

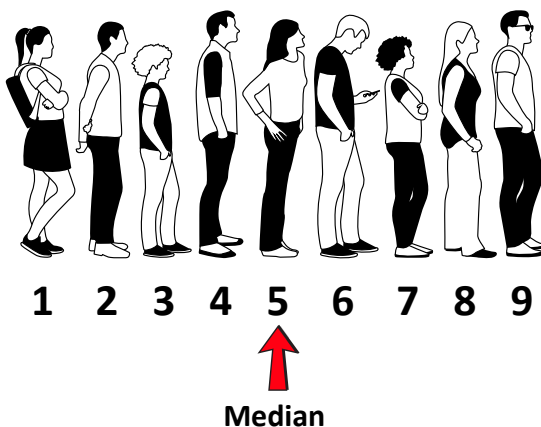
Box Plots - GCSE Maths

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1. Introduction

- **Box plot** is an important concept used in **Statistics** to represent quantities related to a given dataset graphically and helps us to provide conclusions about that dataset.
- The box plot includes graphical representation of these five quantities - **Median**, **Maximum Value**, **Smallest value**, **First quartile** and the **Third Quartile**.



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2. Box Plots

- Basically **Box Plots** are graphical representation of the following quantities which describe a dataset's important features -

Example: 2 3 2 4 7 8 9 0 6 3 5 4 1 6 8

Total values are 15 the increasing order of these will be -

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

- **Median** - When the elements of the dataset are sorted(in increasing or decreasing order) then the **middle element** is called the Median.

Median will be the middle element that is 4, we can also use the following formula to find median -

$$\text{Median} = \left(\frac{n+1}{2} \right) \text{th element}$$

n = No. of elements

$$\begin{aligned} \text{Median} &= \frac{n+1}{2} = \frac{15+1}{2} \\ &= \frac{16}{2} = 8\text{th element} = 4 \end{aligned}$$

- **Greatest value** - The maximum value among of dataset's elements.
- In the given example the greatest value is 9.
- **Smallest value** - The smallest value among the elements.
- In the given example the smallest value is 0.

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- **Quartile(1st Quartile)** - Basically it is first 25% part of the data. The formula to find 1st quartile is -

$$\text{1st Quartile} = \frac{n + 1}{4}$$

- In the given example -

$$\begin{aligned}\text{1st Quartile} &= \frac{15 + 1}{4} = \frac{16}{4} \\ &= 4\text{th value} = 2\end{aligned}$$

- **Quartile(3rd Quartile)** - Basically it is first 75% part of the data. The formula to find 3rd quartile is -

$$\text{3rd Quartile} = 3 \left(\frac{n + 1}{4} \right)$$

- In the given example -

$$\begin{aligned}\text{3rd Quartile} &= 3 \left(\frac{15 + 1}{4} \right) \text{th} \\ &= 3 \times 4 \\ &= 12\text{th value} = 7\end{aligned}$$



