

Chapter 3

Graphical Methods for Describing Data

3.0 Introduction

Chapter 3 introduces some graphic methods of displaying data. The comparative bar chart, pie chart, and stem-and-leaf display are not supported by the TI-83, although you may be able to find and download some programs that will make these graphs. A TI-83 calculator program to construct a stem & leaf display would not be very useful, since the text space in the calculator window is not extensive.

The histogram and scatter plot, however, are easily done on the TI, and we will use two examples below to illustrate this. Before that, however, we will give you some useful background about doing graphs on this calculator.

3.1 General Rules for Statistical Graphing on the TI-83.

The steps for displaying data on the TI-83 are about what one would imagine:

1. Store the data somewhere in the calculator
2. Tell the calculator what graph you want
3. Make the graph

The first step, storing the data in the calculator, is almost effortless on the TI-83. This calculator is a “list-based” calculator, which means that it stores data in vertical lists, something like a spreadsheet computer program. The TI comes with 6 pre-named lists with the somewhat less than creative names, L1, L2, ..., and L6. (You can – and many times should – create your own lists to store your data for an extended period in your calculator. You can give relatively creative names to those. The pre-named lists can then be used for temporary calculations and graphs of the data.) You can see these numbered lists by executing the following sequence:

Stat > Edit... > Enter

The above sequence should get you to a screen that looks something like the screen at the right. What you see on the screen are the first 3 of the calculator’s lists, L1, L2, and L3. You can see the other numbered lists by pressing the right arrow a few times. If your calculator is new, or you haven't used Lists before, there is no actual data in the list yet – these numbers will be provided by you. And there is no time like the present...

L1	L2	L3	3
2.0000	3.0000	3.0000	
3.0000	2.0000	4.0000	
4.0000	1.0000	3.0000	
1.0000	2.0000	1.0000	
3.0000	2.0000	3.0000	
3.0000	4.0000	1.0000	
3.0000	3.0000	4.0000	
L3(1)=3			

3.2 Entering data

Example 3.17: Mercury Contamination

Mercury contamination is a serious environmental concern. Mercury levels are particularly high in certain types of fish. Citizens of the Republic of Seychelles, a group of islands in the Indian Ocean, are among those who consume the most fish in the world. The article “Mercury Content of Commercially Important Fish of the Seychelles, and Hair Mercury Levels of a Selected Part of the Population” (*Environ. Research* (1983): 305–312) reported the following observations on mercury content (ppm) in the hair of 40 fishermen:

13.26	32.43	18.10	58.23	64.00	68.20	35.35	33.92	23.94	18.28
22.05	39.14	31.43	18.51	21.03	5.50	6.96	5.19	28.66	26.29
13.89	25.87	9.84	26.88	16.81	37.65	19.63	21.82	31.58	30.13
42.42	16.51	21.16	32.97	9.84	10.64	29.56	40.69	12.86	13.80

Be very careful here! You should NOT enter the data in rows and columns as you see them presented here originally. These are data for one variable, and should be entered in one list, top to bottom..

To enter the data for this problem, position the cursor in List1 and enter the data in the order shown. (You can enter the data in whatever order you wish – but it’s easier to keep track of where you are if you go left to right, or top to bottom rather than, say, diagonally.) When the first few data elements are entered, your Data Edit screen should look something like the screen at right:

L1	L2	L3	1
13.260	-----	-----	
32.430			
18.100			
58.230			
64.000			

L1(6)=			

3.3 Preparing the TI-83 for a graphic display

The next step in the process is to tell the calculator what graph you want – in this case, a histogram. The TI-83 has quite a few possibilities for graphs to pick from, and you can actually have up to 3 graphs displayed at once – although that would usually not be recommended. Because the calculator can show more than one graph at a time, specifying what you want it to do will take two steps: (1) how many and which graphs you want displayed, and (2) which type of plot you wish. To specify how many and which graphs to display, we must navigate to the “Stat Plot Menu,” as follows:

2nd > STAT PLOT.

