Features of the TI-83
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Summary. This tutorial is divided into three parts. Part 1 discusses the basics of entering a function, graphing a function, and adjusting the view so you can see different parts of the function close up. Part 2 discusses the use of the table command, which allows you to see a table of input and output values for a function of your choice. Finally, Part 3 discusses ways of displaying statistical data on the calculator.

Introduction. To begin, some of the commands for this calculator are executed by keys on the keyboard, and some commands are menu-driven, meaning that pressing a key results in further options appearing on the keyboard, one of which you can then select.

Throughout this tutorial, you will be asked to execute various commands by either pressing keys or choosing options from a menu on the calculator display. To help you tell the difference, keys on the calculator will be represented by boxes (like [STAT] for instance), and options on a displayed menu will be underlined (like the command 1:Edit appearing in the [STAT] menu).
1. GRAPHING A FUNCTION

Important Keys

[Y=] Displays the screen where up to 10 different functions can be entered.

[GRAPH] Tells the calculator to graph the function(s) Y1, Y2, etc., that have been entered by the user.

[WINDOW] Tells the calculator which “viewing window” to display; that is, which part of the xy-plane to show when it graphs functions.

[TRACE] Allows the user to see the numerical values of the x and y coordinates of points on the graph of a function currently being displayed.

[ZOOM] Allows the user to zoom in on a particular part of the graph of a function currently being displayed.

[2nd] [QUIT] Allows you to exit from a menu that you no longer want to edit.

Example 1.1 Graph the function \( y = x^3 - 2x + 2 \) in the viewing window \(-10 \leq x \leq 10 \) and \(-10 \leq y \leq 10 \).

1. Press \([\text{Y=}]\).
2. Type in \( X \land 3 - 2X + 2 \) on the \( \text{Y1=} \) line.
3. Press \([\text{GRAPH}]\).
   
   At this point, the calculator should display a graph of \( f(x) = x^3 - 2x + 2 \). Your picture (or lack thereof) will depend, however, on the current viewing window. To adjust the viewing window,
4. Press \([\text{WINDOW}]\).
5. Edit the screen so that you have the desired viewing window. When you’re done, it should look like this:
   
   \[
   \begin{align*}
   \text{XMin} &= -10 \\
   \text{Xmax} &= 10 \\
   \text{Xscl} &= 1 \\
   \text{Ymin} &= -10 \\
   \text{Ymax} &= 10 \\
   \text{Yscl} &= 1 \\
   \text{Xres} &= 1
   \end{align*}
   \]

   (Caution!! Use the \([-]\) key, not the \( \square \) key.)
As you might have guessed, Xmin and Xmax tell the calculator the range of the $x$ values you want to see, and Ymin and Ymax tell it the range of $y$ values you want to see. Xscl and Yscl tell the calculator how often to mark the $x$ and $y$ axes, respectively. For example, Xscl=1 tells the calculator to mark the $x$ axis every 1 unit, and Xscl=2 tells the calculator to mark the $x$ axis every 2 units.

When you’re done editing:

6. Press $\text{GRAPH}$ to graph $f(x)$ with the new window coordinates.

Example 1.2. Use $\text{ZOOM}$ and $\text{TRACE}$ to estimate the $x$-intercept of $f(x) = x^3 - 2x + 2$.

1. Use the procedure from the previous example to graph $f(x)$ in a viewing window that shows the $x$-intercept.

2. Press $\text{ZOOM}$. Select option 2, Zoom in, by either pressing $\boxed{2}$ or moving your cursor to that line and pressing $\boxed{ENTER}$.

3. Move the cross-hairs as close as you can to the $x$-intercept, and press enter.

Your calculator should now redraw the function, zooming in on the portion of the graph you put the cross-hairs on.

4. Press $\text{TRACE}$.

Now, a new set of cross-hairs should appear on the graph of $f(x)$. As you hit the left and right arrow buttons, the cross-hairs will move along the graph of $f(x)$, and the $x$ and $y$ coordinates of each point will be displayed at the bottom of the screen.

