| Grade Level/Course: 6th |
|---|
| **Lesson/Unit Plan Name: Box Plots Demystified** |
| **Rationale/Lesson Abstract:** This lesson is designed to introduce the parts of a box plot, and to demonstrate how to construct a box plot from collected data. |
| **Timeframe: Two lessons of one hour each.** |
| **Common Core Standard(s): 6.SP.4, 6.SP.5c**
Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
Summarize numerical data sets in relation to their context, such as by giving quantitative measures of center (median/and or mode) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. |

Instructional Resources/Materials:

Lesson 1
➢ Warm-Up for each student
➢ Poster paper for vocabulary/demo box plot, markers
➢ "Making a Box Plot" worksheet for each student

Lesson 2
➢ Warm-Up for each student
➢ "Box Plots: The Age of Pennies" worksheet for each student
➢ 15 pennies for each group of 3 students
➢ 1 plastic cup for each set of pennies
➢ class set of rulers (optional)

Background Information:

1. This is an example of a generic box plot with all of the parts labeled by the corresponding vocabulary words.
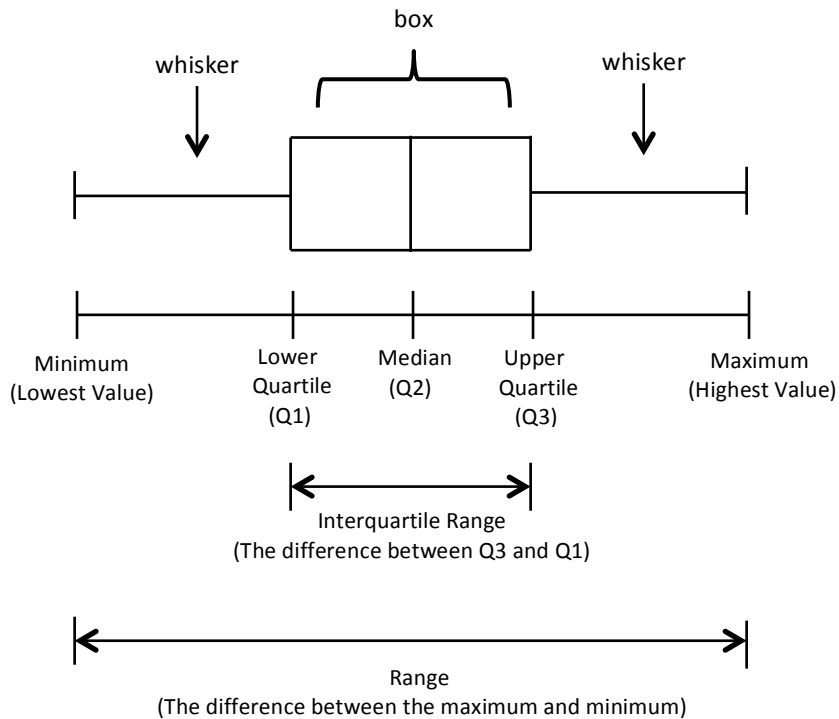
Box Plot Background : Box plots, also known as Box and Whisker plots, are one way to show the distribution, or spread, of a set of data. The "box" shows us the median and the interquartile range; it represents the middle half of the data. The mid-line of the box is the median, also know as the middle quartile (Q2). The "whiskers" mark the statistical extremes, starting with the minimum value on the left, and ending with the maximum value on the right. The lower and upper quartiles (Q1 and Q3) mark opposite sides of the box, and although they are equal in the diagram above, the two halves of the box are often very different sizes.

What are Quartiles? Quartiles are those three values that divide a set of data into four equal parts, or quarters. To find the middle quartile, or Q2, simply find the median of an ordered data set. The lower quartile, or Q1, is the median value between the minimum and the median. The upper quartile, or Q3, is the median value between the median and the maximum. When the number of data points is odd, the median is the middle value. However, when the number of data points is even, the median is *the average of* the two middle values.

Range and Interquartile Range: The range is found by finding the difference between the two extremes, marked by the ends of each whisker. Interquartile Range can be found by subtracting the lower quartile (Q1) from the upper quartile (Q3).

