.5 - 3.28 \\ &= 29.22\end{aligned}$$

Therefore, mean of the data is 29.2.

It represents that on an average, teacher–student ratio was 29.2.

Question 5:



The given distribution shows the number of runs scored by some top batsmen of the world in one-day international cricket matches.

| Runs scored | Number of batsmen |
|---------------|-------------------|
| 3000 – 4000 | 4 |
| 4000 – 5000 | 18 |
| 5000 – 6000 | 9 |
| 6000 – 7000 | 7 |
| 7000 – 8000 | 6 |
| 8000 – 9000 | 3 |
| 9000 – 10000 | 1 |
| 10000 – 11000 | 1 |

Find the mode of the data.

From the given data, it can be observed that the maximum class frequency is 18, belonging to class interval 4000 – 5000.

Therefore, modal class = 4000 – 5000

Lower limit (l) of modal class = 4000

Frequency (f_1) of modal class = 18

Frequency (f_0) of class preceding modal class = 4

Frequency (f_2) of class succeeding modal class = 9

Class size (h) = 1000



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$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 4000 + \left(\frac{18 - 4}{2(18) - 4 - 9} \right) \times 1000 \\ &= 4000 + \left(\frac{14000}{23} \right) \\ &= 4000 + 608.695 \\ &= 4608.695\end{aligned}$$

Therefore, mode of the given data is 4608.7 runs.

Question 6:

A student noted the number of cars passing through a spot on a road for 100 periods each of 3 minutes and summarised it in the table given below. Find the mode of the data:

| | | | | | | | | |
|-----------------------|--------|---------|---------|---------|---------|---------|---------|---------|
| Number of cars | 0 – 10 | 10 – 20 | 20 – 30 | 30 – 40 | 40 – 50 | 50 – 60 | 60 – 70 | 70 – 80 |
| Frequency | 7 | 14 | 13 | 12 | 20 | 11 | 15 | 8 |

From the given data, it can be observed that the maximum class frequency is 20, belonging to 40 – 50 class intervals.

Therefore, modal class = 40 – 50

Lower limit (l) of modal class = 40

Frequency (f_1) of modal class = 20

Frequency (f_0) of class preceding modal class = 12

Frequency (f_2) of class succeeding modal class = 11

Class size = 10



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$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 40 + \left[\frac{20 - 12}{2(20) - 12 - 11} \right] \times 10 \\ &= 40 + \left(\frac{80}{40 - 23} \right) \\ &= 40 + \frac{80}{17}\end{aligned}$$

$$= 40 + 4.7$$

$$= 44.7$$

Therefore, mode of this data is 44.7 cars

Exercise – 14.3

Question 1:

The following frequency distribution gives the monthly consumption of electricity of 68 consumers of a locality. Find the median, mean and mode of the data and compare them.

| Monthly consumption (in units) | Number of consumers |
|--------------------------------|---------------------|
| 65 – 85 | 4 |
| 85 – 105 | 5 |
| 105 – 125 | 13 |
| 125 – 145 | 20 |
| 145 – 165 | 14 |
| 165 – 185 | 8 |
| 185 – 205 | 4 |

To find the class marks, the following relation is used.



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Where You Get Complete Knowledge

$$\text{Class mark} = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Taking 135 as assumed mean (a), d_i , u_i , $f_i u_i$ are calculated according to step deviation method as follows.

| Monthly consumption (in units) | Number of consumers (f_i) | x_i class mark | $d_i = x_i -$ 135 | $u_i = \frac{d_i}{20}$ | $f_i u_i$ |
|-----------------------------------|----------------------------------|---------------------|----------------------|------------------------|-----------|
| 65 – 85 | 4 | 75 | – 60 | – 3 | – 12 |
| 85 – 105 | 5 | 95 | – 40 | – 2 | – 10 |
| 105 – 125 | 13 | 115 | – 20 | – 1 | – 13 |
| 125 – 145 | 20 | 135 | 0 | 0 | 0 |
| 145 – 165 | 14 | 155 | 20 | 1 | 14 |
| 165 – 185 | 8 | 175 | 40 | 2 | 16 |
| 185 – 205 | 4 | 195 | 60 | 3 | 12 |
| Total | 68 | | | | 7 |