You may have noticed that many of the TI-83 keys not only have writing on them to tell you what the key does, but have yellow and green writing above the keys. This calculator keystroke strategy keeps the number of keys to a minimum while building in a maximum capability. You may recall that on your computer the same thing happens. The keys, `1234567890=, print different characters when you capitalize them: ~!@#\$\$%^&*()_+. On the TI-83, the 2nd and ALPHA keys act like the Shift key on your computer, changing the meaning of the keystroke – if you neglected to press 2nd before **STAT PLOT**, the calculator will deliver the results of the “Y=” keystroke. If you correctly executed the 2nd > **STAT PLOT** sequence, you should see the Stat Plot Menu on your screen:

```

STAT PLOTS
1:Plot1...Off
  ▽ L1 L2 □
2:Plot2...Off
  ▽ L1 L2 □
3:Plot3...Off
  ▽ L1 L2 □
4:PlotsOff
5:PlotsOn
  
```

Now, we’re lying a little bit here – what you actually will see are only the first four items in this list, and the fourth item will look like this: 4▼PlotsOff. (Remember, we mentioned these "large" screens in Chapter 0.) The little arrow means that there are more items that are not presented – to see them you need to press the down arrow key on the TI-83. When there are more items at the top of a list in a TI-83 window, you will see a different arrow that looks like this: ▲.

There is quite a bit of information in the Stat Plot Menu, and most of it will be of interest to you at some point in your TI-83 statistical career. Here's a slight guide for this screen.

The Anatomy of the Stat Plot Menu

The diagram shows the Stat Plot Menu with arrows pointing to various elements and their meanings:

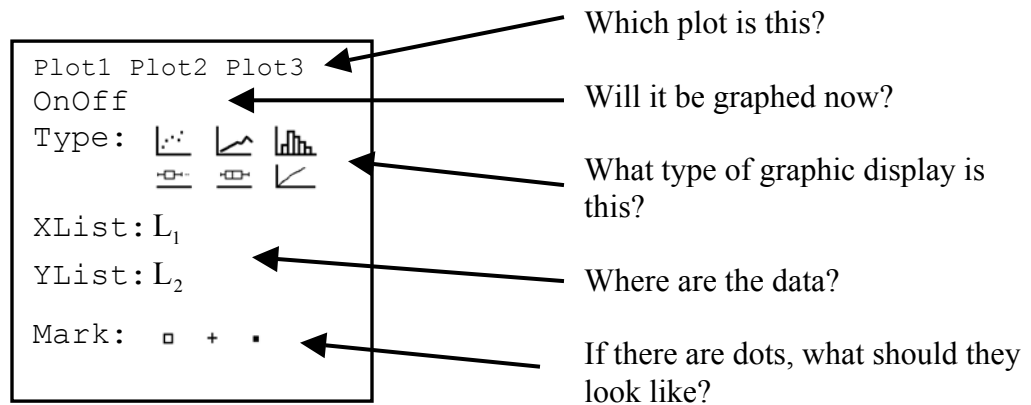
- Arrow pointing to "1:Plot1...Off": Which plot is this???
- Arrow pointing to the plot icon (a small graph with a line and dots): What kind of plot is this???
- Arrow pointing to "L1": What list(s) are used for this plot???
- Arrow pointing to "L2": What list(s) are used for this plot???
- Arrow pointing to the square icon: What character is used (if needed) for dots???

The Stat Plot Menu that you see may differ from the one shown above if you have already been practicing with your calculator to make some statistical graphs; so just in case, arrow down to the “4: PlotsOff” option and press **ENTER** twice – once to tell the calculator you want to turn the plots off, and once to actually execute the command. You should see “PlotsOff” and “Done” appear on the screen. Now press the following sequence:

2nd > STAT PLOT > Plot1...On > Enter

What we have decided to do is use **Plot1** for this histogram. If you are a number 2 or 3 type of person, feel free to use those plots instead. To choose a plot, arrow up or down to the plot number you wish, and press **Enter**. After indicating the plot we wish to use, the calculator will now want us to select the type of plot, and supply other information as well. This is accomplished in the Stat Plot Editor window, which looks like this:

The Anatomy of the Plot Choice Screen



The icons that specify the "type" of plot may not be perfectly clear. The table below translates these icons into a more familiar form.

Icon→English Translation

Scatter plot	LinePlot	Histogram
Modified Box Plot	Skeletal BoxPlot	Normal probability Plot

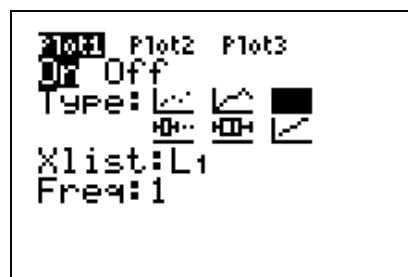
The **XList** and **YList** specify the list you have chosen for your data. The **Mark** is not important for the histogram, but is a feature that is useful in plots to come. It is possible that the Plot Choice Screen doesn't look exactly like you see above. This is because the information needed for a graph will vary depending on the "Type" of graph.