Activity/Lesson: Lesson 1

Warm Up /debrief

Vocabulary - Create a vocabulary poster based on the words from page 1. Fill in definitions as you teach the lesson.

Making a Box Plot- We Do

Using a large piece of poster paper, guide students step-by-step through the creation of a simple box plot. Students should follow your steps on their own blank paper.
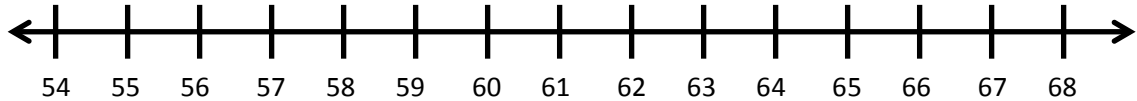
Start with the following data set:

> The heights, in inches, of a group of 6th graders:
> **60, 56, 54, 68, 60, 61, 65, 56, 58**

1. The first step in making a box plot is to order all the data points from least to greatest.

   54, 56, 56, 58, 60, 60, 61, 65, 68

2. Now, we can see our minimum and maximum values, so we can complete step two, which is to create a number line that includes all the values of our data set.

3. The next step is to find the median. There are an odd number of data points in this set, so the median will be the middle value. Start at the extremes, and cross off numbers as you count in towards the center.

   ~~54, 56, 56, 58,~~ (60,) ~~60, 61, 65, 68~~
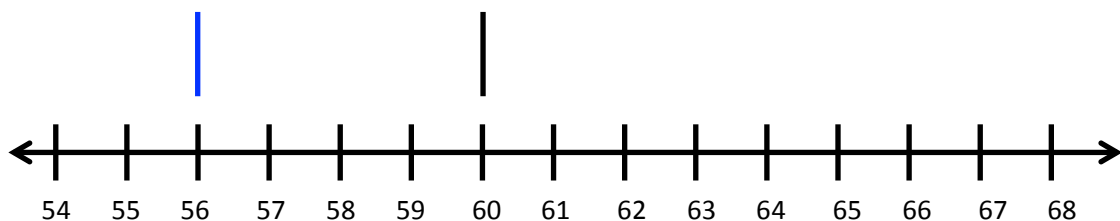
4. Mark the median above the number line.
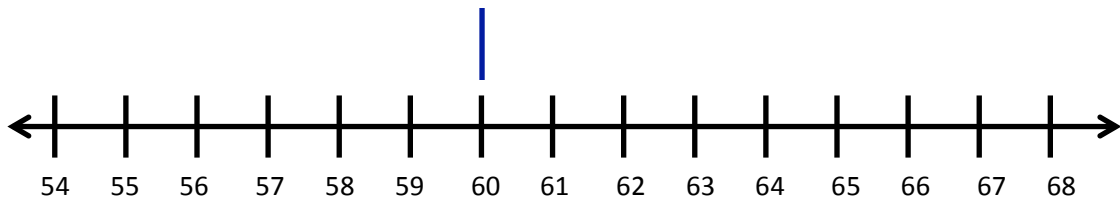
5. Next, let's find the lower quartile. This is the median of the numbers to the left of the median. There is an even number of data points, so the median will be the average of the two middle values. Mark the lower quartile above the number line.

   ~~54,~~ (56, 56,) ~~58~~ → $\dfrac{56+56}{2} = 56$
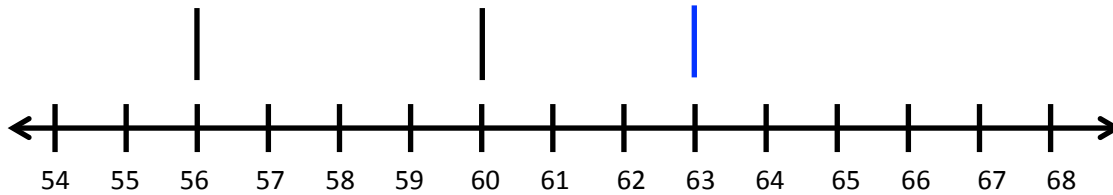