From the table, we obtain

$$\sum f_i u_i = 7$$

$$\sum f_i = 68$$

$$\text{Class size } (h) = 20$$

$$\text{Mean, } \bar{x} = a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) \times h$$

$$= 135 + \frac{7}{68} \times 20$$

$$= 135 + \frac{140}{68}$$

$$= 137.058$$



From the table, it can be observed that the maximum class frequency is 20, belonging to class interval 125 – 145.

Modal class = 125 – 145

Lower limit (l) of modal class = 125

Class size (h) = 20

Frequency (f_1) of modal class = 20

Frequency (f_0) of class preceding modal class = 13

Frequency (f_2) of class succeeding the modal class = 14

$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 125 + \left[\frac{20 - 13}{2(20) - 13 - 14} \right] \times 20 \\ &= 125 + \frac{7}{13} \times 20 \\ &= 125 + \frac{140}{13} = 135.76\end{aligned}$$

To find the median of the given data, cumulative frequency is calculated as follows.

| Monthly consumption (in units) | Number of consumers | Cumulative frequency |
|--------------------------------|---------------------|----------------------|
| 65 – 85 | 4 | 4 |
| 85 – 105 | 5 | 4 + 5 = 9 |
| 105 – 125 | 13 | 9 + 13 = 22 |
| 125 – 145 | 20 | 22 + 20 = 42 |
| 145 – 165 | 14 | 42 + 14 = 56 |



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| | | |
|-----------|---|---------------|
| 165 – 185 | 8 | $56 + 8 = 64$ |
| 185 – 205 | 4 | $64 + 4 = 68$ |

From the table, we obtain

$$n = 68$$

Cumulative frequency (cf) just greater than $\frac{n}{2}$ (i.e., $\frac{68}{2} = 34$) is 42, belonging to interval 125 – 145.

Therefore, median class = 125 – 145

Lower limit (l) of median class = 125

Class size (h) = 20

Frequency (f) of median class = 20

Cumulative frequency (cf) of class preceding median class = 22

$$\begin{aligned}\text{Median} &= l + \left(\frac{\frac{n}{2} - cf}{f} \right) \times h \\ &= 125 + \left(\frac{34 - 22}{20} \right) \times 20 \\ &= 125 + 12 \\ &= 137\end{aligned}$$

Therefore, median, mode, mean of the given data is 137, 135.76, and 137.05 respectively.

The three measures are approximately the same in this case.

Question 2:

If the median of the distribution is given below is 28.5, find the values of x and y .

| | |
|----------------|-----------|
| Class interval | Frequency |
|----------------|-----------|



| | |
|---------|-----|
| 0 – 10 | 5 |
| 10 – 20 | x |
| 20 – 30 | 20 |
| 30 – 40 | 15 |
| 40 – 50 | y |
| 50 – 60 | 5 |
| Total | 60 |

The cumulative frequency for the given data is calculated as follows.

| Class interval | Frequency | Cumulative frequency |
|----------------|-----------|----------------------|
| 0 – 10 | 5 | 5 |
| 10 – 20 | x | $5 + x$ |
| 20 – 30 | 20 | $25 + x$ |
| 30 – 40 | 15 | $40 + x$ |
| 40 – 50 | y | $40 + x + y$ |
| 50 – 60 | 5 | $45 + x + y$ |
| Total (n) | 60 | |

From the table, it can be observed that $n = 60$

$$45 + x + y = 60$$

$$x + y = 15 \quad (1)$$

Median of the data is given as 28.5 which lies in interval 20 – 30.

