

# Teachers Teaching with Technology

T<sup>3</sup> Scotland



T<sup>3</sup> EUROPE

## Statistics

Medians, Quartiles and Boxplots

## Higher Still Statistics Median, Quartiles and Boxplots

The median of a set of data is one measure of the average or centre of the data. When the data is arranged in order, there should be an equal number of data items above and below the median. If the set has an odd number of items, then the median is one of the items. If the set has an even number of items, then the median is the mean of two items.

### Example 1

Find the median for this set of 24 test marks.

100	100	97	95	92	88	85	83
83	81	80	77	75	71	70	69
66	65	63	60	58	54	51	50

### Solution:

Since there are an even number of test marks the median will be the mean of the the middle pair of numbers in an ordered list. i.e. The median will be the mean of the 12th and 13th data items if this list is placed in order.

On the TI-83, the median of any List can be found using LIST MATH (Fig 1 and 2)



Fig 1

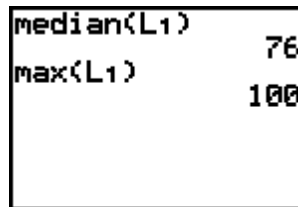


Fig 2

The Lower Quartile, Q1, of a data set can be described as the median of the lower half of the items and the upper quartile, Q3, as the median of the upper half. If the median is one of the elements, it is not included in either half.

### Example 2

Find the quartiles for the set of test scores.

### Solution:

The lower half of this data set has 12 items, so Q1 is the 6th item, in this case 88. Similarly, the upper quartile Q3 is the 18th item, 65.

On the Ti-83 to view the statistical results for a list of data, use STAT CALC 1: 1-Var Stats (Fig 3) followed by the list name (Fig 4).

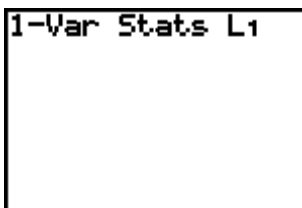


Fig 3

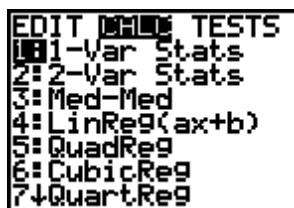


Fig 4

Several statistics appear (fig 5). Use the down arrow several times to see the Quartiles, and Median (Fig 6)

```

1-Var Stats
x̄=75.54166667
Σx=1813
Σx²=142393
sx=15.37354918
σx=15.04985926
n=24
    
```

Fig 5

```

1-Var Stats
n=24
minX=50
Q1=64
Med=76
Q3=86.5
maxX=100
    
```

Fig 6

Also use the VARS 5: Statistics PTS menu (Fig 7) to bring quartiles to the home screen (Fig 8). These variables are meaningful after the 1-Var Stats command has been used.

```

XY Z EQ TEST
3↑x2
4↓w2
5=x3
6=w3
7=Q1
8=Med
9=Q3
    
```

Fig 7

```

Q1           64
Med          76
    
```

Fig 8

The Max, Min and Quartiles of a data set are often displayed in a box and whisker plot (Boxplot).

### Example 3

Create a boxplot of these test marks.

### Solution:

To create this plot use STAT PLOT, and select a plot 1, 2 or 3. For type select the fifth icon. Choose the Xlist to be the List where the data is stored (Fig 9). Set an appropriate window by using ZOOM 9: ZoomStat (Fig 10).

```

2ND PLOT2 Plots
Off Off
Type: [L1] [L2] [L3] [L4] [L5]
Xlist:L1
Freq:1
    
```

Fig 9

```

2ND MEMORY
3↑Zoom Out
4↓ZDecimal
5=ZSquare
6=ZStandard
7=ZTrig
8=ZInteger
9=ZoomStat
    
```

Fig 10

Press GRAPH to see the Boxplot (Fig 11)

TRACE and use the cursor keys to read the extremes and quartiles (Fig 12).

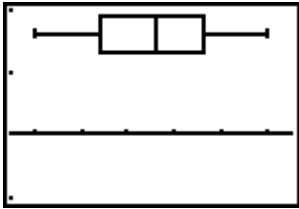


Fig 11

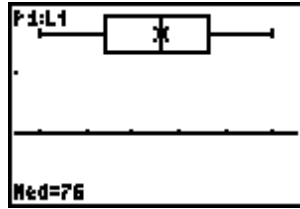


Fig 12

Box plots are particularly effective for comparison of two or more sets of data.

**Example 4:**

Suppose another class sitting the same test score these marks  
 94 93 90 84 81 81 78 75 74  
 70 64 61 54 53 48 40 32

Create two box plots to compare their performance with the original class.

**Solution:**

Enter the new scores into another list, such as L2.  
 Each class is set up in a STAT PLOT (Fig 13).

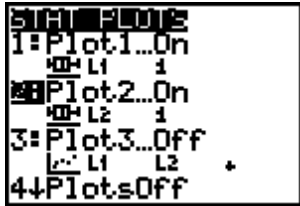


Fig 13

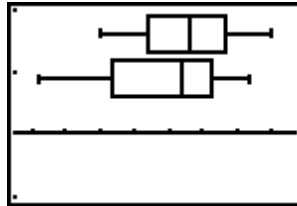


Fig 14

The difference between the third quartile Q3 and the first quartile Q1, is called the interquartile range. It measures the spread of the middle 50% of the data. In this example, the interquartile range of the marks is 10.5

Any data item value less than  $Q1 - 1.5(Q3 - Q1)$  or greater than  $Q3 + 1.5(Q3 - Q1)$  is called an outlier. A modified boxplot will not put outliers on the whisker, but plot them as single points. The whisker will go to the smallest and largest data items that are not outliers.

**Example 5**

Suppose one student from the original class takes the test late and scores 22.  
 Create a modified box plot for the original class.

**Solution:**

Add a score of 22 to L1 and choose the modified box plot icon, icon 4 in the STAT PLOT menu, choose how the outliers will be denoted (Fig 15). We see a different box plot with the outlier plotted separately and the next value,50, at the end of the whisker( Fig 16).

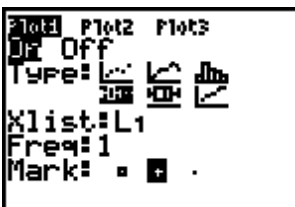


Fig 15

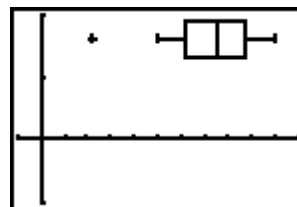


Fig 16

## Exercises

1. Compute the minimum, maximum, median and quartiles for the running speeds of the following creatures.  
Test for outliers.  
Create a boxplot or modified boxplot for the data.

Cheetah	70	Cat	29	Lion	52
Coyote	40	Hyena	40	Greyhound	40
Rabbit	35	Pig	11	Tortoise	0.18
Snail	0.03	Man	28		

2. Compute the minimum, maximum, median and quartiles for heights of the following pupils.

59 61 63 64 65 68 68 69 71 72 73 74 75 75

3. A company has two machines that fill bottles of soft drinks. Samples from each machine show the following number of millilitres per can.

Machine 1: 320, 319, 319, 321, 318, 317, 319, 316, 315, 320

Machine 2: 318, 321, 315, 315, 314, 315, 318, 317, 320, 313

Create a boxplot for each machine.  
Sketch one above the other.  
Describe the performance of the machines.