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6. Now, let's find the upper quartile. This is the median of the numbers to the right of the median. Mark the upper quartile above the number line.
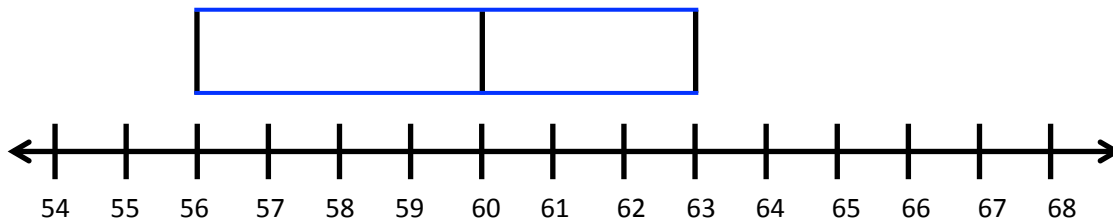
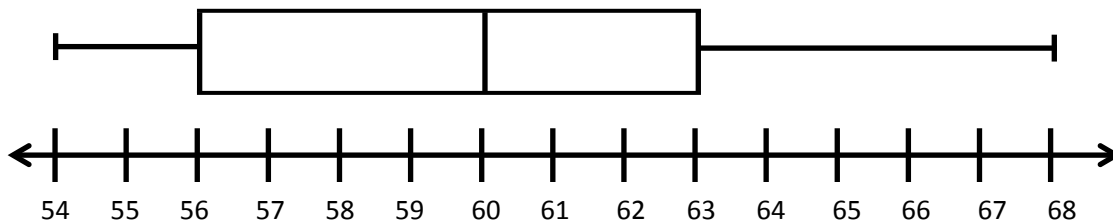60, 61, 65, 68 → $\dfrac{65-61}{2} = 63$

54 55 56 57 58 59 60 61 62 63 64 65 66 67 68

7. Next, complete the box by drawing the top and bottom.

54 55 56 57 58 59 60 61 62 63 64 65 66 67 68

8. Finally, plot the minimum (54) and maximum (68), and connect these extremes to the box, creating the whiskers.

54 55 56 57 58 59 60 61 62 63 64 65 66 67 68

9. Students should finish this plot by labeling the five statistical points that are represented: the minimum, the lower quartile (Q1), the median (Q2), the upper quartile (Q3), and the maximum.

10. As a class, answer the three questions regarding median, range, and interquartile range.

   1. What is the **median** of the data set? 60
   2. What is the **range** of the data set? 14
   3. What is the **interquartile range**? 7

Lesson 2: The Age of Pennies

Objective: Students will work in small groups to collect data about the ages of a set of randomly chosen pennies. Each student will create a box plot with the gathered data, and answer questions to guide their interpretation of the data.

Materials: 20 – 25 pennies *per group* of 3 – 4 students.
Warm-Up Two
Student Worksheets: **"The Age of Pennies" / "Student Instructions" (2 pages)**
Class set of rulers (optional).

The Set Up: Instruct students to each bring 5 – 10 pennies from home, or supply them yourself. Collect all the pennies in a central place, and then re-distribute them in cups (to insure a random distribution), 20 – 25 pennies per cup.

The Lesson: Warm-up Two/ Debrief
Review the box plot that the class made yesterday.
Review the vocabulary list.
Explain the objective of today's lesson.
Make Groups of 3-4 students each.
**Distribute** the cups of pennies/worksheets.

> The student worksheet guides the student step-by-step, so that once they begin working, the students should have enough information to work independently. However, it is important to fully explain the activity, and check that students understand how to find the age of a penny. Demonstrate the process clearly before allowing students to proceed independently.

Assessment: The warm-ups are intended for use as a formative assessment, to discover how much review needs to be done before beginning instruction. After both lessons, collect student box-plots to determine if any key concepts need to be re-taught. The question and answer section of lesson two should be reviewed whole-class, to review concepts and correct misconceptions.

