

# Regressions and Scatter Plots on TI-89 Calculators

These instructions are designed to enable you fit a variety of curve types to data given as sets of points using the regression commands of the calculators, and then to graph the resulting functions along with the data points in order to check the fit visually. This guide is for the TI-89 and its family; there is a separate one for the TI-83/84 and its ilk.

For the data, I am using the table from problem 33, p. 89, in Finney, Demana, Waits, Kennedy *Calculus: Graphical, Numerical, Algebraic*, Prentice Hall, 2003. The instructions ask for a quadratic regression on the data and a plot comparing the regression curve to the data points. The instructions further say that  $t = 0$  will represent 1990,  $t = 1$  1991, and so on.

Year	INS Funding (\$ billions)
1993	1.5
1994	1.6
1995	2.1
1996	2.6
1997	3.1

<b>Step 1: Getting ready to enter the data.</b>	
<p>You're going to be using the Stats/List Editor, which is one of the Flash Apps. First, press the APPS key.</p> <p>Choose FlashApps...</p>	
<p>And then the Stats/List Editor.</p>	
<p>You'll get to a screen that asks you what folder to use. Ignore this, and hit <b>ENTER</b> again.</p>	
<p>You'll get to the data entry screen. Mine already has a bunch of numbers in it. If you don't have list1 as the first list on the left, first try using your left arrow key to see if you're just over too far. If it's still not there, go to the Extra Commands section at the end of this document.</p>	
<p>To clear out the first column, move your cursor to the list1 at the top of the column, and then press <b>CLEAR</b> and <b>ENTER</b>. (Do not press <b>DEL</b>. If you have already pressed <b>DEL</b>, you'll also want to look at the Extra Commands section.) Before pressing <b>CLEAR</b>:</p>	

After pressing <b>CLEAR</b> :	
(The difference is at the bottom.)	
After pressing <b>ENTER</b> :	
Pretty.	
Do the same thing with List 2. You should get a nice empty pair of lists, as seen at right. (I've emptied the other two lists on my screen, too, so they don't distract you.)	

<b>Step 2: Entering the data.</b>	
This is easy. Put the cursor just under the list1, on the dashed line, and type the first value from the $x$ -column (it may be called something else, like $t$ , but it's the independent variable that we're going to be using for the regression, whatever it happens to be called.)	
Hit <b>ENTER</b> . The 3 (for 1993) will appear in the right place in the list, and you'll be on the next line ready to enter the next value. Keep doing this for the rest of the values in the first column. (Note that you do want to enter an entire column at once rather than one point at a time. It is ridiculously difficult to enter the $x$ and then the $y$ before going on to the next point.	
Now move your cursor to the list2 column and do the same thing with the dollar amounts.	
What if you make a mistake typing? You can type over a value to replace it. If you enter too many values, put the cursor on the one you want to remove, and hit the <b>←</b> key.	
That's it, the data is in.	

<b>Step 3: Finding the regression equation.</b>	
Hit <b>F4</b> , the Calc menu.	
The 1-Var Stats and 2-Var Stats are used for calculating things like mean and standard deviation, and their syntax is not difficult, but is beyond the scope of this tutorial.	

Move your cursor down to Regressions, and press the right arrow key to see the pop-out menu.



The commands are for the various sorts of functions you can select to model your data.

This problem specifically asks for a quadratic regression, and that's the QuadReg command here.

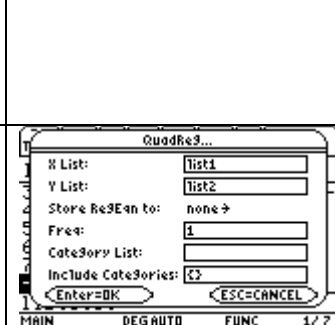


Select it. You will get a dialog box as shown here.

This command has been used before on this calculator, and clearly the last time I used lists 1 and 4. I'll just change the 4 to a 2 by backspacing the 4 out. If you don't have anything in those places, you'll have to type out the word "list" letter by letter. (I know, poor you.) The T is a key of its own, next to X, Y, and Z. Once you've gotten the word in once, you can copy and paste it. See Extra Commands for how to do that.



Now you tell the calculator where to look for our data, which would be in lists 1 and 2.



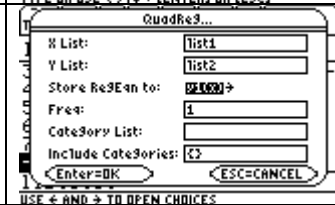
By itself, this would get you the equation you want, but since you know you're going to want to graph the result, it's simplest to tell the calculator to go ahead and store the result in one of the Y positions on the  $\overline{Y=}$  screen. Move your cursor down to the line that says "Store RegEqn to:" and press the right arrow for the drop-down menu.



Move your cursor to the name of the function you want to use (in my case, it's y1) and press **ENTER**.