3.2 Creating the Histogram

Example 3.17: Mercury Contamination

Since we are constructing a histogram, move the blinking cursor to the histogram icon, the one at the upper right in the array of icons -- it sort of looks like it might be a histogram. (Lest you be critical of its imprecise appearance, remember that there are only so many pixels the engineers have available to use.) Now, you should be a bit careful here – the Types of graphs are displayed in a little 2 x 3 array, but you don't move between the choices with \blacktriangle , \blacktriangledown , \blacktriangleleft , and \blacktriangleright ; you only use the \blacktriangleleft and \blacktriangleright . Using the \blacktriangle and \blacktriangledown will move you off the graph choices. When your cursor is over the histogram icon, press **Enter**. Now the Plot Choice Screen will look like the figure below.

The plot choice screen has changed because of your selection of the histogram as your graph of choice. Since our data has been entered into List1, we must make sure the calculator understands that – which means making sure that the **Xlist** is set at L_1 . Even though your calculator may already have this setting correct, let's make sure we know how to do it. Your cursor should now be blinking on the histogram icon, so execute the following keystrokes:



$\blacktriangledown > 2^{\text{nd}} > 1$

Check to make sure you have an L_1 by the **Xlist** – there are couple things you could get messed up with here. First, you might not have pressed the 2^{nd} hard enough, in which case you would see a "1." Or, you might have pressed the green **Alpha** key instead of the yellow 2^{nd} key, in which case you would see a little "Y" with a blinking "A" calling for your attention. (Just so we're on the same wavelength, "blinking A" is not a British expression for "darn A" – a blinking A is an A that is blinking at you.) If you have erred in your keystroke, \blacktriangleleft back over the offending character and correct the problem.

We can now actually see our histogram, but the calculator may not actually be ready to display it. The graphics screen on the TI-83 is a busy creature, and you may have already used the calculator to graph some math functions in previous math classes. If so, you may have to do a couple preparation steps. First, we need to get rid of any math functions still in residence from earlier work. To do that press the "Y =" key. If you see the usual graphing screen, but there are no functions to graph, you are in the clear. But if you see something like " $Y_1 = 2x + 4$ " you need to erase that " $2x + 4$." To do that, arrow up or down as needed and press the **Clear** key for each function. It will not disturb the calculator if you forget to do this – but a very fine statistical histogram might be cluttered up by a weird mathematical function.

Another slightly disconcerting problem is that your TI-83 really has no clue where your histogram is! This is especially a problem if you have used the calculator for graphing math functions. If you have already graphed mathematical functions you are familiar with the idea of "setting the window." However, if you are new to the TI-83, you need to understand how to perform this essential task. It is not difficult to set the window. Basically, you must be able to (a) tell the calculator where your graph is, and (b) sometimes improve on what is presented to you.

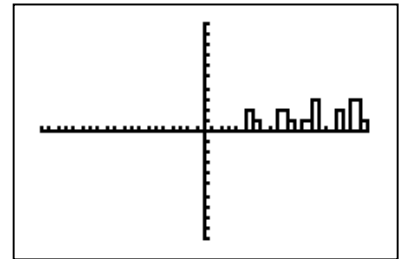
```

WINDOW
Xmin=-20
Xmax=20
Xscl=1
Ymin=-10
Ymax=10
Yscl=1
Xres=1

```

Press the **Window** key and you should see something like the screen displayed at right. If your numbers differ, change them to match the window.

The numbers in this screen define the usual Cartesian Coordinate system, with the "x" and "y" variables ranging from -20 to 20. If you press the **Graph** key on the calculator you can get a very good idea of how your TI-83 handles statistical graphics by observing the screen at the right, where the histogram appears to be occupying only a small part of the screen



The calculator is overlaying your statistical graph on the mathematical graphing space, the Cartesian Coordinate system. Your "setting the window" task is to set the "x" and "y" minimum and maximum values to bring the histogram to the major part of the screen. You could do this by trial and error, but the TI, using its "**Zoom**" options, will give you a fairly good approximation. Press the "**Zoom**" key and you should see the Zoom screen, as presented below:

```

ZOOM MEMORY
1:Zbox
2:Zoom In
3:Zoom Out
4:ZDecimal
5:ZSquare
6:ZStandard
7:ZTrig
8:Zinteger
9:ZoomStat
0:ZoomFit

```

The Zoom options of the TI-83 are presenting some built-in capabilities for setting the graphic screen. Most of these are for graphing mathematical functions, but there is one that is designed to help statistics students – you guessed it, **ZoomStat**. Press

ZoomStat and you should see your histogram, based on your calculator's best guess about an appropriate window.



