

## EXERCISE 11.1

1. The following frequency distribution represents the achievement of a student's group upon a memory test:
  - (i) Plot cumulative frequency graph of group scores.
  - (ii) Determine median, lower and upper quartiles,  $D_3$ ,  $P_{90}$  and interquartile range graphically.

**Note:** Write your answers in whole numbers.

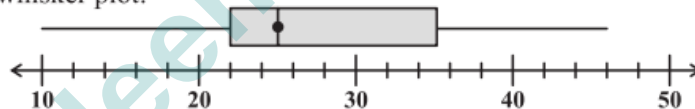
| Scores          | 44 – 48 | 49 – 53 | 54 – 58 | 59 – 63 | 64 – 68 | 69 – 73 | 74 – 78 |
|-----------------|---------|---------|---------|---------|---------|---------|---------|
| No. of Students | 3       | 12      | 15      | 23      | 12      | 8       | 7       |

2. Construct an ogive for the following distribution of scores:

| Scores | 69 – 79 | 79 – 89 | 89 – 99 | 99 – 109 | 109 – 119 |
|--------|---------|---------|---------|----------|-----------|
| $f$    | 4       | 10      | 13      | 8        | 5         |

Determine median, lower and upper quartiles,  $D_6$ ,  $P_{80}$  and interquartile range graphically.

3. Find  $Q_1$ ,  $Q_3$ , median, range and  $IQR$  for the dataset given below:  
 3, 6, 8, 4, 7, 5, 10, 11, 13, 9, 14, 12, 15, 16, 17  
 Also draw a box-and-whisker plot.
4. Find  $Q_1$ ,  $Q_3$ , median, range,  $IQR$  and extreme values plot for the following data:  
 102, 98, 95, 100, 93, 110, 108, 104, 97, 96, 92, 101, 99, 105, 107  
 Also draw a box-and-whisker plot.
5. Find  $Q_1$ ,  $Q_3$ , median, minimum and maximum values for the following box-and-whisker plot:



6. Draw the box-and-whisker plot, if min. value = 12, max. value = 26, median = 19,  $Q_1 = 14$  and  $Q_3 = 24$ .

7. Construct a scatter diagram and draw a line of best fit for the following quiz scores for 8 students in a class:

|                            |    |    |    |    |    |    |    |    |
|----------------------------|----|----|----|----|----|----|----|----|
| <b>1<sup>st</sup> quiz</b> | 14 | 28 | 34 | 36 | 43 | 45 | 46 | 49 |
| <b>2<sup>nd</sup> quiz</b> | 16 | 20 | 33 | 35 | 38 | 39 | 42 | 43 |

Describe correlation between 1<sup>st</sup> and 2<sup>nd</sup> quiz scores also.

8. The following table shows the test scores (one measuring speed and the other measuring strength) of football players out of 200:

|                            |     |     |     |     |     |     |     |     |     |     |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| <b>1<sup>st</sup> Test</b> | 20  | 38  | 70  | 40  | 100 | 110 | 50  | 136 | 150 | 80  |
| <b>2<sup>nd</sup> Test</b> | 160 | 142 | 130 | 120 | 70  | 50  | 140 | 44  | 36  | 100 |

- (i) Construct a scatter diagram and draw a line of best fit.  
 (ii) Describe correlation between the 1<sup>st</sup> and 2<sup>nd</sup> tests.  
 (iii) Abdullah scores 60 in the 2<sup>nd</sup> test. Estimate his score in the 1<sup>st</sup> test.
9. The following table shows the number of daily social media hours and GPA of university students.

|                           |     |     |     |     |     |     |     |     |     |     |
|---------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| <b>Social Media Hours</b> | 0.5 | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
| <b>GPA</b>                | 4.0 | 3.9 | 3.7 | 3.5 | 3.3 | 3.1 | 2.9 | 2.8 | 2.6 | 2.5 |

- (i) Construct a scatter diagram and draw a line of best fit.  
 (ii) Identify the nature of correlation between social media use and GPA.  
 (iii) Estimate the GPA for a student who spends 6.5 hours on social media.

