

# Box-and-Whisker Plots

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# CONCEPT 1

## Box-and-Whisker Plots

### Introduction

*It's all about the Dogs*



Kelly loves dogs. She has been researching the sled dogs connected with the Iditarod. She has noticed that the dogs are very well loved by the mushers who care for them and that there seems to be a very unique connection between them.

Kelly was pleased to see that there are veterinary services for the dogs along the trail route. Here the dogs can receive medical attention if they become injured along the way.

Most of the teams begin with between 12 and 16 dogs, but most don't finish with that many. Some of the dogs can become tired or hurt, and sometimes a dog can die along the journey too.

Kelly did some research about the 2010 dog teams and discovered that the top ten teams had arrived back with somewhere between 7 and 13 dogs.

She wrote these statistics down in her notebook.

11, 11, 12, 10, 9, 10, 13, 7, 9, 7

Kelly wants to create a display of this information. She has decided to create a box-and-whisker plot to show the number of dogs who finished in 2010 in the top 10 teams.

**Do you have an idea how to do this? If you do, then draw a box-and-whisker plot now in your notebook using this data. If not, then pay attention to this lesson and you will learn all that you need to know about box-and-whisker plots.**

### *What You Will Learn*

By the end of this lesson you will be able to complete the following:

- Draw a box-and-whisker plot to represent given data.
- Use a box-and-whisker plot to find the median, quartiles, and extremes of a set of data.
- Compare and interpret double box-and-whisker plots of real-world data.

**Teaching Time****I. Draw a Box-and-Whisker Plot to Represent Given Data**

In the past few sections you have learned all about different ways to analyze and display data. Now we are going to learn about a new one it is called a box-and-whisker plot.

**A box-and-whisker plot depicts the distribution of data items.**

Recall that the median is the middle number when the data is arranged in order from the least to greatest. The median separates the data into two equal parts. **On a box-and-whisker plot, the median represents half or fifty percent of all of the data points.**

**Data can then be separated into quartiles.** *Quartiles* divide data into four equal parts. The median is the *middle quartile*. The *lower quartile* is the median of the lower half of the data. The lower quartile represents one fourth or twenty-five percent of the smaller data points. The *upper quartile* is the median of the upper part of the data. The upper quartile represents one fourth or twenty-five percent of the largest data points.

$$\begin{array}{ccccccc} \underline{62, 67, 75, 76, 78} & 81, & 81, & \underline{83, 85, 88, 90, 92} \\ \text{Lower Quartile} & & \text{Median} & & \text{Upper Quartile} \\ & & 81 = \text{Median} & & \\ & & 75 = \text{Median of Lower Quartile} & & \\ & & 88 = \text{Median of Upper Quartile} & & \\ & & 62 \text{ is the smallest value. } & & 92 \text{ is the largest value.} \end{array}$$

**Let's look at the steps that we need to follow to build a box-and-whisker plot. Here is an example**

Example

Create a box-and-whisker plot to display the data below.

45, 58, 34, 42, 52, 49, 50, 45, 51

**Step 1:** To determine the median of the set of data, arrange the data in order from least to greatest. Identify the data value in the middle of the data set. In this case, the median is 49.

34, 42, 45, 45, 49, 50, 51, 52, 58

**Step 2:** Identify the median for the lower quartile. In this case, two data values share the middle position in the lower quartile. Recall that when two data values share the middle position, find the mean. To find the mean, add the data values and then divide by two. The median of the lower quartile is 43.5.

$$\begin{array}{c} \underline{34, 42, 45, 45, 49, 50, 51, 52, 58} \\ 42 + 45 = 87 \\ 87 \div 2 = 43.5 \end{array}$$