Name:

Making a Box Plot

Follow along with your teacher's directions to make your own box plot. A number line has been provided for you, but you will need to add your own numbers.
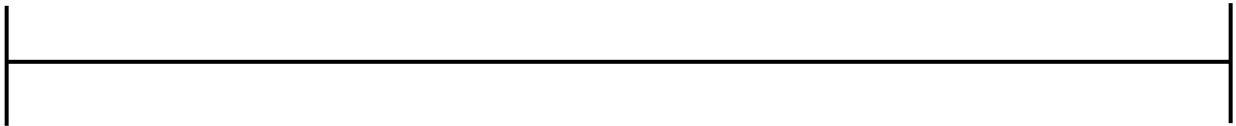
1. What is the **median** of your data set? _____

2. What is the **range**? _____

3. What is the **interquartile range**? _____

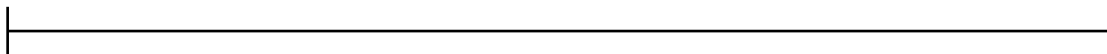4. Is the data **skewed** to the left or to the right? _____

Box Plots: The Age of Pennies   Name:

Collect your data: Find the age of each of your pennies, and record the data here.

Order your data: Order the ages from least to greatest.

Use your group data and the instructions on the next page to build a box plot. You may want to use a ruler. A number line has been provided for you.

1. What is the **median** of the data set? _____

2. What is the **range** of the data set? _____

3. What is the **interquartile range**? _____

4. Is your data **skewed** left or right? _____

Student Instructions for building a box plot: "The Age of Pennies"

1. Collect the data:

Take your first penny out of the cup, and find the date near Lincoln's chin. Subtract this date from the current year. For example, if the current year is 2015, and your penny has the date 1985, then the subtraction problem is:

$$\begin{array}{r} 2015 \\ -\ 1985 \\ \hline 30 \end{array}$$

So, your penny is 30 years old! Record the number 30 on your work sheet, and put that penny to the side. Don't put it back in the cup!

Repeat Step 1 with your partners until there are no more pennies in the cup.

2. Order the data

On your worksheet, order the data from least to greatest.

3. Make your number line.

Add numbers to your number line that will include all of your data.

4. Make your box plot.

   a. Find the median. Mark this value above your number line.

   b. Find the lower quartile. Mark this value above your number line.

   c. Find the upper quartile. Mark this value above your number line.

   d. Creating a box by drawing lines above and below the three marked data points.

   e. Record the maximum and minimum values above the number line.   These will be the ends of your whiskers.

   f. Draw lines from the minimum and maximum values to your box.

   g. Congratulations! You have created a box plot for your data.

   h. High five your partners. Then, answer the questions.

Warm-Up One: Box Plots

y

A data set has these numbers:

5, 7, 13, 2, 8, 7, 11

What is the first step in finding the **median** for this data set?

Find the **median** for a data set that has these numbers:

5, 7, 13, 2, 8, 7, 11

x

A student is finding the **median** of a data set. She starts at the maximum and minimum, and starts crossing out numbers:

~~10~~, ~~12~~, 13, 17, ~~20~~, ~~25~~

When she gets to the middle, there are two numbers left. What should she do?

Find the **median** for this set of data:

5, 8, 11, 13, 15, 15

Warm-Up Two: Box Plots

1. What is the median of this box plot?

2. What is the range?

A group of students are recycling aluminum cans. This box plot shows the number of cans recycled by each student.

Recycling Aluminum Cans

8 10 12 14 16 18 20 22 24
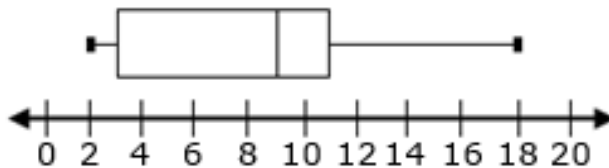**Number of Cans Collected**
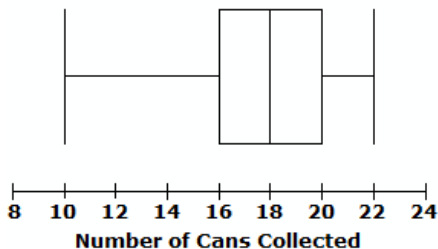
Use this box plot to answer questions 1 -2.