5. Repeat steps 2-4 as needed until $\text{TRACE}$ produces a value of $x$ such that $f(x)$ is close to zero. (Note: The value of the $x$-intercept is about -1.769 to three decimal places.)

Note. Another nice feature of the $\text{TRACE}$ command is that it lets you type in an $x$ value of your choice (that appears on the currently displayed graph) and moves the cross-hairs to that point, also telling you what the associated $y$ value for the displayed function is. To try it, graph any function and press $\text{TRACE}$. Then, key in the $x$ value you want, and press $\boxed{ENTER}$.

2. USING THE TABLE COMMAND

Setup.

The $\text{TABLE}$ command allows you to plug in multiple input values for a function (or several functions) which have been defined on the $\boxed{Y=}$ screen.
Before beginning the next example, you’ll want to set the calculator so it will allow you to choose our own input values. To do this, first press [2nd] [TBLSET]. The last two lines of the screen should be labeled “Indpnt” and “Depend,” representing the independent (input) variable and the dependent (output) variable. To set the calculator so that it will let you choose your own input values when using the table command, edit the screen (if necessary) so that the “Ask” option is highlighted on the “Indpnt” line and the “Auto” command is highlighted on the “Depend” line. To highlight an option, move your cursor to it and press [ENTER]. When you’re done, use [2nd] [QUIT] to exit the menu. (Note. This procedure does not need to be repeated unless a user changes some of the options on the [TBLSET] menu.)

**Example 2.1.** Compare the growth rates of the power function \( f(x) = 2^x \) and \( g(x) = 100x^2 \) by plugging in various lists of \( x \)-values.

1. Enter the formulas for \( f(x) \) and \( g(x) \) for Y1 and Y2.

2. Press [2nd] [TABLE]. Use the [DEL] key, if necessary, to get rid of unwanted input values in the X column.

3. Key in a desired list of input values by typing numbers in the X column and hitting [ENTER]. The output values for Y1 and Y2 should be displayed as you type in your X values. To choose a new list of input values, just type the new X values over the top of the old ones, or use the [DEL] key to get rid of the old X values.

**Note.** If you plugged in some larger values for X in the above example, you might have noticed strange output values with E’s in them. For instance, if you let X=20, the value for Y1 is displayed as 1.05E6. This is the calculator’s way of expressing scientific notation. In other words, 1.05E6 means 1.05 \( \times \) 10\(^6\). Similarly, for very small numbers, 2.35E-8 means 2.35 \( \times \) 10\(^{-8}\).

### 3. STATISTICAL GRAPHICS AND CALCULATION

**Important Key/Option Sequences**
STAT 1:Edit
Displays a screen where various lists of data can be entered, one list for each column. Calculations can then be done with the data, or it can be plotted.

STAT CALC
Displays a variety of options. The ones we will be concerned with are those ending in “Reg” (meaning regression). These options ask the calculator to find the formula for a certain type of function that best approximates a set of data points. For example, 4:LinReg(ax+b) asks the calculator for the best-fit line for a set of data points.

2nd STAT PLOT
Displays a variety of data plotting options. This is the screen where you can turn the statistical point plotting on and off, change the way your calculator displays data when it plots it, etc.

ZOOM 9:ZoomStat
Tells the calculator to automatically adjust the plotting window to fit a set of data points that you want plotted.

Part 1. Using the STAT PLOT Menu.

Pressing 2nd STAT PLOT reveals a menu where 3 different statistical plots can be selected. Anytime you want to plot statistical data on your calculator, like making a scatter plot, a histogram, or a box plot, this is the menu you want to visit to set the calculator up.

To view the options that are available, press 2nd STAT PLOT 1:Plot1.... This should reveal a screen with a variety of options that you can highlight. On the first line, either On or Off will be highlighted. Highlighting On puts the calculator in statistical plotting mode. On the next line, you should see “Type:” followed by six different icons. Each icon represents a different type of statistical plotting mode; from left to right and top to bottom, they are Scatterplot, xyLine, Histogram, modBoxplot, Boxplot, NormProbPlot. For details on these options, see the examples that follow in the upcoming parts.