Therefore, median class = 20 – 30



Lower limit (l) of median class = 20

Cumulative frequency (cf) of class preceding the median class = $5 + x$

Frequency (f) of median class = 20

Class size (h) = 10

$$\text{Median} = l + \left(\frac{\frac{n}{2} - cf}{f} \right) \times h$$
$$28.5 = 20 + \left[\frac{\frac{60}{2} - (5 + x)}{20} \right] \times 10$$

$$8.5 = \left(\frac{25 - x}{2} \right)$$

$$17 = 25 - x$$

$$x = 8$$

From equation (1),

$$8 + y = 15$$

$$y = 7$$

Hence, the values of x and y are 8 and 7 respectively.

Question 3:

A life insurance agent found the following data for distribution of ages of 100 policy holders. Calculate the median age, if policies are given only to persons having age 18 years onwards but less than 60 year.

| Age (in years) | Number of policy holders |
|----------------|--------------------------|
| Below 20 | 2 |



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|----------|-----|
| Below 25 | 6 |
| Below 30 | 24 |
| Below 35 | 45 |
| Below 40 | 78 |
| Below 45 | 89 |
| Below 50 | 92 |
| Below 55 | 98 |
| Below 60 | 100 |

Here, class width is not the same. There is no requirement of adjusting the frequencies according to class intervals. The given frequency table is of less than type represented with upper class limits. The policies were given only to persons with age 18 years onwards but less than 60 years. Therefore, class intervals with their respective cumulative frequency can be defined as below.

| Age (in years) | Number of policy holders (f_i) | Cumulative frequency (cf) |
|----------------|------------------------------------|-------------------------------|
| 18 – 20 | 2 | 2 |
| 20 – 25 | $6 - 2 = 4$ | 6 |
| 25 – 30 | $24 - 6 = 18$ | 24 |
| 30 – 35 | $45 - 24 = 21$ | 45 |
| 35 – 40 | $78 - 45 = 33$ | 78 |
| 40 – 45 | $89 - 78 = 11$ | 89 |
| 45 – 50 | $92 - 89 = 3$ | 92 |
| 50 – 55 | $98 - 92 = 6$ | 98 |
| 55 – 60 | $100 - 98 = 2$ | 100 |



| | | |
|---------------|--|--|
| Total (n) | | |
|---------------|--|--|

From the table, it can be observed that $n = 100$.

Cumulative frequency (cf) just greater than $\frac{n}{2}$ (i.e., $\frac{100}{2} = 50$) is 78, belonging to interval 35 – 40.

Therefore, median class = 35 – 40

Lower limit (l) of median class = 35

Class size (h) = 5

Frequency (f) of median class = 33

Cumulative frequency (cf) of class preceding median class = 45

$$\begin{aligned}\text{Median} &= l + \left(\frac{\frac{n}{2} - cf}{f} \right) \times h \\ &= 35 + \left(\frac{50 - 45}{33} \right) \times 5 \\ &= 35 + \frac{25}{33} \\ &= 35.76\end{aligned}$$

Therefore, median age is 35.76 years.

Question 4:

The following distribution gives the state-wise teacher-student ratio in higher secondary schools of India. Find the mode and mean of this data. Interpret the two measures.

| Number of students per teacher | Number of states/U.T |
|--------------------------------|----------------------|
| 15 – 20 | 3 |
| 20 – 25 | 8 |



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|---------|----|
| 25 – 30 | 9 |
| 30 – 35 | 10 |
| 35 – 40 | 3 |
| 40 – 45 | 0 |
| 45 – 50 | 0 |
| 50 – 55 | 2 |

It can be observed from the given data that the maximum class frequency is 10 belonging to class interval 30 – 35.

Therefore, modal class = 30 – 35

Class size (h) = 5

Lower limit (l) of modal class = 30

Frequency (f_1) of modal class = 10

Frequency (f_0) of class preceding modal class = 9

Frequency (f_2) of class succeeding modal class = 3

$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 30 + \left(\frac{10 - 9}{2(10) - 9 - 3} \right) \times (5) \\ &= 30 + \left(\frac{1}{20 - 12} \right) 5 \\ &= 30 + \frac{5}{8} = 30.625\end{aligned}$$

Mode = 30.6

It represents that most of the states/U.T have a teacher-student ratio as 30.6.

