Chapter 13: Statistics

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Exercise 13.1 — Mean of Grouped Data

Q1 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

SOLUTION

Using the direct method:

Class	f_i	x_i	$f_i \times x_i$
0 – 2	1	1	1
2 – 4	2	3	6
4 – 6	1	5	5
6 – 8	5	7	35
8 – 10	6	9	54
10 – 12	2	11	22
12 – 14	3	13	39

$\Sigma f_i = 1 + 2 + 1 + 5 + 6 + 2 + 3 = 20$
$\Sigma f_i \times x_i = 1 + 6 + 5 + 35 + 54 + 22 + 39 = 162$

Mean $= \Sigma f_i \times x_i / \Sigma f_i = 162/20 = 8.1$
$\therefore$ Mean number of plants per house = 8.1

Answer: 8.1

Q2 Consider the following distribution of daily wages of 50 workers of a factory.

Daily wages (in Rs): 500-520, 520-540, 540-560, 560-580, 580-600
Number of workers: 12, 14, 8, 6, 10

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

SOLUTION

Using the assumed mean method with a = 550 and h = 20:

Class	f_i	x_i	$d_i = x_i - 550$	$f_i \times d_i$
500 – 520	12	510	−40	−480
520 – 540	14	530	−20	−280
540 – 560	8	550	0	0
560 – 580	6	570	20	120
580 – 600	10	590	40	400

$\Sigma f_i = 12 + 14 + 8 + 6 + 10 = 50$

$\Sigma f_i \times d_i = -480 + (-280) + 0 + 120 + 400 = -240$

$\text{Mean} = a + (\Sigma f_i \times d_i / \Sigma f_i)$

$= 550 + (-240/50)$

$= 550 - 4.8 = 545.2$

$\therefore$ Mean daily wages = Rs 545.20

Answer: Rs 545.20

Q3 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 children: 7, 6, 9, 13, f, 5, 4

SOLUTION

Using the direct method with mean = 18:

Class	f_i	x_i	$f_i \times x_i$
11 – 13	7	12	84
13 – 15	6	14	84
15 – 17	9	16	144
17 – 19	13	18	234
19 – 21	f	20	20f
21 – 23	5	22	110
23 – 25	4	24	96

$\Sigma f_i = 7 + 6 + 9 + 13 + f + 5 + 4 = 44 + f$

$\Sigma f_i \times x_i = 84 + 84 + 144 + 234 + 20f + 110 + 96 = 752 + 20f$

Mean $= \Sigma f_i \times x_i / \Sigma f_i$

$18 = (752 + 20f) / (44 + f)$

$18(44 + f) = 752 + 20f$

$792 + 18f = 752 + 20f$

$792 - 752 = 20f - 18f$

$40 = 2f$

$f = 20$

$\therefore$ The missing frequency f = 20

Answer: f = 20

Q4 Thirty women were examined in a hospital by a doctor and the number of heartbeats per minute were recorded and summarised as follows. Find the mean heartbeats per minute for these women, choosing a suitable method.

Number of heartbeats 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

SOLUTION

Using the assumed mean method with a = 75.5 and h = 3:

Class	f_i	x_i	$d_i = x_i - 75.5$	$u_i = d_i/3$	$f_i \times u_i$
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

$\Sigma f_i = 2 + 4 + 3 + 8 + 7 + 4 + 2 = 30$

$\Sigma f_i \times u_i = -6 + (-8) + (-3) + 0 + 7 + 8 + 6 = 4$

$\text{Mean} = a + h \times (\Sigma f_i \times u_i / \Sigma f_i)$

$= 75.5 + 3 \times (4/30)$

$= 75.5 + 3 \times 0.1333...$

$= 75.5 + 0.4 = 75.9$

$\therefore$ Mean heartbeats per minute = 75.9

Answer: 75.9

Q5 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?

SOLUTION

The classes are not continuous. Making them continuous:
49.5-52.5, 52.5-55.5, 55.5-58.5, 58.5-61.5, 61.5-64.5

Using the step deviation method with a = 57 and h = 3:

Class	f_i	x_i	$u_i = (x_i - 57)/3$	$f_i \times u_i$
49.5 – 52.5	15	51	−2	−30
52.5 – 55.5	110	54	−1	−110
55.5 – 58.5	135	57	0	0
58.5 – 61.5	115	60	1	115
61.5 – 64.5	25	63	2	50

$\Sigma f_i = 15 + 110 + 135 + 115 + 25 = 400$
$\Sigma f_i \times u_i = -30 + (-110) + 0 + 115 + 50 = 25$

Mean $= a + h \times (\Sigma f_i \times u_i / \Sigma f_i)$
$= 57 + 3 \times (25/400)$
$= 57 + 3 \times 0.0625$
$= 57 + 0.1875 = 57.19$ (approx.)

