

## Using the TI-83: Scatter Plots and Regression

To view the data scatter plot and to determine the model for the equation, we must first enter the data in the calculator lists. Then, we may view the scatter plot in order to analyze the graph and to determine what models may be appropriate for the data. Finally, we will determine the equation for the appropriate model. We will analyze the data below in this example.

<b>x</b>	0	1	2	3	4	5	6	7	8
<b>y</b>	7	10	13	16	19	22	25	28	31

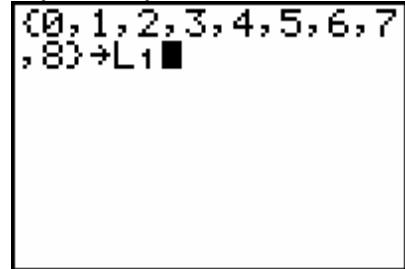
### Entering Data in the Lists of the TI-83 Calculator

Start at the home screen, the screen for which no menus are displayed. We could, of course, start at another location without any difficulty.

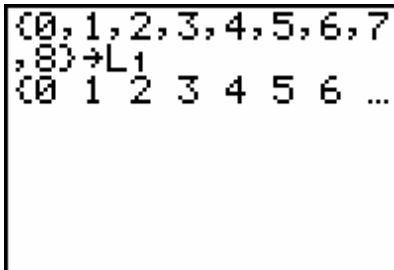


There are two ways in which we can enter data into the calculator, by typing the data entries, separated by commas, within braces or using STAT. Here, we will enter the inputs using the braces and commas. We obtain the left brace and right brace using the key strokes 2<sup>nd</sup> ( and 2<sup>nd</sup> ), respectively. The comma is on the key above the seven. The → is printed on the screen when you press STO, the key above ON.

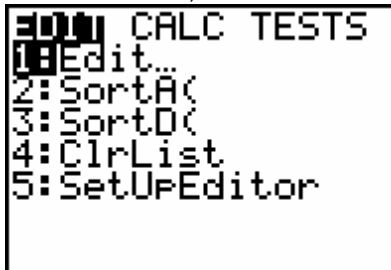
Start at the home screen, the screen for which no menus are displayed. We could, of course, start at another location without any difficulty.



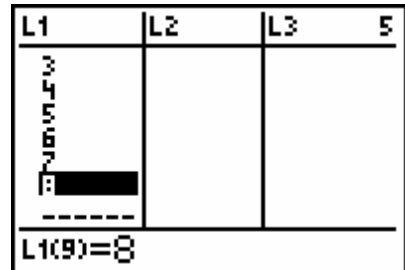
When we press ENTER, the input list is stored in the calculator as list L1.



Now, we will enter the data into the lists using STAT. If we press STAT and select 1 or press ENTER for Edit,

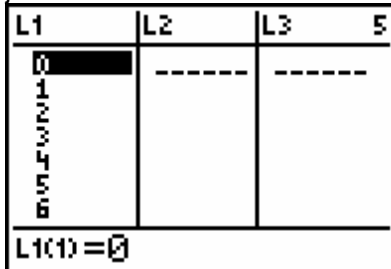


If we press the down arrow key, then we can view the rest of the entries in the L1 list.



Using the right arrow key, we can scroll across the screen to view all the entries.

we see that the inputs that we just entered are stored in list L1.



We can enter the outputs in list L2 in a similar manner.

If we have a list of entries that we want to delete, we can delete them one at a time using DEL or simply move to the top of the list using the up arrow key, press CLEAR, and then press ENTER.

The TI-83 has six built in lists, L1, L2, L3, L4, L5, and L6.

L1	L2	L3	1
██████	-----	-----	
L1(1) =			

You move within the list of list using the arrow keys. Using the RIGHT ARROW we can change the screen to display L4, L5, and L6.

Notice the number in the upper right hand corner of the screen

L4	L5	L6	6
-----	-----	██████	
L6(1) =			

as you use the right and left arrow keys to move from list to list. This number indicates the number of the list in the table of lists in which you are working.

Using this number, we know that there are five more lists to the left of our current list location.

To simplify our discussion of the calculators and our work, we will use list names L1 and L2 for the inputs and the outputs, respectively.

In addition to lists L1, L2, L3, L4, L5, and L6, we use five-character list names of our choice as long as the name of the list begins with a letter.

To enter the new lists, we first must move to the top row using the UP ARROW

L4	L5	7	6
-----	-----	-----	
L6 =			

and then move to the right using the RIGHT ARROW until a new, unnamed list is displayed on the screen.