To see what its best guess at a window is, press the **Window** key:

```

WINDOW
Xmin=5.19
Xmax=78.701666...
Xscl=10.501666...
Ymin=-3.60828
Ymax=14.04
Yscl=1
Xres=1
    
```

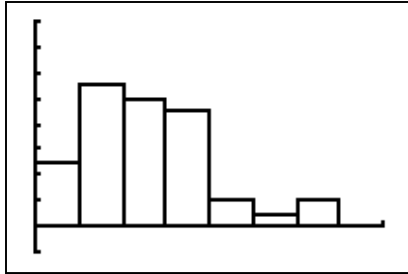
Basically your TI has checked the data in List1 – remember, that's where you said it was – and used a built-in algorithm to set the graphics window. As a general rule, it doesn't do too badly at automatically setting windows, but in the case of the histogram the TI doesn't really give the best choices. Use your cursor to change the calculator's choices to the values in the screen below, and read about what you are doing to the right of the screen..

Anatomy of the Window for Histograms

<pre> WINDOW Xmin=0 Xmax=80 Xscl=10 Ymin=-2 Ymax=16 Yscl=4 Xres=1 </pre>	<p>Set the low and high values for the "x" scale at reasonable integers.</p> <p>Set the class size for the histogram</p> <p>Set the low and high values for the "y" scale at reasonable integers.</p> <p>Set the tick-mark length for the frequencies (bar heights).</p> <p>??? Doesn't seem to do anything!</p>
--	--

The only mysterious setting here is the "Xres=1" setting. It does actually do something -- it sets the pixel resolution. (We're not sure what that is; it sounds terribly nerdy and

we've never gone wrong with setting it at "1" so we don't mess with it.) The central idea here is that you can't just depend on **Zoom > ZoomStat** to give you the most interpretable window. The class sizes and tick marks are very helpful in interpreting the graphs, and the class sizes and tick mark locations are functions of the Window settings. Just any old numbers your calculator chooses will not necessarily do. For example, you might want to see more detail in the distribution. Then change the **Xscl** to 2 and again press the **Graph** button. Now you should see more detail:



3.3 Creating the Scatter plot

Our next task will be to create the scatter plot. You will be pleased to know that much of what you learned while graphing the histogram will be relevant here for the scatter plot. We will use the Vermont Sugarbush data for our example.

Example 3.21: Vermont Sugarbushes

As you may recall, this is a bivariate data set, with y = mean crown dieback (%), and x = soil pH. The following observations were read from the scatter plot:

x	3.3	3.4	3.4	3.5	3.6	3.6	3.7	3.7	3.8	3.8
y	7.3	10.8	13.1	10.4	5.8	9.3	12.4	14.9	11.2	8.0
x	3.9	4.0	4.1	4.2	4.3	4.4	4.5	5.0	5.1	
y	6.6	10.0	9.2	12.4	2.3	4.3	3.0	1.6	1.0	

The task of entering bivariate data is similar to entering univariate data. Once again, we enter data after the **Stat > Edit** combination as we did with the histogram. The significant difference with bivariate data is that the data occurs in pairs. This is a slight problem, in that one must keep track of the two variables to make sure the right x is entered with the right y . While the data could be entered pair wise it is usually much more efficient from the standpoint of numbers of keystrokes to enter the data for the x variable and then go back and enter it for the y variable. For this example, we chose to enter the data in List2 and List3, since we had data we didn't want to lose in List1. (Something about mercury contamination...) After entry our Edit Screen looks like the screen at right.

