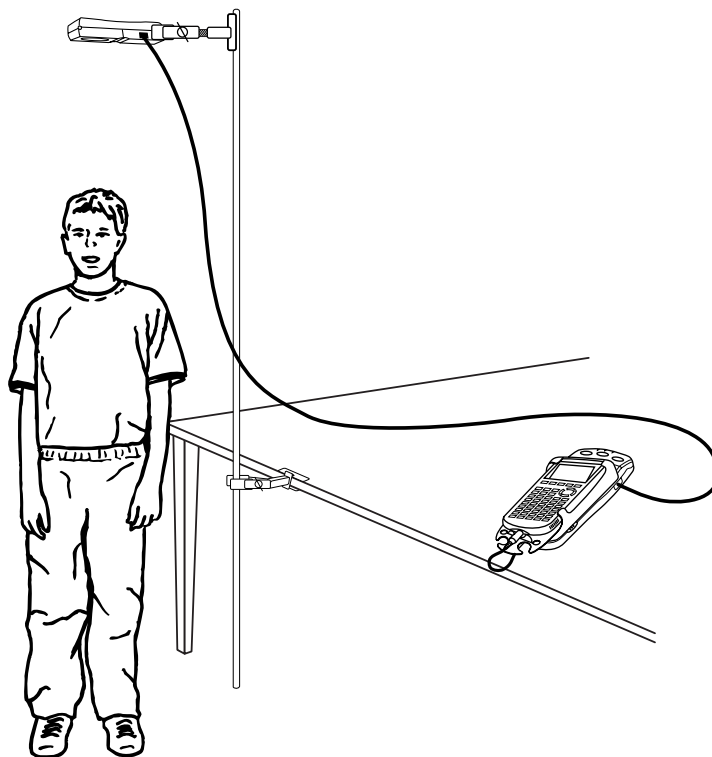


# How Tall?

## Describing Data with Statistical Plots

How tall are students in your class? Is there anyone especially tall? Or short? What is the average height of your classmates? One way to answer these questions is to measure the height of everyone in the class and then analyze the data statistically.

An easy way to measure everyone's height rapidly is to use the Motion Detector. You can fasten the detector above the floor, and students can stand under it to quickly record their heights. Once you have a set of heights for your classmates, you will plot the results using a special statistical plot called a *box plot*.



### OBJECTIVES

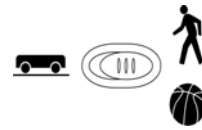
- Measure the heights of your classmates using a Motion Detector.
- Describe the height data using statistical concepts.
- Describe the height data using a box plot.

### MATERIALS

TI-83 Plus or TI-84 Plus graphing calculator  
EasyData application  
CBR 2 or Go!Motion and direct calculator cable  
or Motion Detector and data-collection interface

## PROCEDURE

1. Set up the Motion Detector and calculator.
  - a. Open the pivoting head of the Motion Detector. If your Motion Detector has a sensitivity switch, set it to Normal as shown.
  - b. Turn on the calculator and connect it to the Motion Detector. (This may require the use of a data-collection interface.)
2. Position the Motion Detector about 2.5 m from the floor, so that the disc is pointing straight downward. There must be no obstructions beneath the detector.
3. Set up EasyData for data collection.
  - a. Start the EasyData application, if it is not already running.
  - b. Select **(File)** from the Main screen, and then select **New** to reset the application.
  - c. Select **(Setup)** from the Main screen, and then select **Events with Entry**.
4. The Main screen will show the distance to the floor in meters. Record this value in the Data Table on the *Data Collection and Analysis* sheet. Check to see that the value makes sense.
5. Collect data.
  - a. Select **(Start)** to prepare to collect data.
  - b. Have the first student stand directly under the Motion Detector and select **(Keep)** to make a measurement.
  - c. Enter **1** for the first measurement. Select **(OK)** to store the data.
  - d. Have the second student stand directly under the Motion Detector and select **(Keep)** to make a measurement.
  - e. Enter **2** for the second measurement. Select **(OK)** to store the data.
  - f. Repeat this process for each student in the group.
  - g. After the last student is marked, select **(Stop)** to end data collection.
6. When data collection is complete, a graph of distances will be displayed. You should see a scatter of points, corresponding to the distance from the Motion Detector to the head of each student. In a moment, you will convert these readings to heights. Scroll across the graph to the right-hand point using the cursor keys, and make a note of the number of measurements,  $n$ , you made. Record the value in the Data Table.
7. Select **(Main)** to return to the Main screen. Exit EasyData by selecting **(Quit)** from the Main screen and then selecting **(OK)**.