Since the calculator is in ALPHA mode, indicated by the A at the

L5	L6	██████	A
-----	-----		
Name =			

top of the new list, we simply type the name of the list and press ENTER.

For example, we might like to name the input list DATA1. So, we type DATA1 and press ENTER.

L5	L6	DATA1	7
-----	-----	-----	
DATA1 =			

Now we have a new list named DATA1.

Since we will use list L1 for the inputs and list L2 for the outputs, we move back to the left using the LEFT ARROW until these lists are displayed on the screen.

7	L2	L3	1
-----	-----	-----	
L1 =			

Again, if there were any individual entries in this list that we want to remove, we can delete them by using the UP ARROW or DOWN ARROW to move to the appropriate position and then deleting list entry using the delete key, DEL. If we want to clear an entire list, we move to top of the list using the UP ARROW until the list name is highlighted, press CLEAR, and then press ENTER.

The list is now ready for entering the data. Now we simply type the data, pressing ENTER or the DOWN ARROW after each entry.

L1	L2	L3	1
██████	-----	-----	
L1(1) =			

We move to L2 using the RIGHT ARROW and enter the data in the same way.

L1	L2	L3	Z
3	16		
4	19		
5	22		
6	25		
7	28		
8	31		
-----			
L2(10) =			

Since we can view the entries in both lists simultaneously, we can easily check that the entries are entered correctly and that the lists are of the same length. Thus, using the EDIT entry in the STAT menu is the simplest manner in which to enter data.

To exit the lists, we simply QUIT using the key sequence 2<sup>nd</sup> MODE. This brings us back to the HOME SCREEN.

If we want to display a list on the home screen, we can access the list names using LIST or by simply typing the list name on the HOME SCREEN and pressing ENTER.

The list entries are displayed on the screen within braces. We can view the entries that are not displayed on the screen by pressing the RIGHT ARROW.

It is important to note that the built in lists L1, L2, L3, L4, L5, and L6, accessed using the 2<sup>nd</sup> key in combination with the 1, 2, 3, 4, 5, or 6 key, respectively, on the calculator, are different from lists that we may enter by typing L and one of these numbers when we are entering an alpha-numeric list name. Unfortunately, these list names can be difficult to distinguish initially.

Since our lists are L1 and L2, we can use the keypad to display these list names on the screen: L1, L2, L3, L4, L5, and L6 are displayed in yellow above the 1, 2, 3, 4, 5, and 6 keys, respectively.

We use the key sequence 2<sup>nd</sup> 1 ENTER to display list L1 on the screen.

L1							
(0	1	2	3	4	5	6	...

Using the RIGHT ARROW we can display the rest of the entries.

L1							
...	2	3	4	5	6	7	8)

This is the same manner in which we examined the input list earlier when we entered the inputs between braces and separated by commas. Notice that the commas are not used to separate the list entries whether we enter the list using the STAT EDIT menu or on the home screen.

You can store the data in any list and then move the data to L1 and L2. Suppose you have input list DATA1 and output list DATA2.

We use the key sequence 2<sup>nd</sup> STAT to access the list names. If you have not entered lists with names other than L1, L2, L3, L4, L5, or L6, you will not have any lists under NAMES.

NAMES	OPS	MATH
1: DATA1		
2: DATA2		
3: EXC		
4: EXC1		
5: EXC2		
6: EXC3		
7: EXC4		

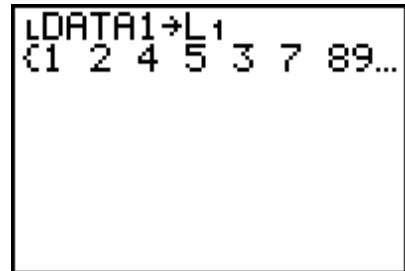
Although the list names appear in the LIST NAMES menu in the form in which we entered them in the STAT EDIT menu, the calculator is programmed to use a prefix L when typing user entered list names on the HOME SCREEN. So, the list that we named DATA1 is presented as LDATA1 when we select this list by pressing 1 or ENTER in the LIST NAMES menu. We can see this in the next screen capture.

Pressing 1 or ENTER we display the list name on the screen.



We press STO to store the list and L1, key sequence 2<sup>nd</sup> 1, to indicate the list into which we want to store the data. We press ENTER to execute.

The calculator displays the new list entries on the screen within braces.



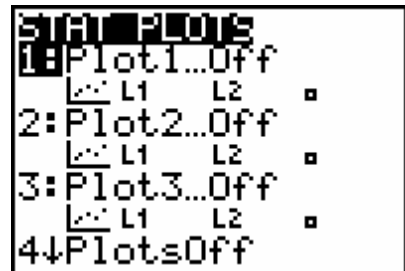
So, we can save data in user named lists and move the data to other lists to rename the data list or to move the data into a list that might be easier to access in our calculations.