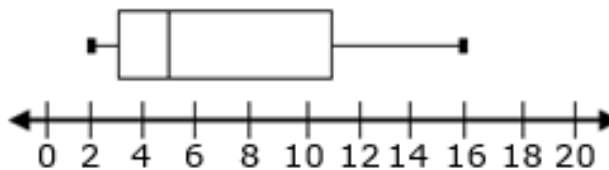Match the data sets to the box plots on the right.

1) **2, 3 ,4 ,5 ,9 ,11, 18**
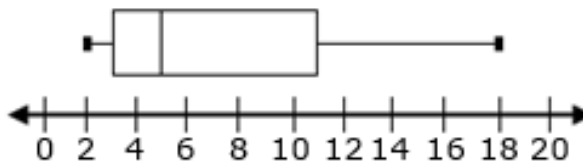
2) **2, 3, 4, 9, 10, 11, 18**

3) **2, 3, 4, 5, 9, 11, 16**

A.

0 2 4 6 8 10 12 14 16 18 20

B.

0 2 4 6 8 10 12 14 16 18 20

C.

0 2 4 6 8 10 12 14 16 18 20

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A data set has these numbers:

5, 7, 13, 2, 8, 7, 11

What is the first step in finding the **median** for this data set?

The first step would be to put all the data points in order from least to greatest.

y

Find the **median** for a data set that has these numbers:

5, 7, 13, 2, 8, 7, 11

After putting the numbers in order: 2,5,7,7,8,11,13

I crossed off the numbers from each end until I found the median: 7.

x

A student is finding the **median** of a data set. She starts at the maximum and minimum, and starts crossing out numbers:

~~10~~, ~~12~~, 13, 17, ~~20~~, ~~25~~

When she gets to the middle, there are two numbers left. What should she do?

She should find the average of the two middle values:

(13+17)/2=15

Find the **median** for this set of data:

5, 8, 11, 13, 15, 15

~~5, 8,~~ (11, 13,) ~~15, 15~~

11+13/2=12
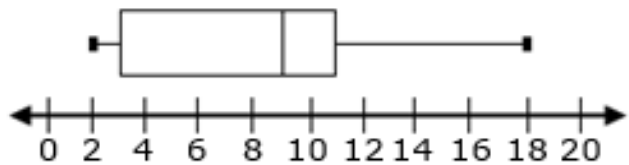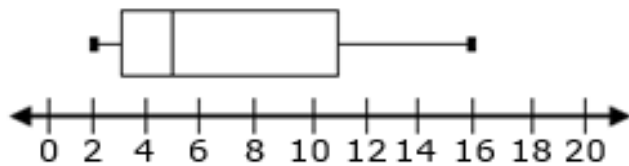
The median is 12.

Warm-Up Two: Answers

1. What is the median of this box plot?

This box plot has a median of 18.

2. What is the range?

This box plot has a minimum of 10 and a maximum of 22, so the range is 12. (22 – 10 = 12)

A group of students are recycling aluminum cans. This box plot shows the number of cans recycled by each student.

Recycling Aluminum Cans

8 10 12 14 16 18 20 22 24
Number of Cans Collected
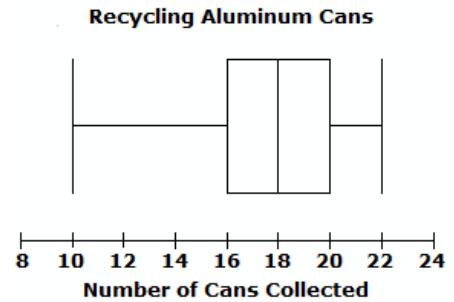
Use this box plot to answer questions 1 -2.

Match the data sets to the box plots on the right.