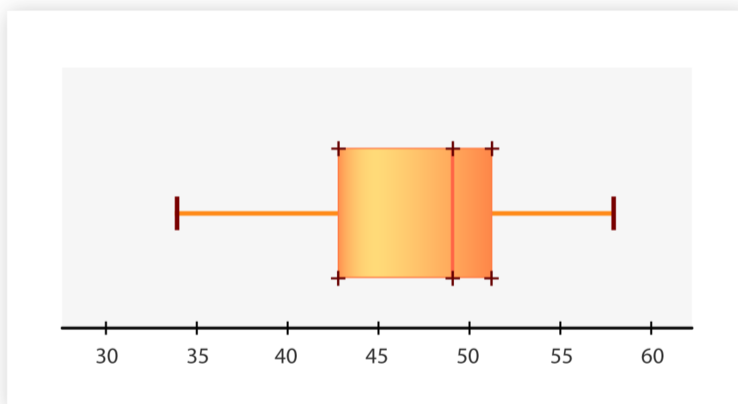
**Step 3:** Identify the median of the upper quartile. Again, two data values share the middle position. Therefore, you must determine the mean of the two numbers. Since the numbers 51 and 52 are only one away from each other, the median is the number in the exact middle of the two. In this case, the median of the upper quartile is 51.5. This method works whenever the two numbers that share the middle position are one away from each other.

34, 42, 45, 45, 49, 50, 51, 52, 58

$$51 + 52 = 103$$

$$103 \div 2 = 51.5$$

**Step 4:** Draw a number line. The first value on the number line should be near the smallest number in the data set. In this case, the smallest number is 34. Therefore, the number line will start at 30. The last value on the number line should be near the largest number in the set of data. The largest number in the data set is 58. Therefore, the number line will end at 60. Because the difference in the data values is not that great, the number line will be labeled by fives.

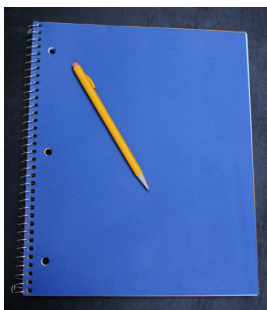


The smallest value, 34, is marked on the number line as “I.” The largest value, 58, is marked on the number line as “I.”

The median of the first, second, and third quartiles are marked as “+.”

**Step 5:** Draw a box around the first, second, and third quartiles. Draw whiskers from the box to the smallest and largest values.

**Step 6:** Give the box-and-whisker plot a title.



*Take a few minutes to write these steps down in your notebook. Then continue with the next example.*

Example

The data values on the table below depict the number of televisions sold at a department store each month for nine months. Create a box-and-whisker plot to display the data.

TABLE 1.1:

April	May	June	July	August	September	October	November	December
110	98	91	102	89	95	108	118	152

**Step 1:** To determine the median of the set of data, arrange the data in order from least to greatest. Identify the data value in the middle of the data set. For this set of data, 102 is the median.

89, 91, 95, 98, 102, 108, 110, 118, 152

**Step 2:** Identify the median for the lower quartile. Again, since two data values share the middle position, find their mean. The median for the lower quartile is 93.

$$\underline{89, 91, 95, 98}, 102, 108, 110, 118, 152$$

$$91 + 95 = 186$$

$$186 \div 2 = 93$$

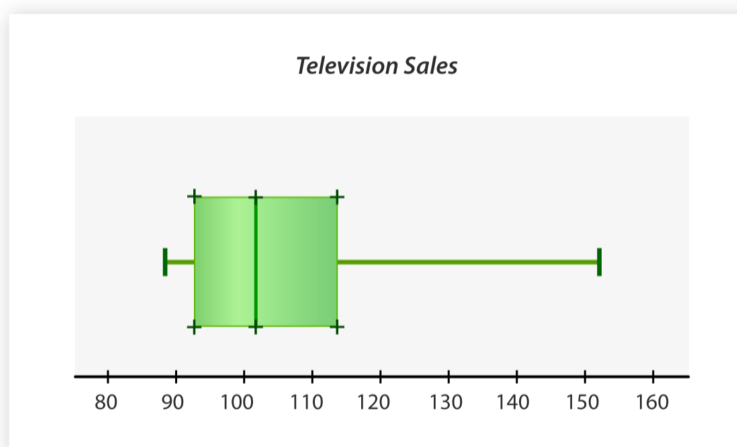
**Step 3:** Identify the median of the upper quartile. Remember to find the mean of the two data values that share the middle position. The median of the upper quartile is 114.

$$89, 91, 95, 98, 102, \underline{108, 110, 118, 152}$$

$$110 + 118 = 228$$

$$228 \div 2 = 114$$

**Step 4:** Draw a number line. The first value on the number line should be near the smallest number in the data set. In this case, the smallest number is 89. Therefore, the number line will start at 80. The last value on the number line should be near the largest number in the set of data. The largest number in the data set is 152. Therefore, the number line will end at 160. In this case, label the number line by tens.