Step deviation method is chosen as the values of f_i and d_i are large.

Answer: 57.19 (approx.)

Q6 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.

SOLUTION

Using the step deviation method with a = 225 and h = 50:

Class	f_i	x_i	$u_i = (x_i - 225)/50$	$f_i \times u_i$
100 – 150	4	125	−2	−8
150 – 200	5	175	−1	−5
200 – 250	12	225	0	0
250 – 300	2	275	1	2
300 – 350	2	325	2	4

$\Sigma f_i = 4 + 5 + 12 + 2 + 2 = 25$

$\Sigma f_i \times u_i = -8 + (-5) + 0 + 2 + 4 = -7$

$\text{Mean} = a + h \times (\Sigma f_i \times u_i / \Sigma f_i)$

$= 225 + 50 \times (-7/25)$

$= 225 + 50 \times (-0.28)$

$= 225 - 14 = 211$

∴ Mean daily expenditure on food = Rs 211

Answer: Rs 211

Q7 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): 0.00-0.04, 0.04-0.08, 0.08-0.12, 0.12-0.16, 0.16-0.20, 0.20-0.24
Frequency: 4, 9, 9, 2, 4, 2

Find the mean concentration of SO_2 in the air.

SOLUTION

Using the direct method:

Class	f_i	x_i	$f_i \times x_i$
0.00 – 0.04	4	0.02	0.08
0.04 – 0.08	9	0.06	0.54
0.08 – 0.12	9	0.10	0.90
0.12 – 0.16	2	0.14	0.28
0.16 – 0.20	4	0.18	0.72
0.20 – 0.24	2	0.22	0.44

$\Sigma f_i = 4 + 9 + 9 + 2 + 4 + 2 = 30$

$\Sigma f_i \times x_i = 0.08 + 0.54 + 0.90 + 0.28 + 0.72 + 0.44 = 2.96$

Mean $= \Sigma f_i \times x_i / \Sigma f_i = 2.96/30 = 0.0987$ ppm (approx.)

$\therefore$ Mean concentration of $SO_2 = 0.099$ ppm (approx.)

Answer: 0.099 ppm (approx.)

Q8 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

SOLUTION

Note: Class widths are unequal, so we use the direct method.

Class	f_i	x_i	$f_i \times x_i$
0 – 6	11	3	33
6 – 10	10	8	80
10 – 14	7	12	84
14 – 20	4	17	68
20 – 28	4	24	96
28 – 38	3	33	99
38 – 40	1	39	39

$\Sigma f_i = 11 + 10 + 7 + 4 + 4 + 3 + 1 = 40$
$\Sigma f_i \times x_i = 33 + 80 + 84 + 68 + 96 + 99 + 39 = 499$

Mean $= \Sigma f_i \times x_i / \Sigma f_i = 499/40 = 12.475$
$\therefore$ Mean number of days absent = 12.48 (approx.)

Answer: 12.48 days (approx.)

Q9 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

SOLUTION

Using the assumed mean method with a = 70 and h = 10:

Class	f_i	x_i	$d_i = x_i - 70$	$u_i = d_i/10$	$f_i \times u_i$
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

$\Sigma f_i = 3 + 10 + 11 + 8 + 3 = 35$

$\Sigma f_i \times u_i = -6 + (-10) + 0 + 8 + 6 = -2$

$\text{Mean} = a + h \times (\Sigma f_i \times u_i / \Sigma f_i)$

$= 70 + 10 \times (-2/35)$

$= 70 - 20/35$

$= 70 - 0.57 = 69.43$ (approx.)

$\therefore$ Mean literacy rate = 69.43%

Answer: 69.43%

Exercise 13.2 — Mode of Grouped Data

Q1 The following table shows the ages of the patients admitted in a hospital during a year:

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.

SOLUTION

Finding Mode:

The class with the highest frequency is 35-45 (f = 23).

So the modal class is 35-45.