### Viewing the Scatter Plot

Since we are graphing data points, the graph that we want to make is a scatter plot. We want to make sure that the graph that we display has only the data points: a scatter plot does not have connected dots. We can graph multiple data sets and functions at the same time. If we want to graph only the data points, we must make sure that only the plot of interest is turned on and that no functions are selected for graphing.

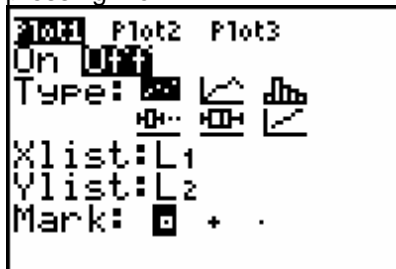
We can return to the HOME SCREEN using QUIT, key sequence 2<sup>nd</sup> MODE. You can also return to the HOME SCREEN by pressing CLEAR. Please be careful of where the cursor is when you press CLEAR since you could delete data or other important information.

We need to set up one of the STAT PLOTS so that the data in the lists L1 and L2 will be graphed. To begin, we press 2<sup>nd</sup> and Y= to access the STAT PLOT.

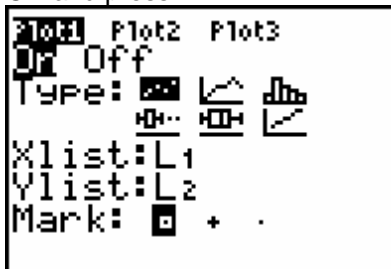


We must be careful of using CLEAR when we are working within the data lists since we could delete data or erase an entire list of entries. In addition, when we are working in the function menu, Y=, pressing ENTER can cause us to delete the function that we just entered or a function that we want to save. Therefore, we should make a point of using the key sequence 2<sup>nd</sup> MODE for QUIT; CLEAR may be quicker in some cases but it can cause us to waste time re-entering information, equations, or data.

Then we select one of the plots. Here we will select PLOT1 by pressing 1 or ENTER.



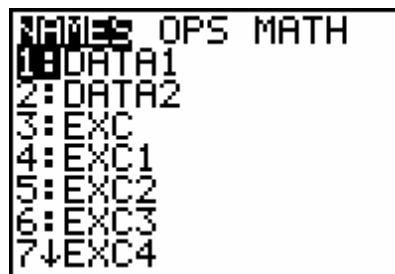
We see that the plot is currently Off. To turn the plot on, we make sure that the blinking cursor is on ON and press ENTER.



Now that the plot is turned on we must make sure that we select the type of graph that we want, a scatter plot, specify the input list and output list that we want to graph, and select the mark that we would like to use in the graph. In this case, the scatter plot is already selected, the correct lists have been specified, and a good mark is selected.

If we want to change any of the information, we use the arrow keys to move around on the screen and we press ENTER on the graph type or the mark type that we want to select. If we want to specify lists L1, L2, L3, L4, L5, or L6, we use 2<sup>nd</sup> and the

corresponding key 1, 2, 3, 4, 5, or 6, respectively. If we want to use a different lists, DATA1 and DATA2, for example, we access the list names using LIST and press ENTER or the corresponding list number on the screen.



Here we select list 1, DATA1, for the inputs, and list 2, DATA2, for the outputs.



We can also type the corresponding input list and output lists at the appropriate locations on the screen. Now this plot will graph the data

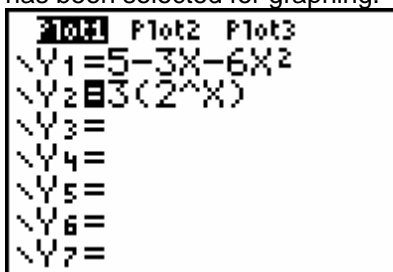


in lists DATA1 and DATA2. However, since the data that we have been discussing is in L1 and L2, we change these back to the original form.



Since we want to graph only the data at this time, we want to make sure that we do not have any functions turned on for graphing. We press Y= to see if there are any functions selected for graphing. If the equal sign for the function equation is highlighted then the function has been selected for graphing.

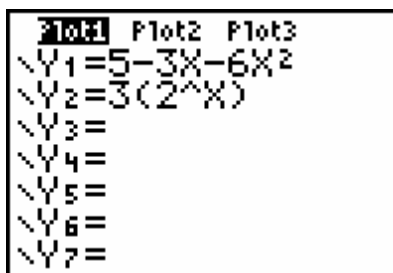
Here we see that there are two functions  $Y_1$  and  $Y_2$ , one of which has been selected for graphing.



