

Box and Whisker Plots

Introduction

This leaflet will show how to calculate box and whisker plots. Box Plots are summary plots based on the median and interquartile range which contains 50% of the values. Whiskers extend from the box to the highest and lowest values, excluding outliers. A line across the box indicates the median.

Box and Whisker Plots

Worked example

For the following ordered data construct a box plot.

3, 5, 5, 6, 6, 7, 8, 10, 11, 12, 12

Median or 50th Percentile or Q_2

$$\begin{aligned} & \text{is at the } \frac{n+1}{2} \text{ value.} \\ & = \frac{11+1}{2} = 6\text{th value} \\ Q_2 & = 7 \end{aligned}$$

Lower Quartile or 25th Percentile or Q_1

$$\begin{aligned} & \text{is at the } \frac{n+1}{4} \text{ value.} \\ & = \frac{11+1}{4} = 3\text{rd value} \\ Q_1 & = 5 \end{aligned}$$

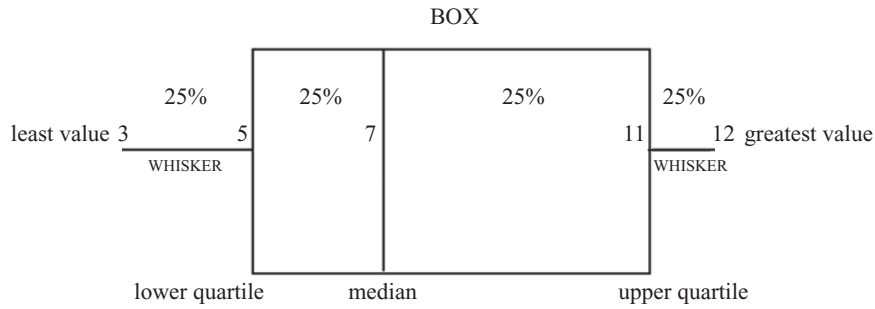
Upper Quartile or 75th Percentile or Q_3

$$\begin{aligned} & \text{is at the } \frac{n+1}{4} \times 3 \text{ value.} \\ & = \frac{11+1}{4} \times 3 = 9\text{th value} \\ Q_3 & = 11 \end{aligned}$$

Interquartile range or IQR

$$\begin{aligned} & = \text{Upper Quartile} - \text{Lower Quartile} \\ & = Q_3 - Q_1 \\ & = 11 - 5 \\ & = 6 \end{aligned}$$

The middle 50% of the data has range = 6.



Extreme Values

The “Whiskers” extend to the smallest and largest data point $\leq 1.5 (IQR)$ from Q_1, Q_3 .

Outliers are points lying between $1.5 \times IQR$ and $3 \times IQR$ from Q_1, Q_3 .

Extreme Outliers are points lying beyond $3 \times IQR$ from Q_1, Q_3 .

Fences

Inner Fences are $1.5 \times IQR$ from the edges of the box: i.e. 1.5 box lengths.

Outer Fences are $3 \times IQR$ from the edges of the box: i.e. 3 box lengths.

Exercises

For the following:

- Find the median, lower quartile, upper quartile and the interquartile range.
- Draw a box and whisker plot, identifying any outliers.

Remember to order the data before you begin.

- 32 30 36 27 24 33 34
- 998 92 432 223 785 335 367 444 457 458 488

Answers

- $Q_1 = 27, Q_2 = 32, Q_3 = 34 \quad IQR = 7$
No outliers.
- $Q_1 = 335, Q_2 = 444, Q_3 = 488 \quad IQR = 153$
Outliers=785, 92, extreme outliers = 998