## ANALYSIS

1. Remember that the Motion Detector points downward toward the floor, and measured distance to the top of each student. To convert these readings into heights, you need to subtract the readings from the distance to the floor, leaving the heights.
  - a. Enter the distance to the floor in meters.
  - b. Press **(-)** **(2nd)** **[L6]** **(STO)** **(2nd)** **[L6]** to enter an expression like  $2.5 - L6 \rightarrow L6$ .  
*Note: The distance to the floor may be different from 2.5 m.*
  - c. Press **(ENTER)** to complete the operation.

2. You now have a list of the heights of your classmates. One way to determine the minimum and the maximum values is to sort the data and see what values are first and last. You can also determine the median value, which is the middle value of an ordered list. (If there is an even number of students in the data set, then the median is the average of the middle two values.)

To find these three values (the minimum, median, and maximum) you first need to sort the data.

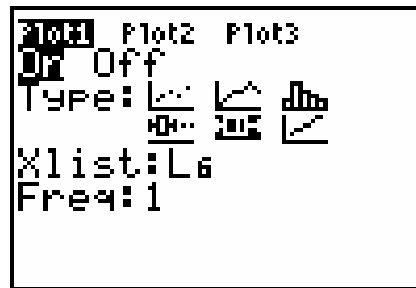
- a. To sort the values in L6, your height data, press  $\text{2nd}$  [LIST].
  - b. Press  $\text{D}$  to reveal the OPS menu. Press  $\text{ENTER}$  to paste SortA( to the home screen.
  - c. Press  $\text{2nd}$  [L6].
  - d. Press  $\text{)}$  to close the SortA function, and press  $\text{ENTER}$ . The calculator will sort the values in ascending order and then show Done.
  - e. Press  $\text{STAT}$   $\text{ENTER}$  and use the cursor key to scroll to L6.
  - f. Record the first element in the list, which is the minimum height, in the Data Table on the *Data Collection and Analysis* sheet.
  - g. Scroll down to the middle element in the list (or the middle two, if you have an even number of elements, and average the two values). Record the median height in the Data Table.
  - h. Use the cursor keys to scroll down to the last value, and record the maximum height in the Data Table.
  - i. Select  $\text{2nd}$  [QUIT] to leave the list editor.
3. You have found the maximum, median and minimum values in a very direct way – by scrolling through the sorted list elements. The calculator can perform these and other, more detailed, calculations. The following steps will have the calculator find a set of descriptive statistics, including the mean, median, minimum, and maximum values of the height data.
- a. To enter the 1-Var Stats function press  $\text{STAT}$  and press  $\text{D}$  to open the CALC menu. Press  $\text{ENTER}$  to paste the 1-Var Stats function to the home screen.
  - b. Press  $\text{2nd}$  [L6].
  - c. Press  $\text{ENTER}$  to complete the calculation.
  - d. The 1-Variable Statistics command calculates a number of statistics all at once. Use the  $\text{V}$  key to scroll down to reveal values of the mean (shown as  $\bar{x}$ ), minX, Med, and maxX.
  - e. Record the mean, minimum, median, and maximum heights in the Data Table on the *Data Collection and Analysis* sheet.
  - f. Press  $\text{CLEAR}$  to return to the calculator's home screen.

⇒ Answer Question 1 on the *Data Collection and Analysis* sheet.