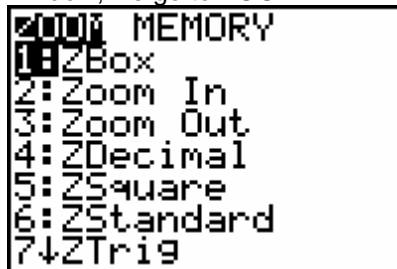
If we want to save these functions for future use, we must make sure that the equal sign in the equation is not highlighted. We move to the equation of interest, here  $Y_2$ , position the cursor on the equal sign, and press enter. Remember that we move around on the screen using the arrow keys.

Curves for function equations selected for graphing, indicated by a highlighted equal sign, will be generated when we use any of the calculator's graphing capabilities. If the graph window is not appropriate for the function, the curve will not appear on the screen. However, the calculator takes time to generate data for all functions selected for graphing. Therefore, if our graph seems to take longer than usual to generate, we will most likely find that we have at least one function selected for graphing when we examine the Y= menu. In addition, when we are generating a scatter plot and we find a stray line or curve on the screen, we are guaranteed to find at least one function selected for graphing. Once we have turned off this function for graphing and generate the desired graph again, we will be able to view the desired scatter plot (and/or function curve) on the screen.

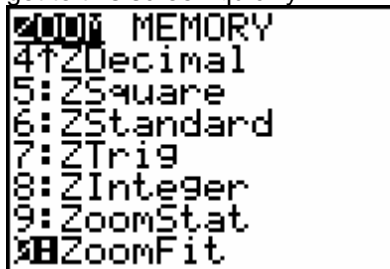
Since the equal signs are no longer highlighted, neither of these functions will be graphed.



To get a quick graph of the data without needing to set the window, we go to ZOOM.

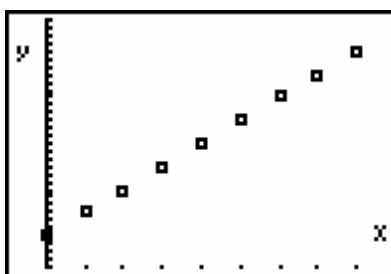


We move to the next screen of ZOOM entries using the UP ARROW or DOWN ARROW; press the UP ARROW once to get to this screen quickly.



We select 9 for ZoomStat; we can move down to ZoomStat using the DOWN ARROW and press ENTER.

Now, we have our graph.

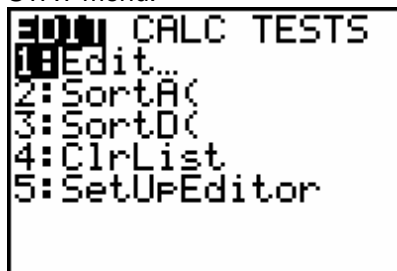


We are ready to analyze the scatter plot to determine what model is appropriate for the data. In this case, a linear model is appropriate for the data since the output increases as the input increases and the scatter plot displays no curvature, no extrema, and no asymptotes. |

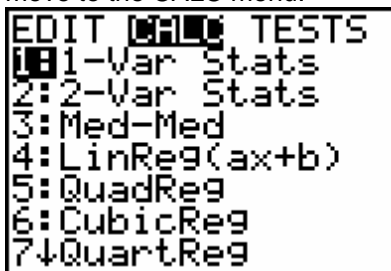
## Regression

We access the built in regression programs using CALC on the STAT menu. We can determine the equation for the data and store the equation in the calculator so that we can view the graph or use the function equation later.

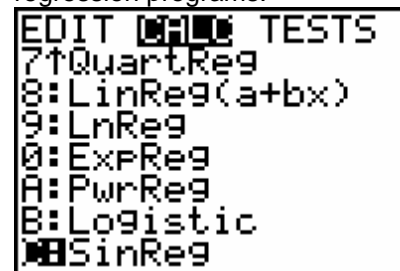
We press STAT to access the STAT menu.



Since we want to find the function equation for the data, we will use the RIGHT ARROW to move to the CALC menu.



By pressing the UP ARROW we can view all the options that are available. The entries ending with Reg are the built in regression programs.



