

Regressions and Scatter Plots on TI-83/84 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-83 family of calculators; there is a separate one for TI-89s.


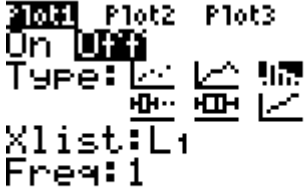
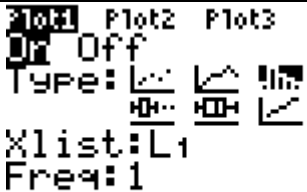
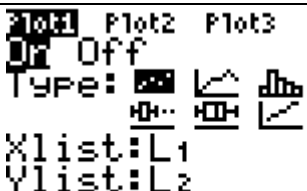

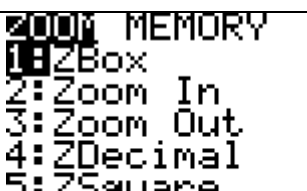

For the data, I am using the table from problem 33, p. 89, in Finney, Demana, Waits, Kennedy *Calculus: Graphical, Numerical, Algebraic*, Prentice Hall, 2003. The instructions ask for a quadratic regression on the data and a plot comparing the regression curve to the data points. The instructions further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

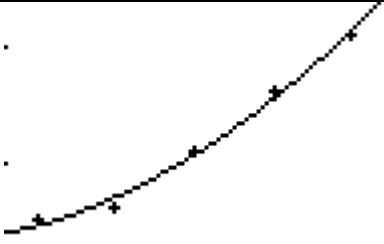
Year	INS Funding (\$ billions)
1993	1.5
1994	1.6
1995	2.1
1996	2.6
1997	3.1

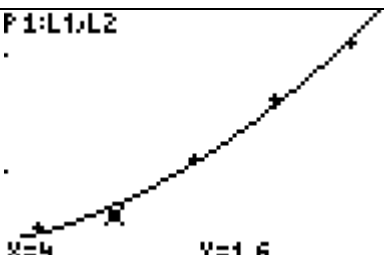
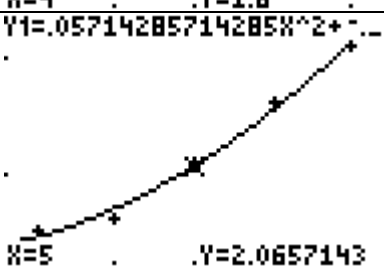
Step 1: Getting ready to enter the data.	
<p>To get to the entry screen, first press the [STAT] key, which is near the arrows.</p> <p>Choose Edit... (by hitting [ENTER]).</p>	
<p>In this case, there's already some data in the first two lists, and I'll clear it out first. If what you see isn't L1, L2, and L3, first try using the arrow keys to move left on the screen; maybe you just can't see them. If they still aren't there, see the Extra Commands section at the end of this document. You want the SetUpEditor command.</p>	
<p>To clear out the first column, move your cursor to the L1 at the top of the column, and then press [CLEAR] and [ENTER]. (Do not press delete. If you have already pressed delete, you'll also want to look at the SetUpEditor command.)</p>	
<p>Before pressing [CLEAR]:</p>	

<p>Step 3: Finding the regression equation.</p> <p>Once again, hit the [STAT] key. It's not necessary to leave the data entry screen first.</p>	<pre> 2nd [CALC] TESTS 1: Edit... 2: SortA(3: SortD(4: ClrList 5: SetUpEditor </pre>
<p>This time, move your cursor to the right to the CALC menu.</p> <p>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. Ignore them. Med-Med is the first of the regressions, but if you don't know what a median-median line is, just skip it. The next several commands are for the various sorts of functions you can select to model your data.</p>	<pre> EDIT [CALC] TESTS 1: 1-Var Stats 2: 2-Var Stats 3: Med-Med 4: LinReg(ax+b) 5: QuadReg 6: CubicReg 7: QuartReg </pre>
<p>This problem specifically asks for a quadratic regression, and that's the QuadReg command here.</p>	<pre> EDIT [CALC] TESTS 1: 1-Var Stats 2: 2-Var Stats 3: Med-Med 4: LinReg(ax+b) 5: QuadReg 6: CubicReg 7: QuartReg </pre>
<p>Select it. You will be taken back to the main screen.</p> <p>Notice the vast blank expanse of screen. I had nothing else there to begin with. You definitely don't want anything in front of the command on the <i>same line</i>. If there's something there, delete it.</p>	<pre> QuadReg █ </pre>
<p>Now you tell the calculator where to look for your data, which would be in lists 1 and 2. Those names, L1 and L2, are on the 1 and 2 keys on your calculator. Hit the 2nd button first to access them, and separate them by a comma (just above the 7 key), like this:</p>	<pre> QuadReg L1,L2 █ </pre>
<p>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 [Y=] screen. I'm going to append a comma followed by Y1. You can find the Y variables by using the [VARS] key, just below the arrows on your keyboard.</p> <p>First, enter the comma.</p>	<pre> QuadReg L1,L2, █ </pre>