$$\text{No. of Elements} = 15$$

$$\text{1st Quartile} = 2$$

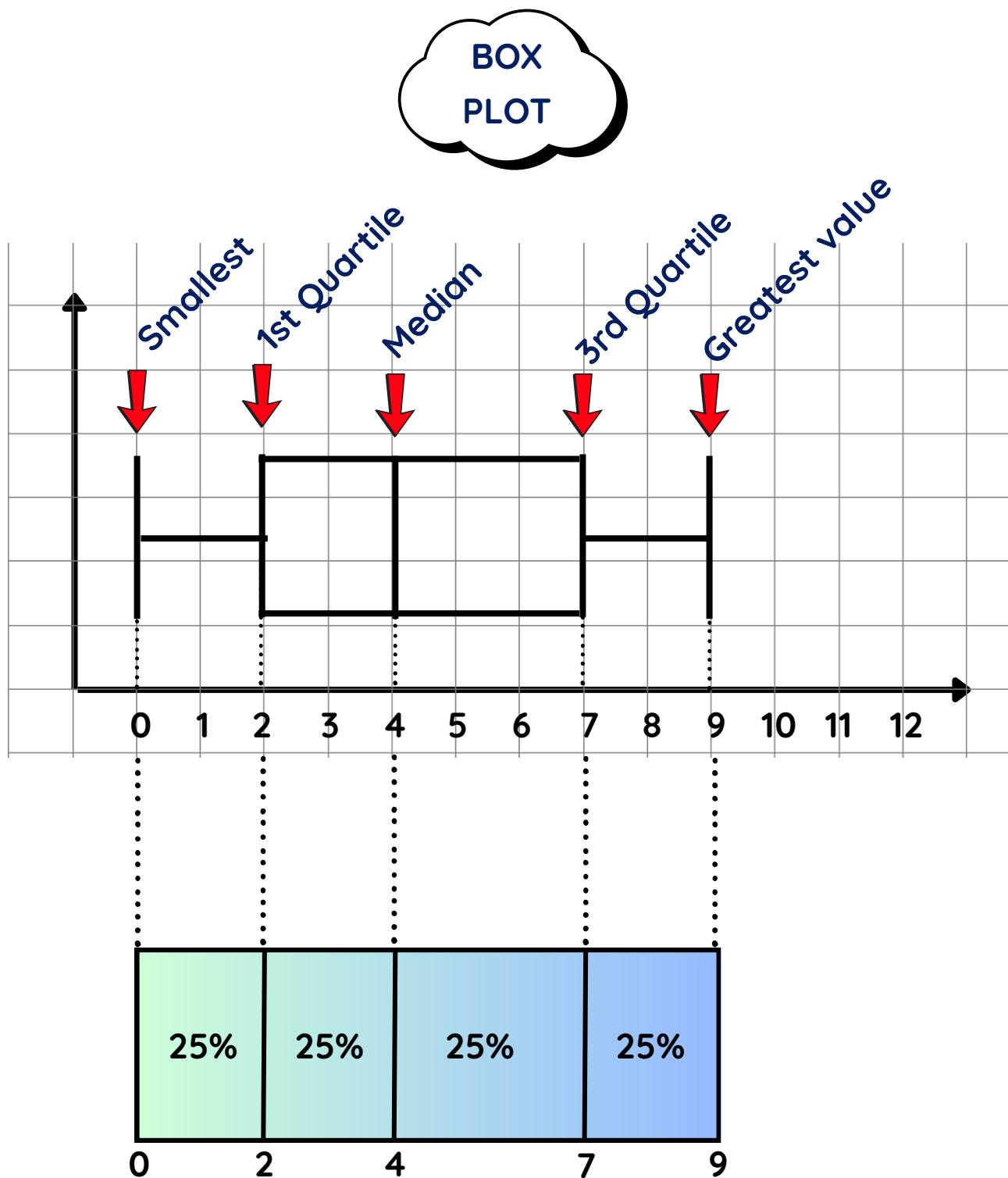
$$\text{3rd Quartile} = 7$$

$$\text{Median} = 4$$

$$\text{Greatest value} = 4$$

$$\text{Smallest Value} = 0$$

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It should be noted that in a box plot graphical representation, upper and lower quartiles are connected like a Rectangle and the median lies within that rectangle. Also, the 1st quartile is connected to the smallest value using a horizontal line, and similarly, the 3rd quartile is connected to the greatest value.