1) **2, 3 ,4 ,5 ,9 ,11, 18**

   C

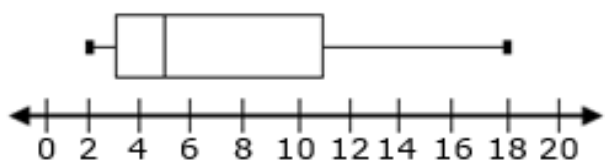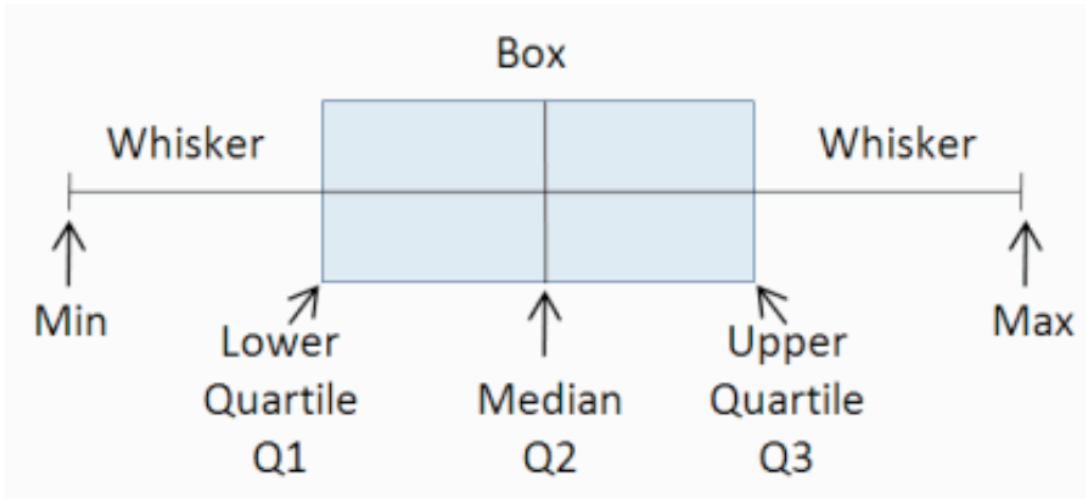2) **2, 3, 4, 9, 10, 11, 18**

   A

3) **2, 3, 4, 5, 9, 11, 16**

   B

A.

0 2 4 6 8 10 12 14 16 18 20

B.

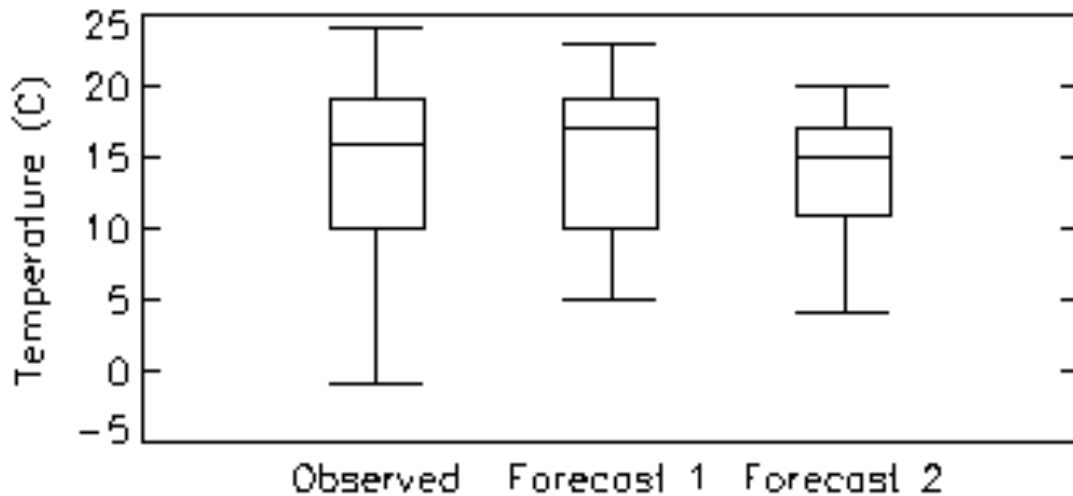0 2 4 6 8 10 12 14 16 18 20

C.