$l = 35, h = 10, f_1 = 23, f_0 = 21, f_2 = 14$

$\text{Mode} = l + [(f_1 - f_0) / (2f_1 - f_0 - f_2)] \times h$

$= 35 + [(23 - 21) / (2 \times 23 - 21 - 14)] \times 10$

$= 35 + [2 / (46 - 35)] \times 10$

$= 35 + (2/11) \times 10$

$= 35 + 1.82 = 36.82$ (approx.)

Finding Mean (using assumed mean method, a = 40, h = 10):

Class	f_i	x_i	$u_i = (x_i - 40)/10$	$f_i \times u_i$
5 – 15	6	10	−3	−18
15 – 25	11	20	−2	−22
25 – 35	21	30	−1	−21
35 – 45	23	40	0	0
45 – 55	14	50	1	14
55 – 65	5	60	2	10

$\Sigma f_i = 6 + 11 + 21 + 23 + 14 + 5 = 80$

$\Sigma f_i \times u_i = -18 + (-22) + (-21) + 0 + 14 + 10 = -37$

$\text{Mean} = a + h \times (\Sigma f_i \times u_i / \Sigma f_i)$

= 40 + 10 × (−37/80)
= 40 − 4.625 = 35.38 (approx.)

Mode ≈ 36.82 years, Mean ≈ 35.38 years.
Maximum number of patients are in the age group 36-37 years.
The average age of all patients is about 35.38 years.

Answer: Mode = 36.82 years, Mean = 35.38 years

Q2 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.

SOLUTION

The class with the highest frequency is 60-80 (f = 61).
So the modal class is 60-80.

l = 60, h = 20, f_1 = 61, f_0 = 52, f_2 = 38

Mode = $l + [(f_1 - f_0) / (2f_1 - f_0 - f_2)] \times h$
= $60 + [(61 - 52) / (2 \times 61 - 52 - 38)] \times 20$
= $60 + [9 / (122 - 90)] \times 20$
= $60 + (9/32) \times 20$
= $60 + 180/32$
= 60 + 5.625 = 65.625
∴ Modal lifetime = 65.63 hours (approx.)

Answer: 65.63 hours (approx.)

Q3 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): 1000-1500, 1500-2000, 2000-2500, 2500-3000, 3000-3500, 3500-4000, 4000-4500, 4500-5000
Number of families: 24, 40, 33, 28, 30, 22, 16, 7

SOLUTION

Finding Mode:
The class with the highest frequency is 1500-2000 (f = 40).
So the modal class is 1500-2000.

$l = 1500$, $h = 500$, $f_1 = 40$, $f_0 = 24$, $f_2 = 33$

$$\text{Mode} = l + [(f_1 - f_0) / (2f_1 - f_0 - f_2)] \times h$$
$$= 1500 + [(40 - 24) / (2 \times 40 - 24 - 33)] \times 500$$
$$= 1500 + [16 / (80 - 57)] \times 500$$
$$= 1500 + (16/23) \times 500$$
$$= 1500 + 8000/23$$
$$= 1500 + 347.83 = 1847.83 \text{ (approx.)}$$

Finding Mean (using step deviation, a = 2750, h = 500):

Class	f_i	x_i	$u_i = (x_i - 2750)/500$	$f_i \times u_i$
1000 – 1500	24	1250	−3	−72
1500 – 2000	40	1750	−2	−80
2000 – 2500	33	2250	−1	−33
2500 – 3000	28	2750	0	0
3000 – 3500	30	3250	1	30
3500 – 4000	22	3750	2	44
4000 – 4500	16	4250	3	48
4500 – 5000	7	4750	4	28

$\Sigma f_i = 24 + 40 + 33 + 28 + 30 + 22 + 16 + 7 = 200$
$\Sigma f_i \times u_i = -72 + (-80) + (-33) + 0 + 30 + 44 + 48 + 28 = -35$

Mean = a + h × (Σf_i × u_i / Σf_i)
= 2750 + 500 × (−35/200)
= 2750 + 500 × (−0.175)
= 2750 − 87.50 = 2662.50

∴ Modal monthly expenditure = Rs 1847.83, Mean monthly expenditure = Rs 2662.50

Answer: Mode = Rs 1847.83, Mean = Rs 2662.50

Q4 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: 15-20, 20-25, 25-30, 30-35, 35-40
Number of states/U.T.: 3, 8, 9, 10, 3

SOLUTION

Finding Mode:
The class with the highest frequency is 30-35 (f = 10).
So the modal class is 30-35.