There it is. I don't want to change the frequency away from 1, and I've never used the category stuff at all, myself.



That's the command, ready to go. Hit the **[ENTER]** key. The calculator will think for a moment, and then give you its results.

Here's what it means. The **QuadReg** at the top is just telling you what command you used. The second line tells you the form of the equation you're getting so you'll know what the constants represent. And the last three lines tell you the values of those coefficients, to the accuracy of the calculator. In math, you'd type the resulting function as

$$y = 0.057142857143x^2 - 0.151428571429x + 1.139428571429$$

or perhaps with fewer significant figures, as

$$y = 0.05714x^2 - 0.1514x + 1.139.$$

Ignore the value given for  $R^2$ . To learn more, see the Extra Commands section at the end.



If you go to the **[Y=]** screen (**[♦]**, followed by **[F1]**), you can see that the equation in all its digital glory has been entered as **y1** there.



#### Step 4: Plotting the data along with the curve.

In order to get the points to graph along with this, we're going to set up a **Plot**. If you have other functions in your other **Y** lines, you may want to turn them off. Or you can have additional regression results for different types of functions there, which you'd get by using **y2** or **y3** instead of **y1** in the regression command.

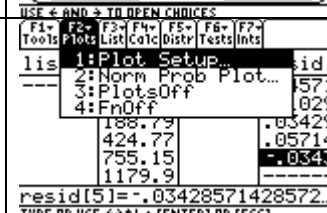
From the **[Y=]** screen, move your cursor to one of the **Plot** lines.

Hit **[F3]** **Edit** to get a dialog box for the plot.

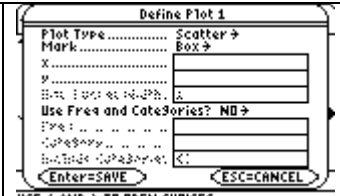


You can get to this same thing from the **Stats/List Editor** Screen. It's **[F2]** **Plots**.

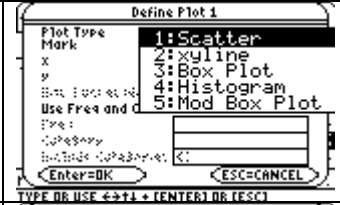
Then you choose **[F1]** **Define** from the list of plots.



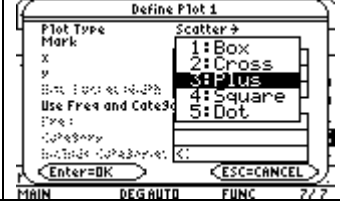
Okay, back to the Define Plot 1 screen:



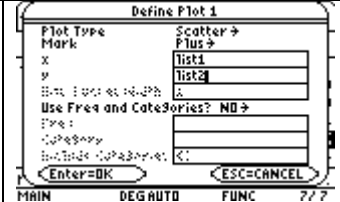
If you move your cursor to the Plot Type entry (Scatter here), you'll see the five types of plots you can get. As it happens, we want Scatter, so hit **ENTER**.



Next, choose a Mark. I like the Plus, myself. **ENTER**.

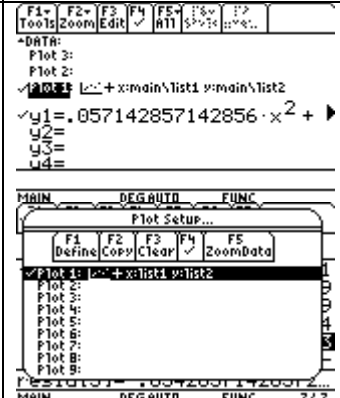


As you can see above, my  $x$  and  $y$  lists are not specified, so this time I'll be typing the names in myself, "list1" and "list2" – I *could* go back and copy them, but instead I'll type the first one and copy it to paste in for the second.



I definitely do *not* want to use frequencies. If that says YES, change it to NO.

Then hit **ENTER** to save the plot. If you *don't* hit enter, I promise you'll wish you had. I've done that many times myself. I say bad words. At this point you'll be on the screen that got you to the Plot Setup (either the **Y=** screen or the Plot Setup screen).



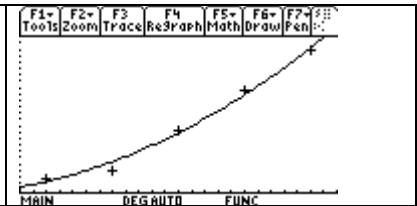
Now for the almost-no-work part that sets up the graph perfectly. You want to Zoom Data. If you're on the **Y=** screen, choose **F2**. (If you're on the Plot Setup screen, **F5** is ZoomData right now. Pick that.)



Scroll down until you see ZoomData.

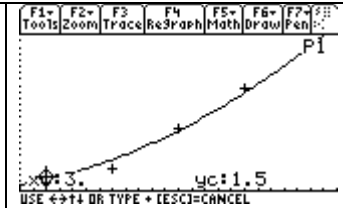


Select ZoomData, and you'll go immediately to a graph with the window set up so that your points from lists 1 and 2 fit perfectly. And the regression curve is superimposed on them, just like you want.



