

Exercise walk-through

4.2

Histograms, cumulative frequency and box plots

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1. Unit 3.4 at a glance

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Core S1-S5: data types, table extraction, two-way tables, the chart bank and the basic averages. Extension additions: histograms with UNEQUAL class intervals, cumulative frequency diagrams, box plots, quartiles, inter-quartile range and percentiles.

Must-know: frequency density = frequency over width, area is frequency; cumulative totals plot at UPPER boundaries; median at $n/2$, quartiles at $n/4$ and $3n/4$; grouped mean via midpoints.

3. Extension diagrams

Extension diagrams

Unequal histograms: height is frequency density (widths 2, 3, 5, 10, 15 holding 5, 12, 18, 14, 9 give heights 2.5, 4, 3.6, 1.4, 0.6) and the AREA is the frequency - the 1E specimen marks exactly this.

Cumulative frequency plots at UPPER boundaries (the 1E correction); box plots show the five-number summary with the box spanning the IQR. 60 workers with totals 6, 17, 27, 42, 60 at 10-30 hours: median 21, quartiles 14.1 and 25.8, IQR 11.7.

Check yourself

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Classify data; extract from tables with units; two-way tables that check both ways; the Core chart bank chosen by data type.

Unequal-interval histograms by density; cumulative frequency at upper boundaries with median, quartile and percentile reads; box plots; grouped means; quartiles and the IQR from data or the curve.

Exercises 2.1·2.3

2.1 Classes of widths 4 and 8 hold frequencies 12 and 10. Find both densities. [2]

2.2 For 40 values, at which cumulative frequencies do the median and quartiles read? [3]

2.3 A box plot has minimum 3, Q_1 6, median 8, Q_3 11, maximum 17. Find the IQR and the range. [2]

Exercises 2.1·2.3

2.1 Classes of widths 4 and 8 hold frequencies 12 and 10. Find both densities. [2]

2.1 $12/4 = 3$ and $10/8 = 1.25$.

2.2 For 40 values, at which cumulative frequencies do the median and quartiles read? [3]

2.2 Median at 20; quartiles at 10 and 30.

2.3 A box plot has minimum 3, Q_1 6, median 8, Q_3 11, maximum 17. Find the IQR and the range. [2]

2.3 $\text{IQR} = 11 - 6 = 5$; $\text{range} = 17 - 3 = 14$.

Exercises 2.4·3.2

2.4 A histogram bar of width 5 has density 6. Find its frequency. [2]

3.1 (*Original, 1E family.*) The times 60 workers spend on homework have cumulative frequencies 6, 17, 27, 42, 60 at upper boundaries 10, 15, 20, 25, 30 (hours). (a) State the plotting points. (b) Estimate the median. (c) Estimate the inter-quartile range. [5]

3.2 (*Original.*) A histogram has classes 0–10, 10–20, 20–40, 40–60 with frequencies 30, 20, 30, 10. (a) Compute the densities. (b) A student says the 20–40 class is largest because its bar is tallest. Correct the error using areas. [5]

Exercises 2.4·3.2

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2.4 $5 \times 6 = 30$.

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3.1 (a) Points (10, 6), (15, 17), (20, 27), (25, 42), (30, 60). (b) Worker 30: $20 + 5 \times \frac{3}{15} = 21$ hours. (c) Q_1 : worker 15, $10 + 5 \times \frac{9}{11} = 14.1$; Q_3 : worker 45, $25 + 5 \times \frac{3}{18} = 25.8$; IQR = 11.7 hours.

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3.2 (a) Densities $30/10 = 3$, $20/10 = 2$, $30/20 = 1.5$, $10/20 = 0.5$. (b) By area the 0–10 class holds 30 and the 20–40 class also holds $1.5 \times 20 = 30$ – EQUAL, not larger; height compares frequencies only when widths match.

Exercise 3.3

3.3 (*Original, 2E 40-men family.*) A hall holds 96 m^2 (2 s.f.); safety needs 5.1 m^2 per person (1 d.p.). Using bounds, find the least whole number of people that must be able to fit. [3]

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3.3 LB floor 95.5, UB per person 5.15: $\frac{95.5}{5.15} = 18.5\dots$, so at least 19 people.

Local review guidance: densities before drawing, upper boundaries before plotting; interpolation inside the correct class; area comparisons for unequal widths. This is authored classroom guidance.