0 2 4 6 8 10 12 14 16 18 20
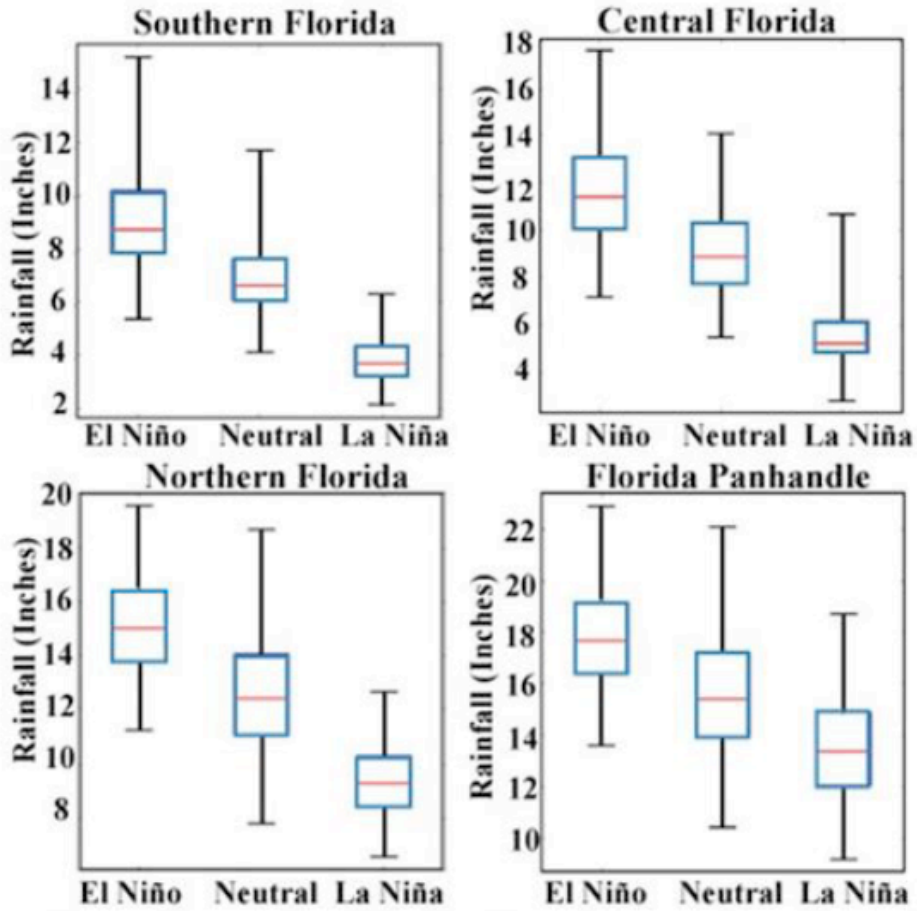
Parts of a Box Plot
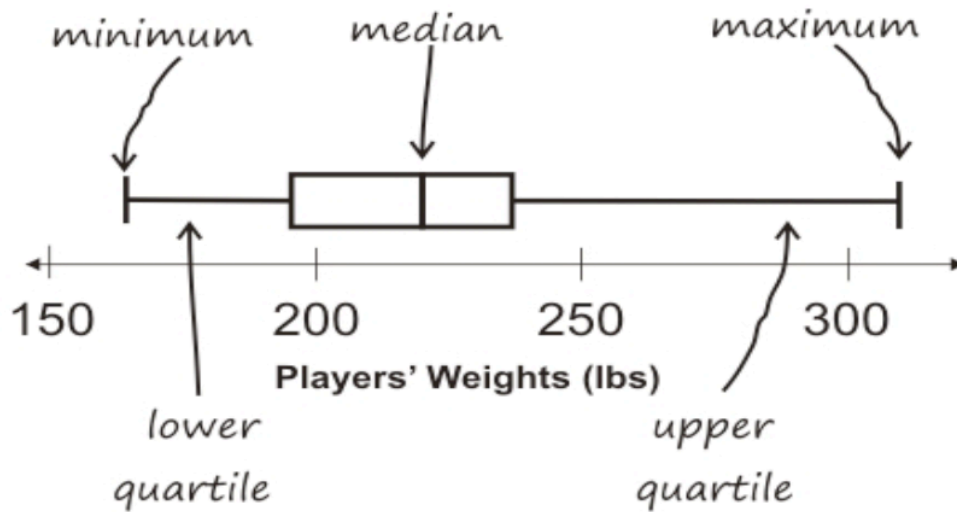