4. Two other important values listed in the statistical summary are the *lower quartile* (denoted Q1) and the *upper quartile* (denoted Q3). These numbers represent the medians of the lower and upper halves of the data respectively. Repeat the Step 3 procedure to and record these values in the Data Table on the *Data Collection and Analysis* sheet.
5. A special type of graph, called a *box-and-whiskers* plot or *box plot* for short, can be used to provide a statistical picture of a data set. It gives a graphical representation of the minimum, lower quartile, median, upper quartile, and maximum by displaying a view of the data distribution. Draw a boxplot with the calculator.
- a. Press  $\text{2nd}$  [STAT PLOT] and press  $\text{ENTER}$  to select Plot 1.

## Activity 28

- b. Change the Plot1 settings to match the screen shown here. Press **ENTER** to select any of the settings you change.
- c. Press **ZOOM** and then select ZoomStat (use cursor keys to scroll to ZoomStat) to draw a graph with the  $x$  and  $y$  ranges set to fill the screen with data.
- d. Press **TRACE** to read values from the graph.

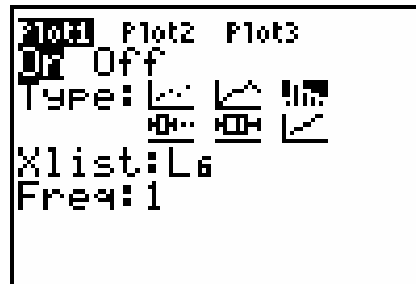


⇒ Answer Questions 2–7 on the *Data Collection and Analysis* sheet.

## EXTENSION

1. Another way to analyze the data you collected in this activity is to create a *histogram*. A histogram is simply a graphical representation of the number of times each height or range of heights occurs in the data set. Redraw the data in histogram form.

- a. Press **2nd** [STAT PLOT] and press **ENTER** to select Plot 1.
- b. Change the Plot1 settings to match the screen shown here. Press **ENTER** to select any of the settings you change.
- c. Press **ZOOM** and then select ZoomStat (use cursor keys to scroll to ZoomStat) to draw a graph with the  $x$  and  $y$  ranges set to fill the screen with data.



2. Describe the data features summarized in this graph. Are the statistical features depicted in the histogram consistent with those shown in the box plot you created earlier? Discuss the similarities and differences between these two plots. What are some advantages and disadvantages to using each type of plot to describe a set of data? Is the box plot or histogram more sensitive to distortion from outliers?

**DATA COLLECTION AND ANALYSIS**

Name \_\_\_\_\_

Date \_\_\_\_\_

**DATA TABLE**

<b>Distance to floor</b>		
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<b><math>n =</math></b>	<b>From data list</b>	<b>Descriptive statistics</b>
<b>minimum</b>		
<b>median</b>		
<b>mean</b>		
<b>maximum</b>		
<b>Q1</b>		
<b>Q3</b>		

**QUESTIONS**

- How do the mean and median values determined by the calculator compare with the ones you read directly from the lists?
  
- Notice that the *box* part of the plot represents the middle portion of the data, while the *whiskers* stretch to the lowest and highest numbers in the data set. The size and location of the box tells you about the distribution of values in the data set. A large box indicates that the data is spread out, while a smaller box means the data is clustered closely. Discuss the size and location of the box part of the plot; describe how it relates to the heights of the members of the class.

## Activity 28

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3. Is the median located near the center of the box? What does the location of the median line in the box tell you about the distribution of heights for the middle half of the data?
  
4. The length of the whiskers on the box plot gives a hint as to the distribution of the data. If one whisker is significantly longer than the other, we say the data is *skewed* in the direction of the shorter whisker. This usually means that the values are bunched together near the shorter whisker. Describe the whiskers on the plot. What do the whisker lengths tell you about the heights for the class?
  
5. The presence of an outlier might cause you to think that the data is skewed in one direction or another when it really is not. Use the method you learned earlier to scroll through the data. Pay close attention to the numbers at the very beginning and very end of the list. Can you identify any outliers in the data set? If so, how does this change your answer to Question 4, if at all?
  
6. Describe how the box plot would be affected if one of the members of your class was exceptionally tall at 2.3 m.
  
7. Suppose that the values for the tallest and shortest members of the class were removed from your data set. How would the median, lower quartile and upper quartile values change, if at all?