### EXERCISE 11.1 - Cumulative Frequency, Ogives, and Box-and-Whisker Plots

#### Question 1: Cumulative Frequency Graph and Graphical Measures

Given Frequency Distribution:

|        |       |       |       |       |       |       |       |
|--------|-------|-------|-------|-------|-------|-------|-------|
| Scores | 44–48 | 49–53 | 54–58 | 59–63 | 64–68 | 69–73 | 74–78 |
| f      | 3     | 12    | 15    | 23    | 12    | 8     | 7     |

#### 1(i) Cumulative Frequency Table

**Step 1:** Find class boundaries and cumulative frequencies.

| Class | Frequency (f) | Class Boundaries | Cumulative Frequency (cf) |
|-------|---------------|------------------|---------------------------|
| 44–48 | 3             | 43.5–48.5        | 3                         |
| 49–53 | 12            | 48.5–53.5        | 15                        |
| 54–58 | 15            | 53.5–58.5        | 30                        |
| 59–63 | 23            | 58.5–63.5        | 53                        |
| 64–68 | 12            | 63.5–68.5        | 65                        |
| 69–73 | 8             | 68.5–73.5        | 73                        |
| 74–78 | 7             | 73.5–78.5        | 80                        |

**Total Frequency (n) = 80**

#### 1(ii) Graphical Determination of Median, Quartiles, D , P , and IQR

**Step 1:** Plot the ogive (cumulative frequency curve):

- X-axis: Class boundaries (43.5, 48.5, 53.5, 58.5, 63.5, 68.5, 73.5, 78.5)

- Y-axis: Cumulative frequencies (0, 3, 15, 30, 53, 65, 73, 80)

**Step 2:** Determine positions:

| Measure                    | Position Formula                       | Position Value |
|----------------------------|----------------------------------------|----------------|
| <b>Median (Q )</b>         | $\frac{n}{2} = \frac{80}{2}$           | 40th value     |
| <b>Lower Quartile (Q )</b> | $\frac{n}{4} = \frac{80}{4}$           | 20th value     |
| <b>Upper Quartile (Q )</b> | $\frac{3n}{4} = \frac{3(80)}{4}$       | 60th value     |
| <b>D (3rd Decile)</b>      | $\frac{3n}{10} = \frac{3(80)}{10}$     | 24th value     |
| <b>P (90th Percentile)</b> | $\frac{90n}{100} = \frac{90(80)}{100}$ | 72nd value     |

**Step 3:** Read from ogive:

| Measure                   | Value (approx.)                  |
|---------------------------|----------------------------------|
| Median (Q )               | 60.5                             |
| Lower Quartile (Q )       | 55.0                             |
| Upper Quartile (Q )       | 65.5                             |
| D                         | 56.5                             |
| P                         | 72.0                             |
| Interquartile Range (IQR) | $Q_3 - Q_1 = 65.5 - 55.0 = 10.5$ |

**Answers (whole numbers):**

- Median 61
- Q 55
- Q 66
- D 57
- P 72
- IQR 11

### Question 2: Construct an Ogive and Determine Measures

**Given Frequency Distribution:**

| Scores | 69–79 | 79–89 | 89–99 | 99–109 | 109–119 |
|--------|-------|-------|-------|--------|---------|
| f      | 4     | 10    | 13    | 8      | 5       |

**Step 1: Cumulative Frequency Table**

| Class   | Frequency (f) | Class Boundaries | Cumulative Frequency (cf) |
|---------|---------------|------------------|---------------------------|
| 69–79   | 4             | 68.5–79.5        | 4                         |
| 79–89   | 10            | 78.5–89.5        | 14                        |
| 89–99   | 13            | 88.5–99.5        | 27                        |
| 99–109  | 8             | 98.5–109.5       | 35                        |
| 109–119 | 5             | 108.5–119.5      | 40                        |

**Total Frequency (n) = 40**

**Step 2: Determine Positions**

| Measure             | Position Formula                       | Position Value |
|---------------------|----------------------------------------|----------------|
| Median (Q )         | $\frac{n}{2} = \frac{40}{2}$           | 20th value     |
| Lower Quartile (Q ) | $\frac{n}{4} = \frac{40}{4}$           | 10th value     |
| Upper Quartile (Q ) | $\frac{3n}{4} = \frac{3(40)}{4}$       | 30th value     |
| D (6th Decile)      | $\frac{6n}{10} = \frac{6(40)}{10}$     | 24th value     |
| P (80th Percentile) | $\frac{80n}{100} = \frac{80(40)}{100}$ | 32nd value     |
| IQR                 | $Q_3 - Q_1$                            | —              |