Weather Report for February 1st

Vertical box plots used to compare weather data in four different regions of Florida.
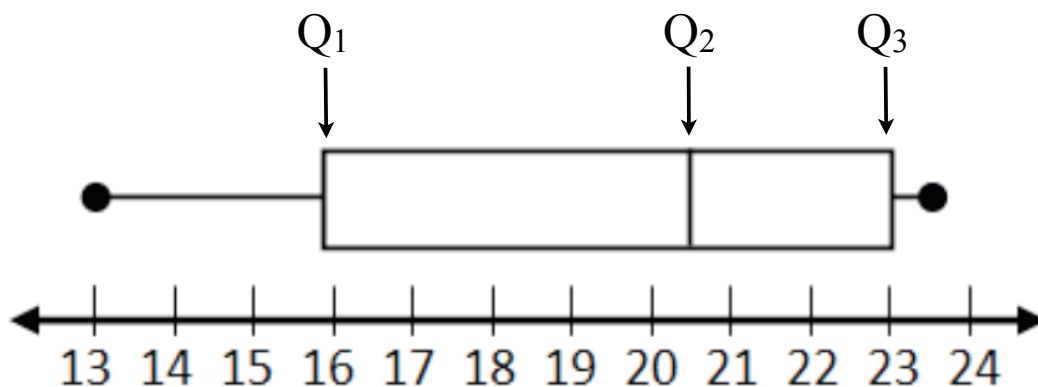

Florida Winter Rainfall (Inches)

Quartiles

Are the parts of this box plot labeled correctly?

No. The lower quartile and upper quartile are mislabeled. Quartiles are three points that divide the data into four quarters.

- -

Interquartile Range

What is the interquartile range of this box plot?

Interquartile range is found by subtracting Q_1 from Q_3.
23 - 16 = 7. Therefore, the interquartile range is 7.

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Skew

How can we describe the overall shape? Is the data skewed left, skewed right, or is it symmetrical? Why?

$$Q_1 \qquad Q_2 \qquad Q_3$$
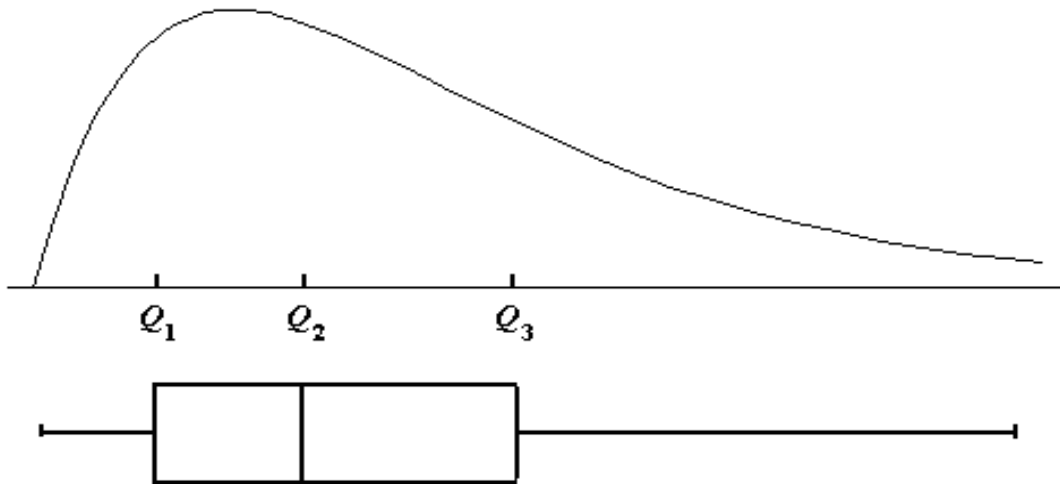
The right half of the data is more widely distributed. Therefore, the data is skewed right.