<p>Now hit the [VAR] key.</p>	<pre> VAR Y-VARS 1:Window... 2:Zoom... 3:GDB... 4:Picture... 5:Statistics... 6:Table... 7:String... </pre>
<p>Move your cursor over to the Y-VARS menu.</p>	<pre> VAR Y-VARS 1:Function... 2:Parametric... 3:Polar... 4:On/Off... </pre>
<p>Choose Function, and then Y1.</p>	<pre> FUNCTION 1:Y1 2:Y2 3:Y3 4:Y4 5:Y5 6:Y6 7:Y7 </pre>
<p>After you hit [ENTER] there, you will be back at the main screen.</p>	<pre> QuadReg L1,L2,Y1 █ </pre>
<p>That's the command, ready to go. Once again hit the [ENTER] key. The calculator will think for a moment, and then give you its results.</p> <p>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</p> $y = 0.0571428571x^2 - 0.1514285714x + 1.1394285714$ <p>or perhaps with fewer significant figures, as</p> $y = 0.05714x^2 - 0.1514x + 1.139.$ <p>If there's a value given for R^2, don't worry about it. To learn more, see the Extra Commands section at the end.</p>	<pre> QuadReg y=ax^2+bx+c a=.0571428571 b=-.1514285714 c=1.394285714 █ </pre>
<p>If you go to the [Y=] screen (the button on the top left of the calculator), you can see that the equation in all its digital glory has been entered as Y1 there.</p> <p>The cursor is actually blinking on the decimal point, and you can't see it here. Sorry.</p>	<pre> Plot1 Plot2 Plot3 \Y1=0.05714285714 285X^2+-.1514285 7142857X+1.39428 57142857 \Y2= \Y3= \Y4= </pre>

Step 4: Plotting the data along with the curve.	
<p>In order to get the points to graph along with this, we're going to set up a STAT 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.</p>	 <pre> STAT PLOTS 1:Plot1...Off L1 1 2:Plot2...Off L1 L2 3:Plot3...Off L1 L2 4↓PlotsOff </pre>
<p>Choose STAT PLOT, which is 2nd of the = key.</p>	 <pre> Plot2 Plot3 On Off Type: Scatter Xlist: L1 Freq: 1 </pre>
<p>Mine are all turned off to begin with. Yours might not be. Select the first one by hitting ENTER.</p>	 <pre> Plot2 Plot3 On Off Type: Scatter Xlist: L1 Freq: 1 </pre>
<p>First you'll want to turn it on. With the cursor on the On, hit ENTER.</p>	 <pre> Plot2 Plot3 On Off Type: Scatter Xlist: L1 Ylist: L2 Mark: □ </pre>
<p>Then select the type of plot you want. We need a scatter plot, which is the first one. It looks like a bunch of dots in the first quadrant (☐). Put your cursor there, and hit ENTER.</p>	 <pre> Plot2 Plot3 On Off Type: Scatter Xlist: L1 Ylist: L2 Mark: □+ </pre>
<p>You'll notice that the bottom of my screen changed. What's there depends on what type of plot is selected at the time. I want the Xlist and Ylist to be L1 and L2, as they are. If yours say something else, put your cursor there and type L1 and L2 from the keyboard as you did earlier. For the Mark, you can choose whatever you like. I'm a little partial to the little crosshair, but it's up to you.</p>	 <pre> Plot2 Plot3 On Off Type: Scatter Xlist: L1 Ylist: L2 Mark: □+ </pre>
<p>Now for the almost-no-work part that sets up the graph perfectly. Hit the ZOOM key at the top middle of the calculator.</p>	 <pre> ZOOM MEMORY 1:ZBox 2:Zoom In 3:Zoom Out 4:ZDecimal 5:ZSquare 6:ZStandard 7↓ZTrig </pre>

<p>Scroll down until you see ZoomStat.</p>	<pre> MEMORY 4:ZDecimal 5:ZSquare 6:ZStandard 7:ZTrig 8:ZInteger 9:ZoomStat 0:ZoomFit </pre>
<p>Select ZoomStat, and you'll go immediately to a graph with the window set up so that your points from L1 and L2 fit perfectly. And the regression curve is superimposed on them, just like you want.</p>	

<p>Step 5: Tracing on this graph</p>	
<p>If you press the <code>TRACE</code> key and try to trace along the curve, you'll probably be a little surprised at the result.</p> <p>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 left corner of the screen it's labeled "P1:L1,L2" – duh.</p>	
<p>To trace on the curve instead, press the down arrow. That will take you down the list of equations in the <code>Y=</code> screen, and it will again tell you at the top which one you're on.</p>	