**Step 3: Read from Ogive**

| Measure             | Value                 |
|---------------------|-----------------------|
| Median (Q )         | 94.5                  |
| Lower Quartile (Q ) | 85.5                  |
| Upper Quartile (Q ) | 102.5                 |
| D                   | 97.0                  |
| P                   | 104.0                 |
| IQR                 | $102.5 - 85.5 = 17.0$ |

**Answers:**

- Median 94.5
- Q 85.5
- Q 102.5
- D 97.0
- P 104.0
- IQR 17.0

**Question 3: Find Q , Q , Median, Range, and IQR**

**Data:** 3, 6, 8, 4, 7, 5, 10, 11, 13, 9, 14, 12, 15, 16, 17

**Step 1: Arrange in Ascending Order**

3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17

$$n = 15$$

**Step 2: Find Median (Q )**

$$\text{Median position} = \frac{n+1}{2} = \frac{16}{2} = 8\text{th value}$$

$$\text{Median} = 10$$

**Step 3: Find Q (Lower Quartile)**

$$Q \text{ position} = \frac{n+1}{4} = \frac{16}{4} = 4\text{th value}$$

$$Q = 6$$

**Step 4: Find Q (Upper Quartile)**

$$Q \text{ position} = \frac{3(n+1)}{4} = \frac{48}{4} = 12\text{th value}$$

$$Q = 14$$

**Step 5: Range and IQR**

- $\text{Range} = \text{Max} - \text{Min} = 17 - 3 = 14$
- $\text{IQR} = Q - Q = 14 - 6 = 8$

**Step 6: Box-and-Whisker Plot**

text

Q Median Q

6 10 14

|||

|-----|-----|

|||

|||

3 10 17

|\_\_\_\_\_|

Min Max

3 6 10 14 17

|||||

|---|---|---|---|

**Five-Number Summary:**

- Minimum = 3
- $Q = 6$
- Median = 10
- $Q = 14$
- Maximum = 17

**Question 4: Find  $Q$ ,  $Q$ , Median, Range, IQR, and Extreme Values Plot**

**Data:** 102, 98, 95, 100, 93, 110, 108, 104, 97, 96, 92, 101, 99, 105, 107

**Step 1: Arrange in Ascending Order**

92, 93, 95, 96, 97, 98, 99, 100, 101, 102, 104, 105, 107, 108, 110

$n = 15$

**Step 2: Find Median ( $Q$ )**

Median position =  $\frac{n+1}{2} = \frac{16}{2} = 8\text{th value}$

**Median = 100**

**Step 3: Find  $Q$  (Lower Quartile)**

$Q$  position =  $\frac{n+1}{4} = \frac{16}{4} = 4\text{th value}$

**$Q = 96$**

**Step 4: Find  $Q$  (Upper Quartile)**

$$Q \text{ position} = \frac{3(n+1)}{4} = \frac{48}{4} = 12\text{th value}$$

$$Q = 105$$

#### Step 5: Range and IQR

- $\text{Range} = \text{Max} - \text{Min} = 110 - 92 = 18$
- $\text{IQR} = Q - Q = 105 - 96 = 9$

#### Step 6: Box-and-Whisker Plot

text

Q Median Q

96 100 105

|||

|-----|-----|

|||

|||

92 100 110

|\_\_\_\_\_|

Min Max

92 96 100 105 110

|||||

---|---|---|---|

#### Five-Number Summary:

- **Minimum** = 92
- **Q** = 96
- **Median** = 100
- **Q** = 105
- **Maximum** = 110

#### Question 5: Find Q , Q , Median, Minimum and Maximum from Box-and-Whisker Plot

(Note: Since the actual plot is not visible, I will provide the general method.)