l = 30, h = 5, f_1 = 10, f_0 = 9, f_2 = 3

Mode = l + [(f_1 − f_0) / (2f_1 − f_0 − f_2)] × h
= 30 + [(10 − 9) / (2 × 10 − 9 − 3)] × 5
= 30 + [1 / (20 − 12)] × 5
= 30 + (1/8) × 5
= 30 + 0.625 = 30.625

Finding Mean (step deviation method, a = 27.5, h = 5):

Class	f_i	x_i	u_i = (x_i − 27.5)/5	f_i × u_i
15 – 20	3	17.5	−2	−6
20 – 25	8	22.5	−1	−8
25 – 30	9	27.5	0	0
30 – 35	10	32.5	1	10
35 – 40	3	37.5	2	6

$\Sigma f_i = 3 + 8 + 9 + 10 + 3 = 33$
$\Sigma f_i \times u_i = -6 + (-8) + 0 + 10 + 6 = 2$

Mean = $a + h \times (\Sigma f_i \times u_i / \Sigma f_i)$
$= 27.5 + 5 \times (2/33)$
$= 27.5 + 10/33$
$= 27.5 + 0.30 = 27.80$ (approx.)

Mode ≈ 30.6, Mean ≈ 27.8.
Most states/U.T.s have a student-teacher ratio of about 30.6.
On average, the ratio is 27.8 students per teacher.

Answer: Mode = 30.6, Mean = 27.8 (approx.)

Q5 The given distribution shows the number of runs scored by some top batsmen of the world in one-day international cricket matches.

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

Find the mode of the data.

SOLUTION

The class with the highest frequency is 4000-5000 (f = 18).
So the modal class is 4000-5000.

$l = 4000$, $h = 1000$, $f_1 = 18$, $f_0 = 4$, $f_2 = 9$

Mode = $l + [(f_1 - f_0) / (2f_1 - f_0 - f_2)] \times h$
$= 4000 + [(18 - 4) / (2 \times 18 - 4 - 9)] \times 1000$
$= 4000 + [14 / (36 - 13)] \times 1000$
$= 4000 + (14/23) \times 1000$
$= 4000 + 14000/23$
$= 4000 + 608.70 = 4608.70$ (approx.)
∴ Mode of the data = 4608.7 runs (approx.)

Answer: 4608.7 runs (approx.)

Q6 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

SOLUTION

The class with the highest frequency is 40-50 (f = 20).
So the modal class is 40-50.

$l = 40, h = 10, f_1 = 20, f_0 = 12, f_2 = 11$

$\text{Mode} = l + [(f_1 - f_0) / (2f_1 - f_0 - f_2)] \times h$
$= 40 + [(20 - 12) / (2 \times 20 - 12 - 11)] \times 10$
$= 40 + [8 / (40 - 23)] \times 10$
$= 40 + (8/17) \times 10$
$= 40 + 80/17$
$= 40 + 4.71 = 44.71$ (approx.)

$\therefore$ Mode = 44.71 cars (approx.)

Answer: 44.71 cars (approx.)

Exercise 13.3 — Median of Grouped Data

Q1 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): 65-85, 85-105, 105-125, 125-145, 145-165, 165-185, 185-205
Number of consumers: 4, 5, 13, 20, 14, 8, 4

SOLUTION

Finding Median:
n = 68, so n/2 = 34

Class	f_i	cf
65 – 85	4	4
85 – 105	5	9
105 – 125	13	22
125 – 145	20	42
145 – 165	14	56
165 – 185	8	64
185 – 205	4	68

n/2 = 34, and cf just exceeding 34 is 42 (class 125-145).
So the median class is 125-145.

l = 125, n = 68, cf = 22 (cf of class before median class), f = 20, h = 20

Median = l + [(n/2 − cf) / f] × h
= 125 + [(34 − 22) / 20] × 20
= 125 + [12/20] × 20
= 125 + 12 = 137

Finding Mean (step deviation, a = 135, h = 20):

Class	f_i	x_i	$u_i = (x_i - 135)/20$	$f_i \times u_i$
65 – 85	4	75	−3	−12
85 – 105	5	95	−2	−10
105 – 125	13	115	−1	−13
125 – 145	20	135	0	0
145 – 165	14	155	1	14
165 – 185	8	175	2	16
185 – 205	4	195	3	12

$\Sigma f_i = 68$, $\Sigma f_i \times u_i = -12 + (-10) + (-13) + 0 + 14 + 16 + 12 = 7$

Mean = $135 + 20 \times (7/68) = 135 + 140/68 = 135 + 2.06 = 137.06$ (approx.)