L1	L2	L3
13.260	3.3000	7.3000
32.430	3.4000	10.8000
18.100	3.4000	13.1000
58.230	3.5000	10.4000
64.000	3.6000	5.8000
68.200	3.6000	9.3000
35.350	3.7000	12.4000
L3 = {7.30000, 10.80000, 13.10000, 10.40000, 5.80000, 9.30000, 12.40000, ...}		

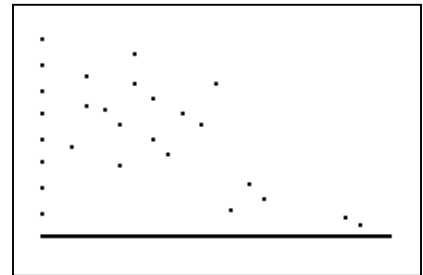
Again, we must tell the TI-83 which plot we are doing in the Plot Choice screen. For the scatter plot we need to select the scatter plot icon (the Upper Left icon of the six displayed.) Notice that as soon as you do this you must specify two lists: the XList and YList. Since we entered our data in the List2 and List3, these lists will be our choices for the scatter plot. Defining which list is the XList and which is the YList determines which variable will be the horizontal axis variable, and which will be the vertical axis variable. Since our "x" variable is in List2, and "y" variable is in List3, the choices in the Plot Choice screen (**2nd > Stat Plot > Plot1...**) would be:

XList: L₂
YList: L₃

We also have another choice at this point, the "Mark" value. The scatter plot is, of course, comprised of dots, and we have some choices as to what we want the dots to look like. Those choices are displayed in the screen by the "Mark:" □ + ■

The obvious choice is just to make the dots dots – that is, the small black squares. Why are we even given a choice at all? It turns out that in some circumstances we might want to have two scatter plots displayed at once, perhaps to compare two different samples of bivariate data. In that situation we could choose to display one scatter plot as small black squares, and the other as plus signs or "open squares." For our learning purposes we don't need to worry about comparing scatter plots – lets just get this one scatter plot up. Arrow the cursor over to the small black square and press **Enter**.

Now we're ready to get the scatter plot. Press the **ZOOM > ZoomStat** option and we'll get the calculator's best guess at a reasonable window for your scatter plot. You should see the graph at right.



There IS the possibility that your calculator will give you a stern error message – something forbidding, like the message below...

```
ERR: DIM MISMATCH
1:Quit
```

If you get this message, there are two usual suspects to round up. The error message is actually telling you that the ordered pairs are messed up somewhere, b/c you don't have the same number of x 's and y 's. Most likely you have either not specified the correct lists (L_2 and L_3 , remember) or you may have left off a number from one of the lists as you entered the data. If you have left off a number in the middle of a list, you can insert it in its rightful place, using the insert keystroke sequence,

2nd > INS

To use this feature, place the cursor at the right place in the right list where you should have entered the right number. (Are you feeling guilty? Please don't – everybody makes this error at some point.) Press the **2nd > INS** sequence, and then enter the missing number. At this point we should see the correct scatter plot.

Remember, based on the data the calculator has estimated what a reasonable window would look like. For the most part the TI-83 does a good job with the scatter plot window, but we might want to add the vertical axis and some tick marks to help interpret the scatter plot. Press the **WINDOW** key and lets see what the calculator came up with:

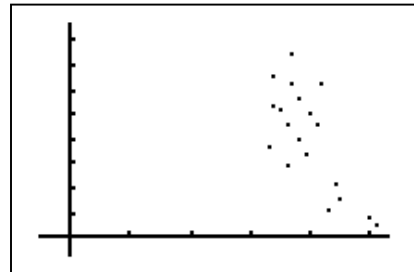
```
WINDOW
Xmin=3.12
Xmax=5.28
Xscl=?
Ymin=-1.363
Ymax=17.263
Yscl=?
Xres=?
```

The TI has found minimum and maximum values for a screen that includes all the dots, and has used the Xscl, Yscl, and Xres from the previous plots. To improve on this choice, change the values in this screen to the following (Just leave the Xres at whatever it is):

```
WINDOW
Xmin=-.5
Xmax=5.28
Xscl=1
Ymin=-1.363
Ymax=17.263
Yscl=2
Xres=?
```

Now press **GRAPH**. Don't press **ZOOM > zoomStat** or you'll undo the changes you just made. We can see the effect of our changes. First of all we have a vertical axis for reference. Second, we have tick marks on each axis at the intervals specified by our choices of Xscl and Yscl. This is a mixed blessing, however, since the cluster of points is more concentrated and it may be more difficult to pick out any pattern in the plot.

In general, these **WINDOW** choices are a matter of taste and judgment, wisdom guided by experience.



3.4 Conclusion

Whew! Learn about graphing on the TI has been a pretty long and intensive task. However, a great deal of what we did here is merely repeated for future plots. When we make other types of plots, you will already know how to set up the Plot Choice screen, and so all you will really need to know is which icon to use.