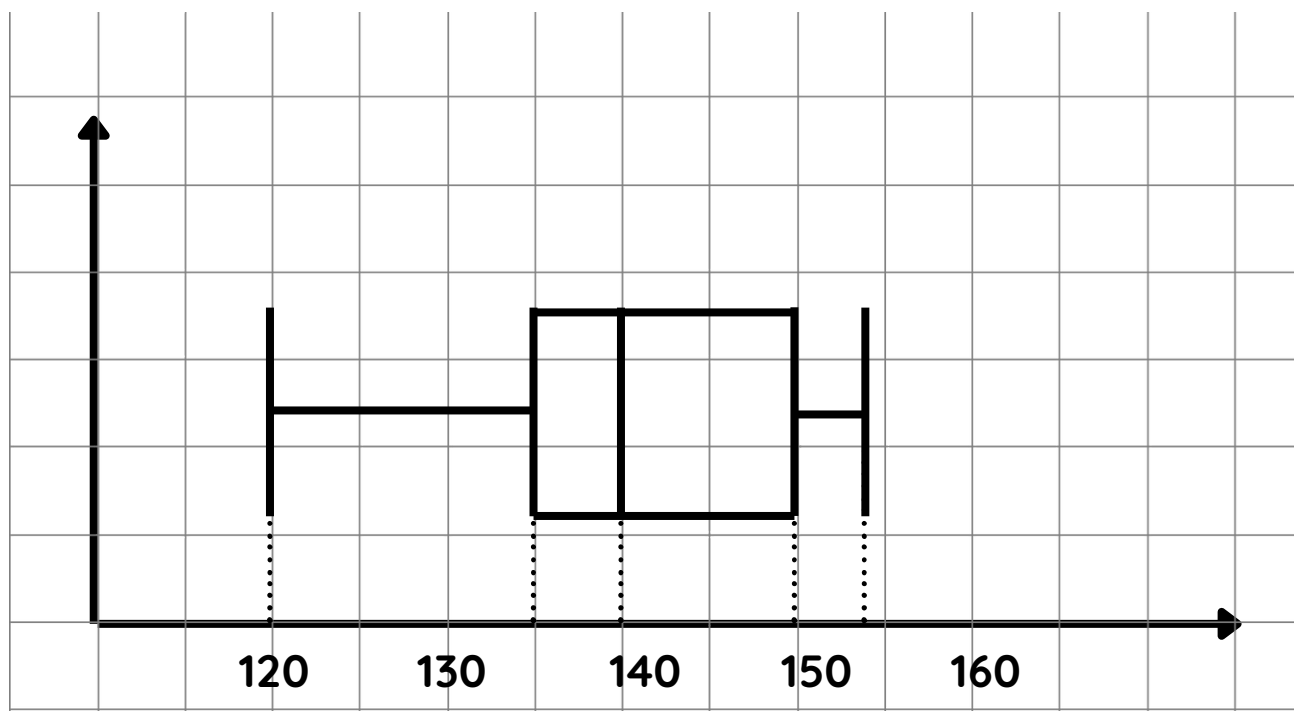
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3. Examples including even and odd number of elements

Example (1): Draw the box plot for the following dataset -

Minimum	LQ	Median	UQ	Maximum
120g	135g	140g	150g	154g

Solution -



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Example (2): Following is a dataset given that is the time taken by 11 students to complete an essay -

15 18 19 21 22 25 26 26 28 30 31

- (a) Write down the median time taken
- (b) Find out the upper and lower Quartiles
- (c) Draw the box plot for the dataset

Solution:

(a) Median for the dataset is -

$$\begin{aligned}\text{Median} &= \frac{n+1}{2} = \frac{11+1}{2} \\ &= \frac{12}{2} \\ &= \text{6th element} = 25\end{aligned}$$

Median = 25

(b) The Upper and Lower Quartiles -

$$\begin{aligned}\text{Lower Quartile} &= \left(\frac{n+1}{4} \right) = \frac{11+1}{4} \\ &= \frac{12}{4} \\ &= \text{3rd element} = 19\end{aligned}$$