Part 2. Scatter Plots and Best-fit Lines.

Example 3.1. Plot the following set of points on an appropriate window: (0,23,2), (100,45), (200,72), (300,85), (400,117).

1. Enter the data in the list variables L1 (for the input values) and L2 (for the output values). Do this by first pressing STAT 1:Edit. Then, delete any previous data in the L1 or L2 column. Finally, enter your data so that the x values are all in L1 and the y values are all in L2, and so that corresponding x and y values are in the same row.
2. Press **2nd** [QUIT] to exit the menu.

3. Press **Y=** to enter the screen where you would normally enter functions.

   To tell your calculator that there are data points you want plotted, turn the statistical plotting mode on as follows:

4. Highlight **Plot1** in the upper left hand corner of your screen by moving your cursor to it and press **ENTER**.

   **Note.** Now that **Plot1** is turned on, you need to make sure that (1) the calculator is set to do a scatter plot, and (2) the calculator is set to read input data from L1 and output data from L2. To make sure this is the case, press **2nd** [STAT PLOT] 1:Plot1... to reveal the menu described in Part 1 above. The option **On** should already be highlighted, since you turned on **Plot1** already. Now, highlight Scatterplot (the upper left-hand icon out of the six icons after “Type:”) if it is not already highlighted. Next, make sure that L1 appears after Xlist: and L2 appears after Ylist: (If you need to type either of these in, keep in mind that the list variables **2nd** [L1] and **2nd** [L2] appear directly on the calculator keyboard. On the last line of the Plot1 screen, after **Mark:**, you can choose what you want your plotted data points to look like by highlighting whichever point style you prefer.

   In addition, if you want your calculator to plot only your data points (and not other functions Y1, Y2, etc., as well), go back to the **Y=** menu and clear out any old functions that were entered earlier. Finally, to plot your data points,

5. Press **GRAPH**.

   If you don’t see anything, it’s probably because your calculator is not using a window that contains your points. You can either use **WINDOW** to choose a window that fits your data, or you can ask your calculator to automatically choose a window that fits your data well as follows:


   Finally, anytime you’re done plotting and working with data, it’s a good idea to turn the statistical plotting mode off; otherwise, your calculator will continue to plot your data every time you graph a function! To do this,

7. Press **Y=**, place your cursor over the highlighted **Plot1**, and press **ENTER** to ‘‘unhighlight’’ it.

**Example 3.2.** Find a formula for the best-fit line for the previous set of data points from the previous example (they are (0,23.2), (100,45), (200,72), (300,85), and (400,117)), and plot this line together with the data points.
1. If necessary, enter this data into the list variables L1 and L2 by doing steps 1 and 2 the previous example.

2. Return to the home screen by pressing 2nd QUIT. In other words, make sure the calculator isn’t inside some menu before going on.

Now, it’s time to find a formula for the best-fit line. Below are two ways which will lead to a formula for the best-fit line. The only difference between the two is that the first merely asks for a formula for the best-fit line. The second asks for the formula of the best-fit line and asks the calculator to store this formula in the variable Y1, thus saving you the trouble of entering the formula in yourself before you graph the line.

3. (a) Press STAT CALC 4:LinReg(ax+b). At this point, you should see ‘‘LinReg(ax+b)’’ on the display of your calculator. Now, press ENTER. The calculator then tells you that the regression line has the formula \( y = ax + b \), that \( a = 0.2276 \), and that \( b = 22.92 \).

   (b) Press STAT CALC 4:LinReg(ax+b). At this point, you should see ‘‘LinReg(ax+b)’’ on the display of your calculator. Now, you want to tell the calculator to store the result of the calculation in the variable Y1. To do this, press VARS Y-VARS 1:Function 1:Y1. Your calculator screen should now read ‘‘LinReg(ax+b) Y1’’. If this is right, press ENTER. The calculator then tells you that the regression line has the formula \( y = ax + b \), that \( a = 0.2276 \), and that \( b = 22.92 \).