Since we are studying linear, quadratic, cubic, exponential, and logistic functions, we will use the LinReg, QuadReg, CubicReg, ExpReg, and Logistic programs. We notice that there are two LinReg programs available, one uses the form  $y = ax + b$  and the other uses the form  $y = a + bx$ . Both linear regression programs, LinReg(ax+b) and LinReg(a+bx), will produce the same linear function equation. However, as we can see from the forms, ax+b and a+bx, the values for a and b will be switched. While it does not matter which one of these programs that we use, we must be careful to write the function equation so that the slope of the linear function is the coefficient of x. To our advantage, the TI-83 is programmed to write the general form for the function equation and the equation coefficients every time we run one of the regression programs.

Since our data is linear, we will use one of the LinReg programs. You can select either one. Here we select option 4; press 4 or move the cursor to the 4 using the UP or the DOWN ARROW and press enter. The selection will appear on the screen.

```
LinReg(ax+b)
```

If we press ENTER, we will get the coefficients and equation for the linear function for this data.

```
LinReg
y=ax+b
a=3
b=7
```

We can enter this equation manually by typing the equation in the function list in Y=. However, we can have the calculator store the equation for us by specifying an equation name when we run the linear regression program. We can also specify the list names: this is necessary if

you plan to use input and output lists other than L1 and L2. LinReg(ax+b) L1, L2 performs linear regression on input L1 and output L2.

```
LinReg(ax+b) L1,
L2
```

To access the list of function names, we press VARS.

```
VAR2 Y-VARS
1:Window...
2:Zoom...
3:GDB...
4:Picture...
5:Statistics...
6:Table...
7:String...
```

We use the RIGHT ARROW to move to Y-VARS, the y-variables,

```
VAR5 Y-VARS
1:Function...
2:Parametric...
3:Polar...
4:On/Off...
```

and we press 1 or ENTER for the function names. We can select any of these function names. Here we select  $Y_1$  by pressing 1 or ENTER.

```
FUNCTION
1:Y1
2:Y2
3:Y3
4:Y4
5:Y5
6:Y6
7:Y7
```

LinReg(ax+b) L1, L2,  $Y_1$  runs linear regression on input list L1 and output list L2, storing the regression equation as  $Y_1$  in the Y= function equation list.

```
LinReg(ax+b) L1,
L2, Y1
```

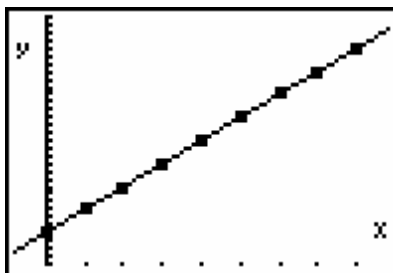
Pressing ENTER, we obtain the same result as before. However, this time we do not need to enter the equation in the calculator since this equation is already stored for us in the function list Y=.

```
LinReg
y=ax+b
a=3
b=7
```

We can view the function equation by simply pressing Y=. Now we have the function  $Y_1=3x+7$  in place of the previous  $Y_1$ .  $Y_2$  has not changed.

```
Y1= 3X+7
Y2= 3(2^X)
Y3=
Y4=
Y5=
Y6=
Y7=
```

If we want to view the data scatter plot together with the graph of the function, we can use ZoomStat as we did when we graphed the data. In this case we do not have to set the graph window since we have not changed the window settings since we graphed the scatter plot for the data set.



We can also set the WINDOW and then press GRAPH to display the graph of the data and the function together. We can now analyze the fit of the continuous function that we found using linear regression to the data set under examination.

We use QuadReg for quadratic regression, CubicReg for cubic regression, ExpReg for exponential regression, and Logistic for logistic regression. You specify the list names, store the function equation, view the function equation, and view the graph in the manner described above.

Please remember that practice is important. Do not be concerned if you get any error messages. Errors happen. You can select QUIT in the ERROR menu to quit or GOTO to go back to where the error occurred in order to try to correct the error.

The error DIM MISMATCH tells us that one of the lists that we are using is longer than the other. In this case, we should check the input list and the output list for missing or extra values; using the EDIT option in the STAT menu, we can quickly check and change the entries in both lists.

If we cannot view our data in the calculator window then we may not have set the window properly or we may not have turned on the STAT PLOT for viewing the lists of data. To check the first of these cases, we press WINDOW to view the values of Xmin, Xmax, Ymin, and Ymax or we can simply press ZOOM and select ZoomStat so that the calculator will automatically set the window to fit the minimum and maximum values of the input and the output for the data. However, if the scatter plot does not appear on the screen then we know that we must check the STAT PLOT using the key combination 2<sup>nd</sup> Y=: we must make sure that one of the STAT PLOTS is turned on to graph the input list and output list of interest using the desired graph type with an appropriate point marker.

*Please remember that you are always welcome to see me for help. - Prof. M.*