The smallest value, 89, is marked with a “I” at the end of the whisker in the lower quartile. The largest value, 151, is marked with a “I” at the end of the whisker in the upper quartile.

The median of the first, second, and third quartiles are marked with a “+.”

**Step 5:** Draw a box around the first, second, and third quartiles. Draw whiskers from the box to the smallest and largest values.

**Step 6:** Give the box-and-whisker plot a title.

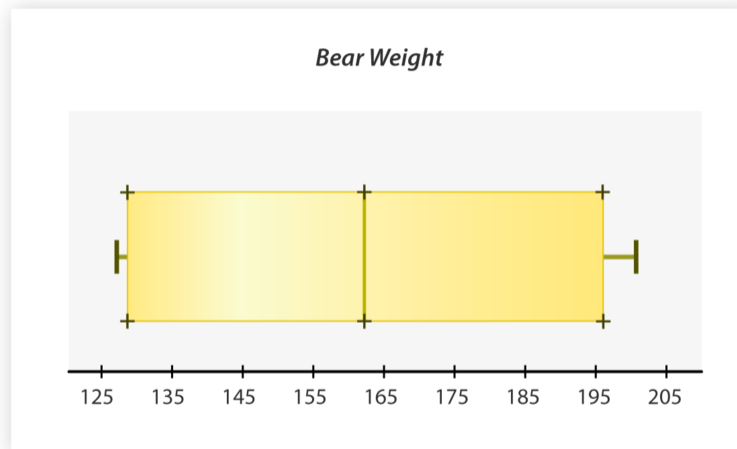
## II. Use a **Box-and-Whisker Plot to Find the Median, Quartiles and Extremes of a Set of Data**

Now that you understand how to create a box-and-whisker plot, we can also use created ones to examine data. Using box-and-whisker plots we can draw inferences and make conclusions.

Let's look at an example.

Example

The weight of bears varies between species. Weight also varies within species as a result of habitat and diet. The box-and-whisker plot was created after recording the weight (in pounds) of several black bears across the country. Use the box-and-whisker plot to answer the questions below.



The number line is labeled by tens. Notice that each section on the number line has been divided into fifths. Therefore, each mark on the number line represents two. This is important to note prior to answering the questions below.

**What are the highest and lowest weights represented on the box-and-whisker plot?** The lowest value or weight is 127 pounds. The highest value or weight is 201 pounds.

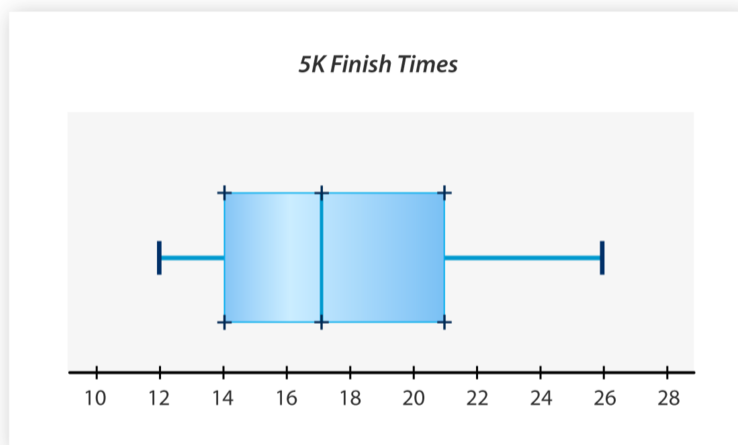
**What is the median weight for a black bear?** The median weight is 163 pounds.

**What is the median weight for the lower quartile?** The median weight of the lower quartile is 129 pounds.

**What is the median weight for the upper quartile?** The median weight of the upper quartile is 196 pounds.

Example

The box-and-whisker plot below was created after recording amount of time it took for several runners to finish a 5K race. Use the box-and-whisker plot to answer the questions below.



The number line on the box-and-whisker plot is labeled by twos. Notice that there is only one section in between each labeled value. Therefore, each mark on the number line represents one. This is important to note when answering the questions below.