In both of the above cases, the calculator indicates that the best-fit line has a formula of \( y = 0.2276x + 22.92 \). Now, it’s time to graph the data together with the best-fit line.

4. Press \( Y= \) to go to the function menu.

If you used step (3b) above, the equation of the best-fit line should already appear on your screen beside Y1. If you used step (3a), you’ll need to type in the function \( Y1 = 0.2276X + 22.92 \) yourself.

Now, you need to turn on the statistical plotting mode (if it’s not already turned on). To do this, look at Plot1 in the upper left hand corner of your screen. If this is not highlighted, move your cursor to it and press enter so that it is.

Finally, as in Example 3.1, you’ll want to double check to see that the Plot1 options are correctly set to plot your data points. Do this by following the instructions in the first paragraph following Step 4 of Example 3.1.

5. Press [GRAPH].
Your calculator should now plot the data points and the best-fit line. If you don’t see this, you probably have a poor viewing window. To ask the calculator to select a viewing window appropriate to your data points, select ZOOM 9:ZoomStat. This should provide you with a good view.

Finally, anytime you’re done plotting and working with data, it’s a good idea to turn the statistical plotting mode off; otherwise, your calculator will continue to plot your data every time you graph a function! To do this,

6. Press \texttt{Y=}, place your cursor over the highlighted 	exttt{Plot1}, and press \texttt{ENTER} to ‘‘unhighlight’’ it.

\textbf{Part 3. Histograms.}

A histogram is a useful way to display a list of data, involving only one variable, where multiple occurrences are possible. Suppose, for instance, that height measurements of a class of 20 students are taken and rounded to the nearest half of an inch, resulting in the data that follows: 66, 68.5, 72, 68, 71.5, 68, 71, 60, 62, 58.5, 67.5, 69, 70, 69.5, 66, 73, 58, 68.5, 67, 66.5.

To get a better idea of what this data is saying, we can organize it into a histogram, as illustrated in the following examples.

\textbf{Example 3.3.} Organize the height data given above into a histogram, grouping the data into the following height categories: 57.5–58.5, 58.5–59.5, ..., 72.5–73.5

1. Press \texttt{STAT 1:Edit} and clear out any old data from the column \texttt{L1}. Then, enter the height data in the column under \texttt{L1} (the order that you enter the 20 numbers in doesn’t matter). Make sure, though, that you have all 20 measurements in your list when you’re done, even if there are repeated measurements.

2. Press \texttt{2nd STAT PLOT 1:Plot1...} to display the Plot1 options. Make sure that \texttt{ON} is highlighted, and highlight the third icon in the ‘‘Type:’’ category (the one that looks like a bar graph) to turn the histogram mode on.

3. Now, you need to tell the calculator that you want it to look at the data in the list variable \texttt{L1} when making the histogram, and that each entry in the list is to be counted once. To do this, you need to make the last two rows on your display look like:

\begin{verbatim}
Xlist:L1
Freq:1
\end{verbatim}

Keep in mind that \texttt{2nd L1} is on the calculator keypad.

Now, you need to tell the calculator what window settings you want, and how wide to make the bars on the histogram. According to the beginning of the
example, we want to start at a height of 57.5 inches and have each category be one inch wide.

4. Press [WINDOW]. Set XMin equal to 57.5 (the starting height), and set XSc1 equal to 1. (XSc1 represents the desired width of each bar/ category.) Set XMax equal to 73.5.

5. Press [GRAPH].

If you don’t see anything, it’s probably because the scale on the y-axis doesn’t match up with your data. Looking at your data, you can see that the maximum number of times a measurement in the same range occurs is three times, so you can go back to [WINDOW] and set YMin equal to 0 and YMax equal to at least 3. After doing this, press [GRAPH] again and you should definitely see the histogram.

6. You can press [TRACE] and move from left to right just as you would on the graph of a function. At the bottom of the screen, it will tell you what height category you’re currently at, and ‘‘n’’ tells you the number of times that measurements in that category occurred.

Example 3.4. Assuming that you’ve just done the previous example, display a histogram of the same data using width categories that are 2 inches wide.