Finding Mode:
Modal class is 125-145 (highest frequency = 20).
$l = 125$, $f_1 = 20$, $f_0 = 13$, $f_2 = 14$, $h = 20$

$$\text{Mode} = 125 + [(20 - 13) / (2 \times 20 - 13 - 14)] \times 20$$
$$= 125 + [7 / (40 - 27)] \times 20$$
$$= 125 + (7/13) \times 20$$
$$= 125 + 140/13 = 125 + 10.77 = 135.77 \text{ (approx.)}$$

∴ Median = 137, Mean ≈ 137.06, Mode ≈ 135.77
The three measures are close, indicating a roughly symmetric distribution.

Answer: Median = 137 units, Mean = 137.05 units, Mode = 135.76 units

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Q2 If the median of the distribution given below is 28.5, find the values of x and y.

Class interval: 0-10, 10-20, 20-30, 30-40, 40-50, 50-60
Frequency: 5, x, 20, 15, y, 5
Total frequency = 60

SOLUTION

Given: $\Sigma f_i = 60$ and Median = 28.5
$5 + x + 20 + 15 + y + 5 = 60$

45 + x + y = 60

x + y = 15 ... (i)

Cumulative frequencies:

Class	f_i	cf
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 = 60

n/2 = 30. Since median = 28.5, the median class is 20-30.

l = 20, n = 60, cf = 5 + x, f = 20, h = 10

Median = l + [(n/2 − cf) / f] × h

28.5 = 20 + [(30 − 5 − x) / 20] × 10

28.5 = 20 + [(25 − x) / 20] × 10

28.5 = 20 + (25 − x)/2

8.5 = (25 − x)/2

17 = 25 − x

x = 8

From (i): y = 15 − x = 15 − 8 = 7

∴ x = 8 and y = 7

Answer: x = 8, y = 7

Q3 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): Below 20, Below 25, Below 30, Below 35, Below 40, Below 45, Below 50, Below 55, Below 60
Number of policy holders: 2, 6, 24, 45, 78, 89, 92, 98, 100

SOLUTION

Converting 'less than' cumulative frequencies to class frequencies:

Class	f_i	cf
15 – 20	2	2
20 – 25	4	6
25 – 30	18	24
30 – 35	21	45
35 – 40	33	78
40 – 45	11	89
45 – 50	3	92
50 – 55	6	98
55 – 60	2	100

n = 100, n/2 = 50
cf just exceeding 50 is 78 (class 35-40).
So the median class is 35-40.

l = 35, n = 100, cf = 45, f = 33, h = 5

Median = l + [(n/2 − cf) / f] × h
= 35 + [(50 − 45) / 33] × 5
= 35 + (5/33) × 5
= 35 + 25/33
= 35 + 0.76 = 35.76 (approx.)
∴ Median age = 35.76 years

Answer: 35.76 years

Q4 The lengths of 40 leaves of a plant are measured correct to the nearest millimetre, and the data obtained is represented in the following table:

Length (in mm): 118-126, 127-135, 136-144, 145-153, 154-162, 163-171, 172-180
Number of leaves: 3, 5, 9, 12, 5, 4, 2

Find the median length of the leaves.

SOLUTION

The classes are not continuous. Making them continuous (subtracting 0.5 from lower limit, adding 0.5 to upper limit):

Class	f_i	cf
117.5 – 126.5	3	3
126.5 – 135.5	5	8
135.5 – 144.5	9	17
144.5 – 153.5	12	29
153.5 – 162.5	5	34
162.5 – 171.5	4	38
171.5 – 180.5	2	40

n = 40, n/2 = 20
cf just exceeding 20 is 29 (class 144.5-153.5).
So the median class is 144.5-153.5.

l = 144.5, n = 40, cf = 17, f = 12, h = 9

Median = l + [(n/2 − cf) / f] × h
= 144.5 + [(20 − 17) / 12] × 9
= 144.5 + (3/12) × 9
= 144.5 + 0.25 × 9
= 144.5 + 2.25 = 146.75
∴ Median length of leaves = 146.75 mm

Answer: 146.75 mm

Q5 The following table gives the distribution of the life time of 400 neon lamps:

Life time (in hours): 1500-2000, 2000-2500, 2500-3000, 3000-3500, 3500-4000, 4000-4500, 4500-5000
Number of lamps: 14, 56, 60, 86, 74, 62, 48

Find the median life time of a lamp.