To find the class marks, the following relation is used.



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Where You Get Complete Knowledge

$$\text{Class mark} = \frac{\text{Upper class limit} + \text{Lower class limit}}{2}$$

Taking 32.5 as assumed mean (a), d_i , u_i , and $f_i u_i$ are calculated as follows.

| Number of students per teacher | Number of states/U.T (f_i) | x_i | $d_i = x_i - 32.5$ | $u_i = \frac{d_i}{5}$ | $f_i u_i$ |
|--------------------------------|-----------------------------------|-------|--------------------|-----------------------|-----------|
| 15 – 20 | 3 | 17.5 | – 15 | – 3 | – 9 |
| 20 – 25 | 8 | 22.5 | – 10 | – 2 | – 16 |
| 25 – 30 | 9 | 27.5 | – 5 | – 1 | – 9 |
| 30 – 35 | 10 | 32.5 | 0 | 0 | 0 |
| 35 – 40 | 3 | 37.5 | 5 | 1 | 3 |
| 40 – 45 | 0 | 42.5 | 10 | 2 | 0 |
| 45 – 50 | 0 | 47.5 | 15 | 3 | 0 |
| 50 – 55 | 2 | 52.5 | 20 | 4 | 8 |
| Total | 35 | | | | – 23 |

$$\begin{aligned}\text{Mean, } \bar{x} &= a + \left(\frac{\sum f_i u_i}{\sum f_i} \right) h \\ &= 32.5 + \left(\frac{-23}{35} \right) \times 5 \\ &= 32.5 - \frac{23}{7} = 32.5 - 3.28 \\ &= 29.22\end{aligned}$$

Therefore, mean of the data is 29.2.

It represents that on an average, teacher–student ratio was 29.2.



Question 5:

The given distribution shows the number of runs scored by some top batsmen of the world in one-day international cricket matches.

| Runs scored | Number of batsmen |
|---------------|-------------------|
| 3000 – 4000 | 4 |
| 4000 – 5000 | 18 |
| 5000 – 6000 | 9 |
| 6000 – 7000 | 7 |
| 7000 – 8000 | 6 |
| 8000 – 9000 | 3 |
| 9000 – 10000 | 1 |
| 10000 – 11000 | 1 |

Find the mode of the data.

From the given data, it can be observed that the maximum class frequency is 18, belonging to class interval 4000 – 5000.

Therefore, modal class = 4000 – 5000

Lower limit (l) of modal class = 4000

Frequency (f_1) of modal class = 18

Frequency (f_0) of class preceding modal class = 4

Frequency (f_2) of class succeeding modal class = 9

Class size (h) = 1000



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$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 4000 + \left(\frac{18 - 4}{2(18) - 4 - 9} \right) \times 1000 \\ &= 4000 + \left(\frac{14000}{23} \right) \\ &= 4000 + 608.695 \\ &= 4608.695\end{aligned}$$

Therefore, mode of the given data is 4608.7 runs.

Question 6:

A student noted the number of cars passing through a spot on a road for 100 periods each of 3 minutes and summarised it in the table given below. Find the mode of the data:

| | | | | | | | | |
|-----------------------|--------|---------|---------|---------|---------|---------|---------|---------|
| Number of cars | 0 – 10 | 10 – 20 | 20 – 30 | 30 – 40 | 40 – 50 | 50 – 60 | 60 – 70 | 70 – 80 |
| Frequency | 7 | 14 | 13 | 12 | 20 | 11 | 15 | 8 |

From the given data, it can be observed that the maximum class frequency is 20, belonging to 40 – 50 class intervals.