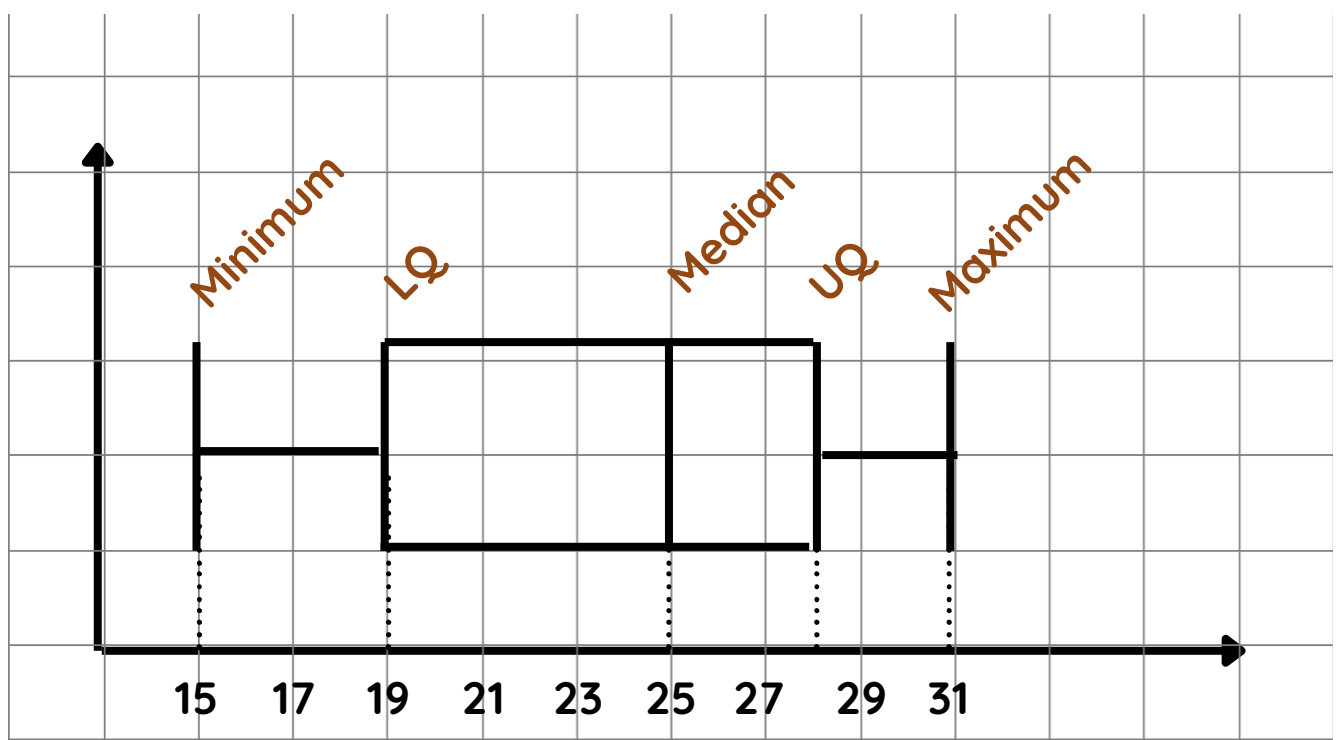
Lower Quartile = 19

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$$\begin{aligned}\text{Upper Quartile} &= 3 \left(\frac{n+1}{4} \right) = 3 \left(\frac{11+1}{4} \right) \\ &= 3 \left(\frac{12}{4} \right) \\ &= 9\text{th element} = 28\end{aligned}$$

Upper Quartile = 28

(c) Box Plot for the given dataset -



Minimum = 15

Lower Quartile = 19

Maximum = 31

Upper Quartile = 28

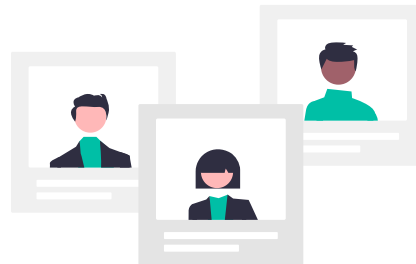
Median = 25

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Example(3): Here is the data collected from a company of the experience of their 10 employees -

3 3 7 8 8 10 11 12 15 18

Draw the box plot for the data -



Answer: To draw the box plot for the given dataset containing an even number of elements first we find Median, Quartiles and Minimum and Maximum value -

Maximum Value = 18

Minimum Value = 3

Median = Average of $(\frac{n}{2})$ th + $(\frac{n}{2} + 1)$ th

= Average of 5th and 6th value

$$= \frac{8 + 10}{2} = \frac{18}{2} = 9$$

Median = 9

3 3 7 8 8 10 11 12 15 18

1st Quartile: Middle element of 1st half
3rd Quartile: Middle element of 2nd half

1st Quartile = 7

3rd Quartile = 12

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Final Answer:

1st Quartile = 7

Minimum Value = 3

Maximum Value = 18

3rd Quartile = 12

Median = 9