**Identify the first and last finish times for the race.** The first finish time or the smallest value identified on the box-and-whisker plot is 12 minutes. The last finish time or largest value on the box-and-whisker plot is 26 minutes.

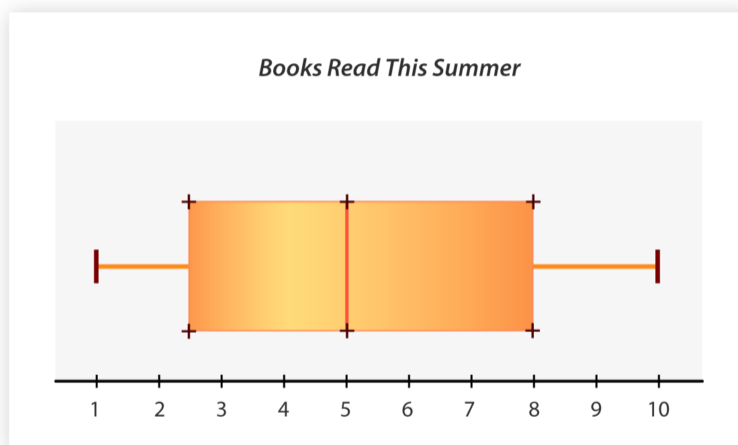
**Identify the median finish time for the race.** The median finish time is 17 minutes.

**What was the median finishing time in the lower quartile?** The median of the lower quartile is 14 minutes.

**What was the median finishing time in the upper quartile?** The median of the upper quartile is 21 minutes.

Example

The box-and-whisker plot below depicts the number of books students read during summer vacation. Write a paragraph to describe the data on the box-and-whisker plot.



**Here is a paragraph that could be written to describe the data.**

The least amount of books read is one. The greatest amount of books read is ten. Five is the median number of books read. Because the number line is labeled by ones, each section in between each number represents one-half. Therefore, the median number of books read in the lower quartile is two and one-half. The median number of books read in the upper quartile is eight. You can see that the data is split evenly. Fifty percent of the students read more than five books. Fifty percent of the students read less than five books.

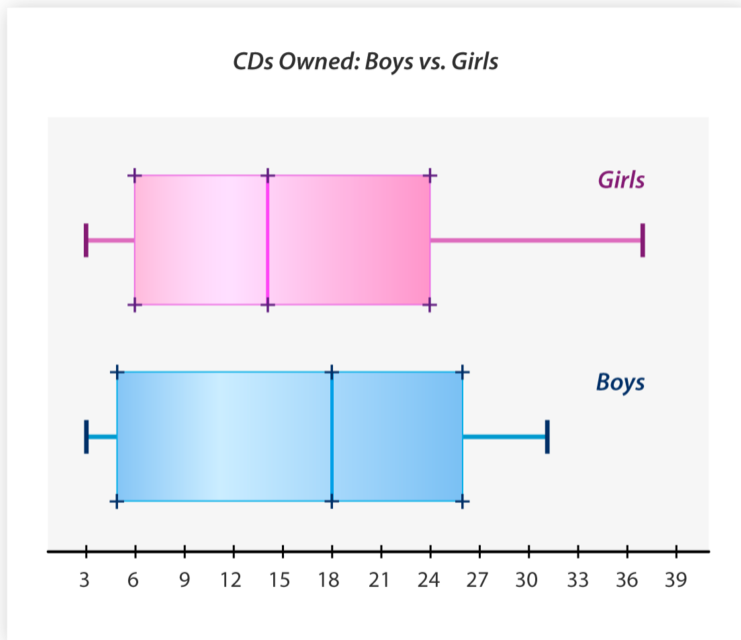


### III. Compare and Interpret Double Box-and-Whisker Plots of Real-World Data

Two sets of data can be compared by making two box-and-whisker plots on one number line. This is called a *double box-and-whisker plot*.

Example

The double box-and-whisker plot compares the number of CDs owned by boys and girls in the seventh grade. Analyze the data to answer the questions below.



**Compare the median number of CDs owned by boys and girls.** The median number of CDs owned by boys is four more than the girls. The median number of CDs owned by boys is 18. The median number of CDs owned by girls is 14.