1. All you need to do (assuming you just completed example 3.3) is press [WINDOW] and change XSc1 from 1 to 2. Then, press [GRAPH].

Notice that some of the bars go off the top of the screen. As in Example 3.3, adjust the YMax on the [WINDOW] screen and press [GRAPH] again to get a better picture.

Finally, if you’re temporarily done working with this data, you should turn the statistical plotting mode off to avoid seeing this data the next time you graph something. To do this,

2. Press [Y=], place your cursor over the highlighted Plot1, and press [ENTER] to ‘‘unhighlight’’ it.

Part 4. Box Plots.

Example 3.5 Make a box plot of the height data provided before Example 3.3. Then, use [TRACE] to view the median and the quartiles of the data.

1. Enter the height data in the list variable L1 (if it isn’t already there) by following the instructions in Step 1 of Example 3.3.
2. Press \textbf{2nd STAT PLOT 1:Plot1...} to display the Plot1 options. Make sure that ON is highlighted, and highlight the fifth icon in the ‘Type:’ category (reading left to right, top to bottom) to turn the box plot mode on.

3. Now, you need to tell the calculator that you want it to look at the data in the list variable L1 when making the box plot, and that each entry in the list is to be counted once. To do this, you need to make the last two rows on your display look like:

\begin{verbatim}
Xlist:L1
Freq:1
\end{verbatim}

Keep in mind that \textbf{2nd L1} is on the calculator keypad.

4. Press \textbf{GRAPH}.

Your calculator should now display the box plot, which looks like two boxes next to each other, and a horizontal line segment coming out of each side. If you don’t see this, you probably have a poor viewing window. To ask the calculator to select a viewing window appropriate to your height data, select \textbf{ZOOM 9:ZoomStat}. This should provide you with a good view.

5. Press \textbf{TRACE}. Now, use the left and right arrow keys to move back and forth. Moving left to right, the calculator should indicate that the minimum height is 58, the first quartile is 66, the median is 68, the third quartile is 69.75, and the maximum height is 73.

Finally, if you’re temporarily done working with this data, you should turn the statistical plotting mode off to avoid seeing this data the next time you graph something. To do this,

6. Press \textbf{Y=}, place your cursor over the highlighted \textbf{Plot1}, and press \textbf{ENTER} to ‘unhighlight’ it.

\textbf{Part 5. Time Plots.} A \textit{time plot} plots a set of observations against the time that they are measured (with time on the horizontal axis). Consider the following sample data, which gives the average annual interest rates (in percent) paid by money market funds:

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
Years after 1990 & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\
\hline
Rate (%) & 7.81 & 5.70 & 3.31 & 2.62 & 3.65 & 5.37 & 4.80 \\
\hline
\end{tabular}
\end{table}

\textbf{Example 3.6.} Make a time plot of the interest paid by money market funds for the years listed in the table above.
1. Press **STAT** 1:Edit and enter the years data in L1 and the interest rates data in L2. As always, make sure that L1 and L2 entries in each row match up.

   Now, you want to have the calculator give you a scatter plot of this data with the points connected by line segments.

2. Press **2nd** **STAT PLOT** 1:Plot1... Then, highlight On to turn the statistical plotting mode on, and highlight the second icon in the ‘‘Type:’’ category (reading left to right, top to bottom) to turn the xy-Line plot mode on.

3. Set Xlist equal to **2nd** L1, and Ylist equal to **2nd** L2.

4. Press **GRAPH**.

   If you don’t see anything, it’s probably the usual culprit, that the viewing window needs adjusting. Either adjust it by yourself using **WINDOW** or ask the calculator to automatically select a good viewing window for your data by pressing **ZOOM** 9:ZoomStat. This should give you a good view of your data.

   Finally, if you’re temporarily done working with this data, you should turn the statistical plotting mode off to avoid seeing this data the next time you graph something. To do this,

5. Press **Y=**, place your cursor over the highlighted Plot1, and press **ENTER** to ‘‘unhighlight’’ it.