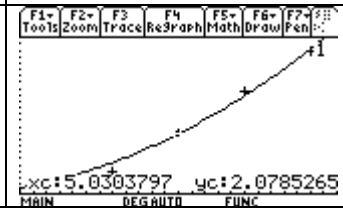
### Step 5: Tracing on this graph

If you press [F3] to trace and try to trace along the curve, you'll probably be a little surprised at the result.



The calculator traces the points on the plot rather than on the curve. Don't panic. I can see that's what it's doing because in the upper right corner of the screen it's labeled P1 for Plot 1.

To trace on the curve instead, press the down arrow. That will take you down the list of equations in the [Y=] screen, and it will again tell you at the top which one you're on, in this case number 1.



### Extra Commands

First, I'll take you through the various regression types available. This is from the Stats/List Editor, Calc, Regressions.



The first two are linear regressions. The dialog boxes these are just like for a quadratic regression. You'll note that you can have the line with the y-intercept first or last. I don't know why they bother with two types. I'll just be showing you the results.



That's a line with slope of 0.42 and y-intercept of 0.08.

MedMed is a median-median line; if you don't know what that is, skip it.

Cubic regression:



Quartic regression:



LnReg gives a natural logarithm function. You'd use it when you want something that's shaped like a logarithm curve. You're supposed to know what that looks like.



ExpReg gives an exponential function. The base is a constant rather than  $e$ , although you could change it to  $e$  algebraically if you chose to. Yeah, right.



On to the next screen full of regression types:



PowerReg is *not* the same thing as an exponential regression. It gives what's called a power function,  $y = ax^b$ , where the variable is the base and the coefficient and power are constants. If  $b$  is a positive integer, you get the quite ordinary polynomial functions through the origin (since there's no horizontal or vertical shift in the formula). If it's something nonintegral, you get something sort of between those. Graph them, and you'll see what I mean.



Logist83 and Logistic

These are used primarily to model functions that appear to have both a lower and an upper horizontal asymptote, like a stretched out S. I'll have to put some additional data in my calculator to get this to work. In good notation, the Logistic 83 form looks like

$$y = \frac{c}{1 + ae^{-bx}}$$

and it's called Logist83 because it's the same result a TI-83 would give. The just-plain-logistic one allows a vertical translation on that one, and looks like this.

$$y = \frac{a}{1 + be^{cx}} + d$$

The 83's version is really the standard logistic function in mathematics.



Finally, SinReg is a sine regression. It's most useful for data that appears to be periodic. You can tell it your guess at the period as a number after the second list, if you have a guess. It's good for data that you believe to be monthly or yearly, or on some other basic time cycle. I'll use an entirely different set of data (what it is doesn't matter at all, I'm just making it up with copious use of the Rand command) in order to get a result.





Choose Copy, which is  $\blacklozenge$ -Shift. Move the cursor to the second box and this time choose Paste (next to copy). Magic. I'd still need to type in the 1 and 2 to complete the list names. One very cool feature here is that the same thing remains in the clipboard until I copy something over it. Even if I turn off the calculator.



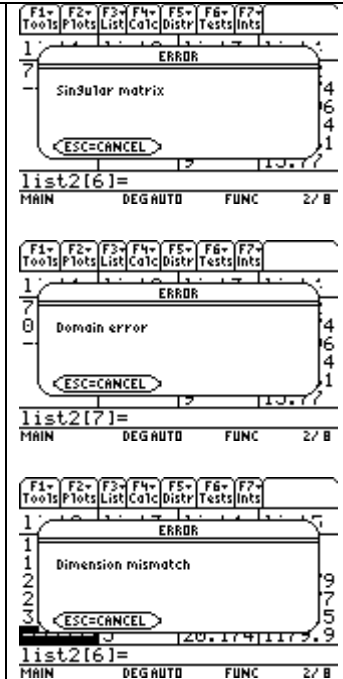
### Common causes of error results on the calculator:

Some of the regressions require a fairly large set of data, definitely more than the 5 points we started with. For instance, when I tried to run a Logist83 regression on that set, I got this screen.

To get a result at all, I just added a bunch more points with increasing values that I thought would make sort of a logistic shape. The sine regression is looking for a periodic pattern, and with too little data or if there isn't one, you might have problems.

The other common place things can go wrong is when (0, 0) is a member of the set of points and the function created can't go through that point. A logarithmic regression where that point is included gives the same domain error as the logistic one did. If you think that a shape is good but can't include the point at the origin, you might try replacing it by something like (0.1, 0.1) to see if you get what you want. When I did that with the LnReg, I got a result this time.

If you should get a dimension mismatch error, chances are your lists aren't the same length. Fix that and try again.



That's all I can think of right now. I hope you find this helpful.