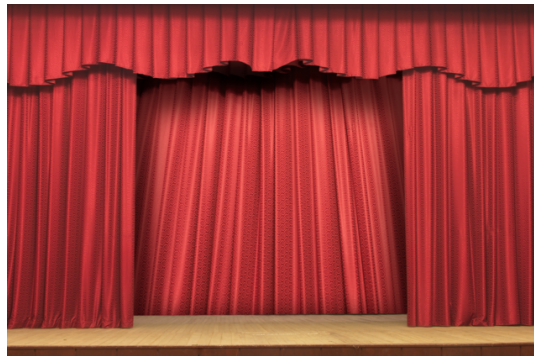
**What is the least number of CDs owned by boys and girls?** The smallest amount of CDs owned by both boys and girls is 3.

**Identify the greatest number of CDs owned by both girls and boys.** The greatest amount of CDs owned by girls is 37. The greatest amount of CDs owned by boys is 31.

**What conclusions can be drawn about the number of CDs owned by girls?** You can see that a larger range of the data values falls in the upper quartile. Therefore, the half of the girls that own more than the median number of CDs has a wider spread in the number of CDs they own.

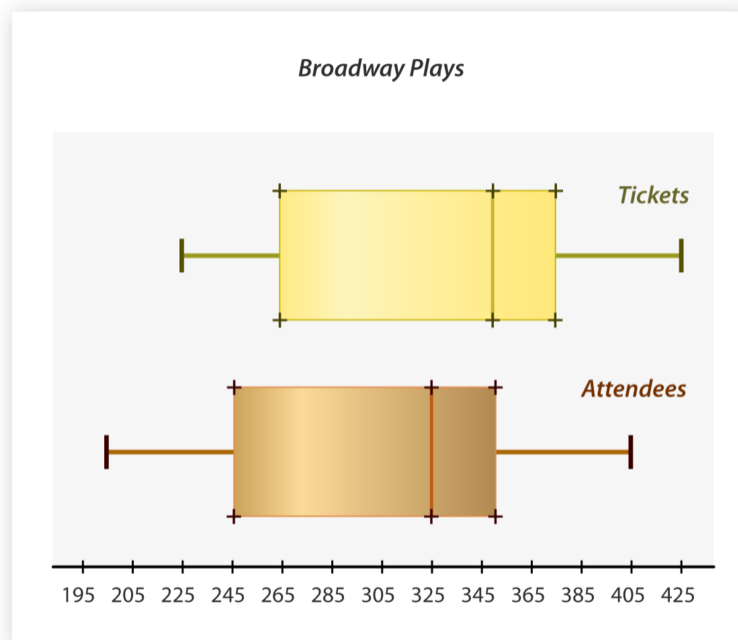
**What conclusions can be drawn about the number of CDs owned by boys?**

You can see that more than half of the data range falls in the lower quartile. Therefore, the half of the boys that own less than the median number of CDs has a greater spread in the number of CDs owned by each boy.



Example

The double box-and-whisker plot below compares the number of tickets purchased for various Broadway plays with the number of people who actually attended. Use the data to answer the questions below.



**Describe the least and greatest amounts of tickets purchased.** The smallest quantity of tickets purchased is 225. The greatest number of tickets purchased is 425.

**Describe the range in attendance for the plays.** The range between the greatest and least number of attendees is 205. The least number of attendees is 200. The greatest number of attendees is 405.

**Compare the data for number of tickets purchased with the data for actual attendance.** It is evident that not all tickets purchased were used to attend the shows. The median number of tickets purchased is 350. The median number of attendance is 325. The majority of the data values fall in the lower quartile for both sets of data, purchases and attendance.

**You can see how useful box-and-whisker plots are for analyzing and interpreting data.**

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## Real Life Example Completed

### *It's all about the Dogs*



**Here is the original problem once again. Reread it and then create a box-and-whisker plot using the data provided. After that, check your work with Kelly's box-and-whisker plot.**

Kelly loves dogs. She has been researching the sled dogs connected with the Iditarod. She has noticed that the dogs are very well loved by the mushers who care for them and that there seems to be a very unique connection between them.

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Kelly did some research about the 2010 dog teams and discovered that the top ten teams had arrived back with somewhere between 7 and 13 dogs.

She wrote these statistics down in her notebook.

11, 11, 12, 10, 9, 10, 13, 7, 9, 7

Kelly wants to create a display of this information. She has decided to create a box-and-whisker plot to show the number of dogs who finished in 2010 in the top 10 teams.