Therefore, modal class = 40 – 50

Lower limit (l) of modal class = 40

Frequency (f_1) of modal class = 20

Frequency (f_0) of class preceding modal class = 12

Frequency (f_2) of class succeeding modal class = 11

Class size = 10



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$$\begin{aligned}\text{Mode} &= l + \left(\frac{f_1 - f_0}{2f_1 - f_0 - f_2} \right) \times h \\ &= 40 + \left[\frac{20 - 12}{2(20) - 12 - 11} \right] \times 10 \\ &= 40 + \left(\frac{80}{40 - 23} \right) \\ &= 40 + \frac{80}{17}\end{aligned}$$

$$= 40 + 4.7$$

$$= 44.7$$

Therefore, mode of this data is 44.7 cars

Exercise – 14.4

Question 1:

The following distribution gives the daily income of 50 workers of a factory.

| Daily income (in Rs) | 100 – 120 | 120 – 140 | 140 – 160 | 160 – 180 | 180 – 200 |
|----------------------|-----------|-----------|-----------|-----------|-----------|
| Number of workers | 12 | 14 | 8 | 6 | 10 |

Convert the distribution above to a less than type cumulative frequency distribution, and draw its ogive.

The frequency distribution table of less than type is as follows.

| Daily income (in Rs) (upper class limits) | Cumulative frequency |
|----------------------------------------------|----------------------|
| Less than 120 | 12 |
| Less than 140 | $12 + 14 = 26$ |

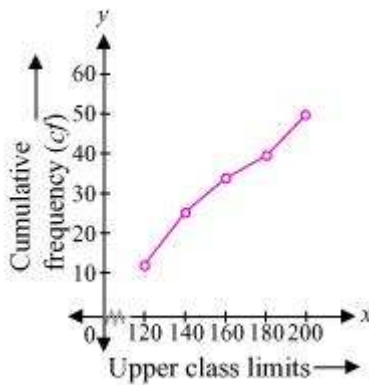


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|---------------|----------------|
| Less than 160 | $26 + 8 = 34$ |
| Less than 180 | $34 + 6 = 40$ |
| Less than 200 | $40 + 10 = 50$ |

Taking upper class limits of class intervals on x -axis and their respective frequencies on y -axis, its ogive can be drawn as follows.



Question 2:

During the medical check-up of 35 students of a class, their weights were recorded as follows:

| Weight (in kg) | Number of students |
|----------------|--------------------|
| Less than 38 | 0 |
| Less than 40 | 3 |
| Less than 42 | 5 |
| Less than 44 | 9 |
| Less than 46 | 14 |
| Less than 48 | 28 |
| Less than 50 | 32 |
| Less than 52 | 35 |

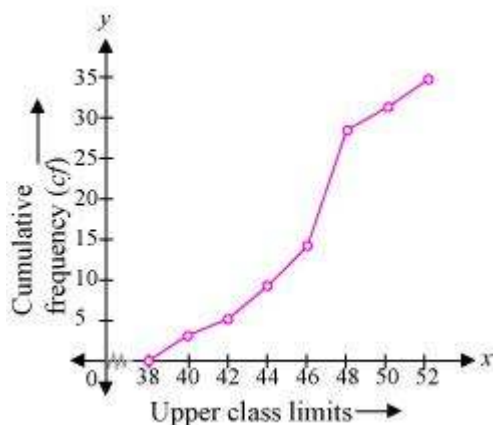


Draw a less than type ogive for the given data. Hence obtain the median weight from the graph verify the result by using the formula.

The given cumulative frequency distributions of less than type are

| Weight (in kg) upper class limits | Number of students (cumulative frequency) |
|--------------------------------------|----------------------------------------------|
| Less than 38 | 0 |
| Less than 40 | 3 |
| Less than 42 | 5 |
| Less than 44 | 9 |
| Less than 46 | 14 |
| Less than 48 | 28 |
| Less than 50 | 32 |
| Less than 52 | 35 |

Taking upper class limits on x -axis and their respective cumulative frequencies on y -axis, its ogive can be drawn as follows.