#### Method to Read Box-and-Whisker Plot:

1. **Minimum Value:** Leftmost point (whisker end)
2. **Q :** Left edge of the box
3. **Median:** Line inside the box
4. **Q :** Right edge of the box
5. **Maximum Value:** Rightmost point (whisker end)

#### Example:

If the plot shows:

- Left whisker ends at 10

- Box starts at 20
- Median line at 30
- Box ends at 40
- Right whisker ends at 50

Then:

- **Minimum = 10**
- **$Q = 20$**
- **Median = 30**
- **$Q = 40$**
- **Maximum = 50**

#### Question 6: Draw Box-and-Whisker Plot

**Given:**

- Minimum = 12
- Maximum = 26
- Median = 19
- $Q = 14$
- $Q = 24$

**Box-and-Whisker Plot:**

text

Q Median Q

14 19 24

| | |

|-----|-----|

| | |

| | |

12 19 26

|\_\_\_\_\_|

Min Max

12 14 19 24 26

| | | |

|---|---|---|---|

**Five-Number Summary:**

- **Minimum = 12**
- **$Q = 14$**
- **Median = 19**
- **$Q = 24$**

- Maximum = 26

### Summary Table

|   | Median          | Q               | Q               | Range | IQR |
|---|-----------------|-----------------|-----------------|-------|-----|
| 1 | 61              | 55              | 66              | 34    | 11  |
| 2 | 94.5            | 85.5            | 102.5           | 50    | 17  |
| 3 | 10              | 6               | 14              | 14    | 8   |
| 4 | 100             | 96              | 105             | 18    | 9   |
| 5 | Depends on plot | Depends on plot | Depends on plot | —     | —   |
| 6 | 19              | 14              | 24              | 14    | 10  |

### Key Formulas

| Measure             | Formula                       |
|---------------------|-------------------------------|
| Median (Q )         | $\frac{n+1}{2}$ th value      |
| Lower Quartile (Q ) | $\frac{n+1}{4}$ th value      |
| Upper Quartile (Q ) | $\frac{3(n+1)}{4}$ th value   |
| Range               | Max – Min                     |
| IQR                 | $Q - Q$                       |
| Decile (D )         | $\frac{k(n+1)}{10}$ th value  |
| Percentile (P )     | $\frac{k(n+1)}{100}$ th value |

### Box-and-Whisker Plot Components

text

Min Q Median Q Max

|||

-----|-----|-----|-----|

| Whisker | Box | Whisker |

- **Box:** Contains 50% of the data (from Q to Q )
- **Whiskers:** Extend to minimum and maximum values
- **Line inside box:** Median

### EXERCISE 11.1 (Continued) - Scatter Diagrams and Correlation

#### Question 7: Scatter Diagram and Line of Best Fit

#### Given Data:

|          |    |    |    |    |    |    |    |    |
|----------|----|----|----|----|----|----|----|----|
| 1st Quiz | 14 | 28 | 34 | 36 | 43 | 45 | 46 | 49 |
| 2nd Quiz | 16 | 20 | 33 | 35 | 38 | 39 | 42 | 43 |

#### 7(i) Scatter Diagram and Line of Best Fit

**Step 1:** Plot the points:

- (14, 16), (28, 20), (34, 33), (36, 35)

- (43, 38), (45, 39), (46, 42), (49, 43)

**Step 2:** Draw a line of best fit through the points.

**Scatter Diagram:**

text

2nd Quiz

^

50 |

|

45 | \* (49,43)

| \* (46,42)

40 | \* (45,39)

| \* (43,38)

35 | \* (36,35)

| \* (34,33)

30 |

|

25 | \* (28,20)

|

20 | \* (14,16)

|

15 |

+---+---+---+---+---+---+---+---+---+--->

10 15 20 25 30 35 40 45 50 1st Quiz

**Step 3:** Draw the line of best fit.

**7(ii) Describe Correlation**

**Observation:** As the 1st quiz score increases, the 2nd quiz score also tends to increase.

**Correlation: Positive Correlation** (moderately strong)

### Question 8: Football Players Test Scores

**Given Data:**

|          |     |     |     |     |     |     |     |     |     |     |
|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1st Test | 20  | 38  | 70  | 40  | 100 | 110 | 50  | 136 | 150 | 80  |
| 2nd Test | 160 | 142 | 130 | 120 | 70  | 50  | 140 | 44  | 36  | 100 |

**8(i) Construct Scatter Diagram and Line of Best Fit**

**Step 1:** Plot the points:

- (20, 160), (38, 142), (70, 130), (40, 120), (100, 70)
- (110, 50), (50, 140), (136, 44), (150, 36), (80, 100)