<p>Extra Commands</p>	
<p>First, I'll take you through the various regression types available. This is from the <code>STAT</code> <code>CALC</code> screen.</p>	<pre> EDIT CALC TESTS 1:1-Var Stats 2:2-Var Stats 3:Med-Med 4:LinReg(ax+b) 5:QuadReg 6:CubicReg 7:QuartReg </pre>
<p>First, a <u>linear regression</u>. The syntax for almost all of these is just like for a quadratic regression: type of regression, x-list, y-list, y-variable for the equation. I'll just be showing you the results.</p> <p>That's a line with slope of 0.42 and y-intercept of 0.08.</p>	<pre> LinReg y=ax+b a=.42 b=.08 </pre>

<p><u>Cubic regression:</u></p>	<pre>CubicReg y=ax³+bx²+cx+d a=-.03333333333 b=.5571428571 c=-2.538095238 d=4.994285714</pre>
<p><u>Quartic regression:</u></p> <p>The missing letters on the second line are, of course, c and d.</p>	<pre>QuarticReg y=ax⁴+bx³+...+e a=.01666666667 b=-.3666666667 c=2.983333333 d=-10.13333333 e=13.6</pre>
<p>On to the next screen full of regression types:</p>	<pre>EDIT [ON] TESTS 7↑QuartReg 8:LinReg(a+bx) 9:LnReg 0:ExpReg A:PwrReg B:Logistic [ON]SinReg</pre>
<p>I'll skip the second version of the linear regression here. It just reports the y-intercept first. I've never understood why you'd want both commands. You get the same line both ways.</p> <p><u>LnReg</u> 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.</p>	<pre>LnReg y=a+blnx a=-.837591512 b=1.92644666</pre>
<p><u>ExpReg</u> 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.</p>	<pre>ExpReg y=a*b^x a=.7962620143 b=1.213778453</pre>
<p><u>PwrReg</u> is <i>not</i> the same thing. 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.</p>	<pre>PwrReg y=a*x^b a=.5137548048 b=.8981553506</pre>
<p><u>Logistic</u></p> <p>This one is 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 form looks like</p> $y = \frac{c}{1 + ae^{-bx}}$	<pre>Logistic y=c/(1+ae^(-bx)) a=31.3361867 b=.43330332 c=8.962428057</pre>

<p>Finally, <u>SinReg</u> 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.</p>	<pre>SinReg y=a*sin(bx+c)+d a=4.321788969 b=.3266007551 c=.3944871991 d=4.623053995</pre>
<p><u>SetUpEditor</u> is the quickest way to get L1 through L6 to show up in the <u>STAT</u> Edit screen. It can do more than that, but you don't need any more for what you're going to be doing.</p> <p>Hit <u>ENTER</u>. You'll be back at the main screen. <u>ENTER</u> again runs the command.</p> <p>(Look, leftover stuff from the last regression.)</p> <p>If you go to the Edit screen now, you should see the lists there in order.</p>	<pre> CALC TESTS 1:Edit... 2:SortA(3:SortD(4:ClrList 5:SetUpEditor a=4.321788969 b=.3266007551 c=.3944871991 d=4.623053995 SetUpEditor Done</pre>
<p>The <u>R²</u> statistic.</p> <p>Both R and R² are values that the calculator automatically finds when it runs the appropriate types of regressions. There's a lot to their meaning, but for your purposes, all that matters is that the closer they are to 1, the better the fit of the curve to the data. (Actually, if R is close to -1, that's good, too, for lines.)</p> <p>To turn it on or off, you have to go to the CATALOG for the command. First the CATALOG key (on the zero), and then the key with the D on it to jump to that section. You're looking for the Diagnostic commands. After selecting it, you'll be back at the main screen. Hit <u>ENTER</u> to execute the command.</p> <p>I'll run the very first regression with this turned on so that you can see how it looks. You are <i>not</i> required to use it at all, and if you don't really understand what it's doing, from AP Stats, for instance, you shouldn't depend on it too much.</p>	<pre> CATALOG DelVar DependAsk DependAuto det(DiagnosticOff DiagnosticOn dim(QuadReg y=ax^2+bx+c a=.0571428571 b=-.1514285714 c=1.394285714 R^2=.989996874</pre>

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 Logistic 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. I got divide by zero error this time.

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.

```
ERR:DOMAIN
[ ]Quit
2:Goto
```

```
ERR:DIVIDE BY 0
[ ]Quit
2:Goto
```

```
ERR:DIM MISMATCH
[ ]Quit
2:Goto
```

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