SOLUTION

Class	f_i	cf
1500 – 2000	14	14
2000 – 2500	56	70
2500 – 3000	60	130
3000 – 3500	86	216
3500 – 4000	74	290
4000 – 4500	62	352
4500 – 5000	48	400

n = 400, n/2 = 200
cf just exceeding 200 is 216 (class 3000-3500).
So the median class is 3000-3500.

l = 3000, n = 400, cf = 130, f = 86, h = 500

Median = l + [(n/2 − cf) / f] × h
= 3000 + [(200 − 130) / 86] × 500
= 3000 + [70/86] × 500
= 3000 + 0.8139 × 500
= 3000 + 406.98 = 3406.98 (approx.)
∴ Median life time = 3406.98 hours

Answer: 3406.98 hours

Q6 100 surnames were randomly picked up from a local telephone directory and the frequency distribution of the number of letters in the English alphabets in the surnames was obtained as follows:

Number of letters: 1-4, 4-7, 7-10, 10-13, 13-16, 16-19
Number of surnames: 6, 30, 40, 16, 4, 4

Determine the median number of letters in the surnames. Find the mean number of letters in the surnames. Also, find the modal size of the surnames.

SOLUTION

Finding Median:

Class	f_i	cf
1 – 4	6	6
4 – 7	30	36
7 – 10	40	76
10 – 13	16	92
13 – 16	4	96
16 – 19	4	100

n = 100, n/2 = 50
cf just exceeding 50 is 76 (class 7-10).
So the median class is 7-10.

l = 7, n = 100, cf = 36, f = 40, h = 3

Median = l + [(n/2 − cf) / f] × h
= 7 + [(50 − 36) / 40] × 3
= 7 + (14/40) × 3
= 7 + 42/40
= 7 + 1.05 = 8.05

Finding Mean (step deviation, a = 8.5, h = 3):

Class	f_i	x_i	u_i = (x_i − 8.5)/3	f_i × u_i
1 – 4	6	2.5	−2	−12

Class	f_i	x_i	$u_i = (x_i - 8.5)/3$	$f_i \times u_i$
4 – 7	30	5.5	−1	−30
7 – 10	40	8.5	0	0
10 – 13	16	11.5	1	16
13 – 16	4	14.5	2	8
16 – 19	4	17.5	3	12

$\Sigma f_i = 100$, $\Sigma f_i \times u_i = -12 + (-30) + 0 + 16 + 8 + 12 = -6$

Mean $= 8.5 + 3 \times (-6/100) = 8.5 - 0.18 = 8.32$

Finding Mode:
Modal class is 7-10 (highest frequency = 40).
$l = 7$, $f_1 = 40$, $f_0 = 30$, $f_2 = 16$, $h = 3$

Mode $= 7 + [(40 - 30) / (2 \times 40 - 30 - 16)] \times 3$
$= 7 + [10 / (80 - 46)] \times 3$
$= 7 + (10/34) \times 3$
$= 7 + 30/34$
$= 7 + 0.88 = 7.88$

$\therefore$ Median = 8.05, Mean = 8.32, Mode = 7.88

Answer: Median = 8.05, Mean = 8.32, Mode = 7.88

Q7 The distribution below gives the weights of 30 students of a class. Find the median weight of the students.

Weight (in kg): 40-45, 45-50, 50-55, 55-60, 60-65, 65-70, 70-75
Number of students: 2, 3, 8, 6, 6, 3, 2

SOLUTION

Class	f_i	cf
40 – 45	2	2
45 – 50	3	5

Class	f_i	cf
50 – 55	8	13
55 – 60	6	19
60 – 65	6	25
65 – 70	3	28
70 – 75	2	30

n = 30, n/2 = 15

cf just exceeding 15 is 19 (class 55-60).

So the median class is 55-60.

l = 55, n = 30, cf = 13, f = 6, h = 5

Median = l + [(n/2 − cf) / f] × h

= 55 + [(15 − 13) / 6] × 5

= 55 + (2/6) × 5

= 55 + 10/6

= 55 + 1.67 = 56.67 (approx.)

∴ Median weight = 56.67 kg

Answer: 56.67 kg