Here, $n = 35$

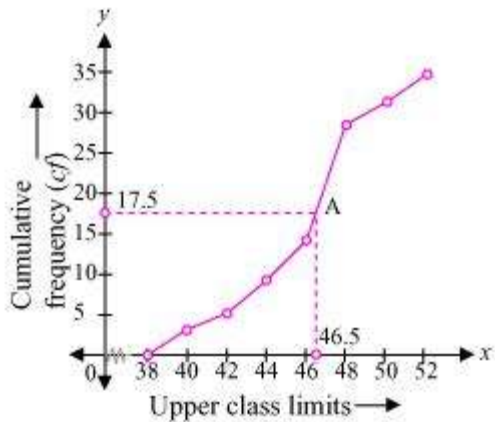


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$$\text{So, } \frac{n}{2} = 17.5$$

Mark the point A whose ordinate is 17.5 and its x-coordinate is 46.5. Therefore, median of this data is 46.5.



It can be observed that the difference between two consecutive upper class limits is 2. The class marks with their respective frequencies are obtained as below.

| Weight (in kg) | Frequency (f) | Cumulative frequency |
|----------------|-------------------|----------------------|
| Less than 38 | 0 | 0 |
| 38 – 40 | $3 - 0 = 3$ | 3 |
| 40 – 42 | $5 - 3 = 2$ | 5 |
| 42 – 44 | $9 - 5 = 4$ | 9 |
| 44 – 46 | $14 - 9 = 5$ | 14 |
| 46 – 48 | $28 - 14 = 14$ | 28 |
| 48 – 50 | $32 - 28 = 4$ | 32 |
| 50 – 52 | $35 - 32 = 3$ | 35 |
| Total (n) | 35 | |



The cumulative frequency just greater than $\frac{n}{2}$ (i.e., $\frac{35}{2} = 17.5$) is 28, belonging to class interval 46 – 48.

Median class = 46 – 48

Lower class limit (l) of median class = 46

Frequency (f) of median class = 14

Cumulative frequency (cf) of class preceding median class = 14

Class size (h) = 2

$$\begin{aligned}\text{Median} &= l + \left(\frac{\frac{n}{2} - cf}{f} \right) \times h \\ &= 46 + \left(\frac{17.5 - 14}{14} \right) \times 2 \\ &= 46 + \frac{3.5}{7} \\ &= 46.5\end{aligned}$$

Therefore, median of this data is 46.5.

Hence, the value of median is verified.

Question 3:

The following table gives production yield per hectare of wheat of 100 farms of a village.

| Production yield (in kg/ha) | 50 – 55 | 55 – 60 | 60 – 65 | 65 – 70 | 70 – 75 | 75 – 80 |
|-----------------------------|---------|---------|---------|---------|---------|---------|
| Number of farms | 2 | 8 | 12 | 24 | 38 | 16 |

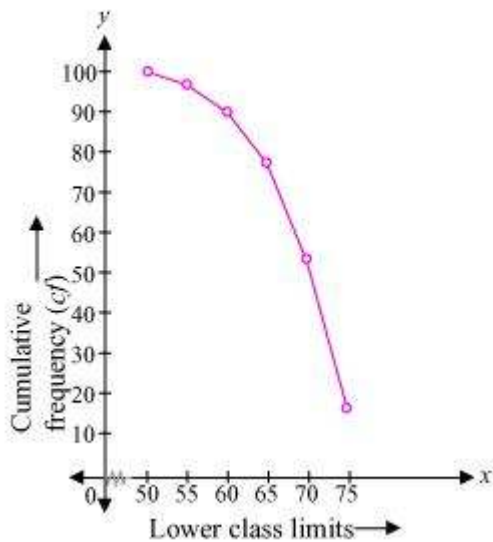
Change the distribution to a more than type distribution and draw ogive.

The cumulative frequency distribution of more than type can be obtained as follows.



| Production yield (lower class limits) | Cumulative frequency |
|------------------------------------------|----------------------|
| more than or equal to 50 | 100 |
| more than or equal to 55 | $100 - 2 = 98$ |
| more than or equal to 60 | $98 - 8 = 90$ |
| more than or equal to 65 | $90 - 12 = 78$ |
| more than or equal to 70 | $78 - 24 = 54$ |
| more than or equal to 75 | $54 - 38 = 16$ |

Taking the lower class limits on x -axis and their respective cumulative frequencies on y -axis, its ogive can be obtained as follows.





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