**Scatter Diagram:**

text

2nd Test

^

180 | \* (20,160)

|

160 | \* (38,142)

|

140 | \* (50,140) \* (70,130)

|

120 | \* (40,120)

|

100 | \* (80,100)

|

80 |

|

60 | \* (100,70)

|

40 | \* (110,50) \* (136,44) \* (150,36)

|

20 |

+-----+-----+-----+-----+-----+-----+-----+-----+-----+----->

20 40 60 80 100 120 140 160 180 1st Test

**Step 2:** Draw the line of best fit (downward sloping).

**8(ii) Describe Correlation**

**Observation:** As the 1st test score increases, the 2nd test score decreases.

**Correlation:** **Negative Correlation** (strong)

**8(iii) Estimate 1st Test Score for 2nd Test = 60**

**Step 1:** Locate 60 on the y-axis (2nd Test).

**Step 2:** From the line of best fit, trace horizontally to the line, then vertically down to the x-axis.

**Estimation:** Approx. **120** on 1st Test

**Answer:** Abdullah's estimated 1st test score **120**

**Question 9: Social Media Hours and GPA**

**Given Data:**

|                          |     |     |     |     |     |     |     |     |     |     |
|--------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Social<br>Media<br>Hours | 0.5 | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
| GPA                      | 4.0 | 3.9 | 3.7 | 3.5 | 3.3 | 3.1 | 2.9 | 2.8 | 2.6 | 2.5 |

### 9(i) Construct Scatter Diagram and Line of Best Fit

**Step 1:** Plot the points:

- (0.5, 4.0), (1, 3.9), (2, 3.7), (3, 3.5), (4, 3.3)
- (5, 3.1), (6, 2.9), (7, 2.8), (8, 2.6), (9, 2.5)

**Scatter Diagram:**

text

GPA

^

4.2 | \* (0.5,4.0)

|

4.0 | \* (1,3.9)

|

3.8 | \* (2,3.7)

|

3.6 | \* (3,3.5)

|

3.4 | \* (4,3.3)

|

3.2 | \* (5,3.1)

|

3.0 | \* (6,2.9)

|

2.8 | \* (7,2.8)

|

2.6 | \* (8,2.6)

|

2.4 | \* (9,2.5)

|

2.2 |

+---+---+---+---+---+---+---+---+---+---+--->

0 1 2 3 4 5 6 7 8 9 10 Hours

**Step 2:** Draw the line of best fit (downward sloping).

**9(ii) Identify the Nature of Correlation**

**Observation:** As social media hours increase, GPA decreases.

**Correlation:** **Negative Correlation** (strong)

**Interpretation:** Higher social media usage is associated with lower GPA.

**9(iii) Estimate GPA for 6.5 Hours**

**Step 1:** Locate 6.5 on the x-axis.

**Step 2:** From 6.5, go vertically up to the line of best fit.

**Step 3:** From that point, go horizontally left to the y-axis.

**Estimation:** Approx. **2.85**

**Answer:** GPA for 6.5 hours **2.85**

**Summary Table**

|   | Correlation         | Key Estimate                   |
|---|---------------------|--------------------------------|
| 7 | Positive (moderate) | —                              |
| 8 | Negative (strong)   | 1st Test 120 for 2nd Test = 60 |
| 9 | Negative (strong)   | GPA 2.85 for 6.5 hours         |

**Key Concepts: Correlation Types****1. Positive Correlation**

- As one variable increases, the other **increases**.
- Line of best fit slopes **upward**.
- **Example:** Study time and test scores.

**2. Negative Correlation**

- As one variable increases, the other **decreases**.
- Line of best fit slopes **downward**.
- **Example:** Social media hours and GPA.

**3. No Correlation**

- No clear relationship between variables.
- Points are scattered randomly.

**Correlation Strength Description**

| Strength    | Description             |
|-------------|-------------------------|
| 0.00 – 0.29 | Weak correlation        |
| 0.30 – 0.49 | Moderate correlation    |
| 0.50 – 0.69 | Strong correlation      |
| 0.70 – 1.00 | Very strong correlation |

**Steps for Constructing Scatter Diagram**

1. **Label axes** with appropriate titles.

2. **Determine scale** for both axes.
3. **Plot points** accurately.
4. **Draw line of best fit** (roughly through middle of points).
5. **Describe correlation** (positive/negative/none).
6. **Make predictions** using the line of best fit.

### Important Notes

#### Line of Best Fit:

- Should have approximately equal points above and below
- Follows the general trend of the data
- Used for making predictions

#### Correlation vs Causation:

- Correlation does not imply causation
- Other factors may influence the relationship