**Now let's create a box-and-whisker plot to display the data.** First, we write the data in order from least to greatest.

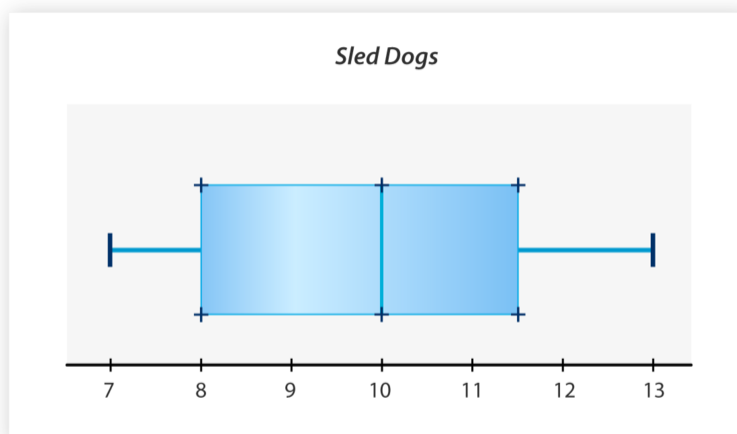
7, 7, 9, 9, 10, 10, 11, 11, 12, 13

The median of all the data is 10.

The median of the lower quartile is 8.

The median of the upper quartile is 11.5

Here is the box-and-whisker plot.



## Vocabulary

Here are the vocabulary words that are found in this lesson.

**Box-and-Whisker Plot** A visual way of organizing data by using median scores to organize data.

**Median** the middle value of a set of data.

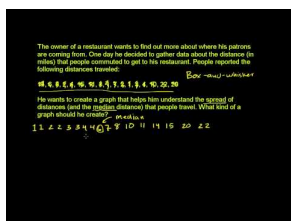
**Quartile** the two halves of the data around the median.

**Lower quartile** the half of the data from the median to the lowest value in the set.

**Upper quartile** the half of the data from the median to the upper value in the set.

**Double box-and-whisker plot** when two different sets of data is displayed on the same number line.

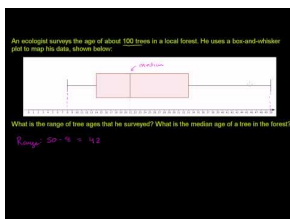
## Technology Integration



**MEDIA**

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**MEDIA**

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## Time to Practice

Directions: Use each set of data to work with box-and-whisker plots.

12, 13, 15, 17, 21, 22, 24, 26, 28, 30, 31

1. What is the median of the set of data?
2. What is the median of the lower quartile?
3. What is the median of the upper quartile?
4. What is the lowest value whisker?
5. What is the highest value whisker?
6. Use the data to create a box-and-whisker plot.

26, 27, 29, 30, 32, 35, 41, 42, 44

7. What is the median of the set of data?
8. What is the median of the lower quartile?
9. What is the median of the upper quartile?
10. What is the lowest value whisker?
11. What is the highest value whisker?
12. Use the data to create a box-and-whisker plot.

100, 105, 107, 109, 110, 120

13. What is the median of the data?
14. What is the median of the lower quartile?
15. What is the median of the upper quartile?
16. What is the lowest value whisker?
17. What is the highest value whisker?
18. Use the data to create a box-and-whisker plot.

19. Create a box-and-whisker plot for the given data: 87, 85, 89, 92, 94, 97, 102, 105, 105, 113, and 108.

20. The table below depicts the number of students in each grade at Keys School. Create a box-and-whisker plot to display the data from the table.

<i>K</i>	<i>1<sup>st</sup></i>	<i>2<sup>nd</sup></i>	<i>3<sup>rd</sup></i>	<i>4<sup>th</sup></i>	<i>5<sup>th</sup></i>	<i>6<sup>th</sup></i>	<i>7<sup>th</sup></i>	<i>8<sup>th</sup></i>
64	75	76	71	80	83	95	92	91

21. Use the data below to create a double box-and-whisker plot

Data Set 1: 25, 28, 22, 21, 23, 28, 29, 32, 31, 29

Data Set 2: 35, 38, 28, 31, 26, 30, 32, 25, 26, 34