

Lists and the Statistical Editor on the TI-83

The TI-83 has several useful operations that can be performed on lists of data points. Often times, we will have a collection of data from some source, and we might want to know the average of these numbers, the sum of all the numbers in our list, or we may wish to construct a graph of the data. These are all done on the TI-83 using lists. We start by examining the way that the TI-83 represents lists.

Naming, Creating and Limitations on Lists with the TI-83

The TI-83 calculator has six built in list variables. Their names are L_1 , L_2 , L_3 , L_4 , L_5 and L_6 . These list names are accessible as the [2nd] function of the number keys [1], [2], ..., [6]. It is best to use these lists whenever possible, because of the convenient manner in which they can be accessed. Simply press [2nd][L_1], for example, to get the first built in list. All lists in the TI-83 calculator are displayed inside curly brackets. Thus, {1, 12, 8}, represents a list with 3 entries or elements. The first entry is the number 1, the second is 12 and the last or third element is 8. There are four common ways to create lists on the TI-83. If the list of data that you would like to analyze is short, the easiest way to enter the list into the calculator is to simply type it in and store it in a list variable. You can use one of the six built in list variables, L_1 through L_6 , or you can make up a name of your own.

The name of a list in the TI-83 must be five or fewer characters. The first character must be a letter (A to Z), while the remaining characters can be letters or numbers. To separate names for list variables, from variables that hold numbers, the TI-83 has a list name indicator. It looks like a small capital L, and this symbol appears to the left of the list name. Thus, \underline{L} TIME1 and \underline{L} DATA5 represent lists, while TIME1 and DATA5 would NOT be lists. The list name indicator is located on the [OPS] submenu of the [2nd][LIST] menu. It is the last entry on this submenu and can be accessed by either

[2nd][LIST] [▶] [▲] [ENTER], or
[2nd][LIST] [▶] [ALPHA][B] [ENTER].

It is a good idea to always use this list indicator symbol when defining your own lists, or when calculating on lists. Some list operations do not require the list indicator symbol (those where only a list would make sense), but many times both a list variable and a number variable could be appropriate. For example, to double all entries in a list, one simply multiplies the list by 2. Thus,

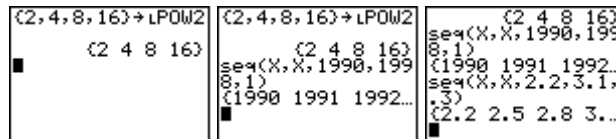
2*DATA

could mean "double all entries in the list named DATA", or "double the number called DATA". The names of all user defined lists are displayed by pressing [2nd][LIST]. If you haven't defined any names yet, no names will appear. On this list name menu, the list indicator is not present in the names of the lists, since all entries are known to be lists. However, when you select a list name and paste it to your home screen, the list indicator symbol will be present. Shown below are screen shots displaying the [LIST] names menu (on a calculator with many user defined list names), a home screen showing the result of

pressing [ENTER] from the screen shot to the left and the [OPS] submenu showing the entry for the list indicator symbol.



You can have as many list names as the memory on your calculator allows. All lists must have less than 1000 entries however. To create a list of the first few powers of 2, say 2, 4, 8, and 16, start on the home screen and enter the **begin list** curly bracket {, which is the [2nd] function of the left parenthesis key, [(]. Next, type in the entries of your list separated by commas. The last entry should not have a comma after it. Enter the **end list** right curly bracket }, and press the store button [STO▶]. Since we are about to store a list to a variable, the TI-83 knows that the next name should be a list name, and the list indicator symbol is not required here. However, it's a good habit to put it there anyway. Paste the list indicator symbol to the home screen by either of the two key-stroke sequences mentioned above for accessing this symbol, then put the calculator in alpha mode (press [2nd][ALPHA]) and type in a name. See the left screen below.



The entry for $_LPOW2$ should now be present on your list names menu. This list is short enough to fit on your home screen. If the list were longer, you could use the right arrow key, [▶] to scroll and see the other entries in a list. We could have also used one of the built in lists, L_1 through L_6 , instead of making up our own name here. For short lists, the "type it in" method works well.

There will be several occasions where we need to produce a list of "equally spaced" numbers. For example, we might have values of the average price of a mid-size car, for the years 1990 to 1998. We want to save a bit of time and quickly generate the year data list, {1990,1991,1992,1993,1994,1995,1996,1997,1998}. The values in this list are equally spaced, as each entry is the previous entry plus 1. The list {2.2, 2.5, 2.8, 3.1} is also equally spaced, and the spacing is 0.3, since to get the "next entry", one simply adds 0.3 to the previous entry. The sequence command on the TI-83 makes it very easy to quickly generate lists of equally spaced numbers, and this is the second method for creating lists that we will look at. To generate a list of equally spaced numbers, the calculator needs to know where to start, where to stop, and the spacing between consecutive entries. The sequence generating command, **seq**, is very flexible. It can generate a very diverse collection of lists. Essentially any equation, in terms of any variable can be used. For equally spaced data lists, both the equation and the variable are the same, and this looks a bit odd. For equally spaced lists, enter

$$\text{seq}(X, X, \text{start_value}, \text{stop_value}, \text{space_size})$$

The general pattern is

`seq(equation_in_variable, variable, start_value, stop_value, space_size)`

The sequence command is the fifth entry, [5:seq(] on the [OPS] submenu of the [2nd][LIST] menu. To get our year data above, we would use `seq(X, X, 1990, 1998, 1)` or just `seq(X, X, 1990, 1998)`, since the default value for the spacing is one. This command tells the calculator to list the sequence of numbers resulting from the equation X (the first X in the command), by substituting into this equation, the values of the variable X (the second X is the variable you substitute for) starting at X = 1990, stopping at X = 1998, and stepping by 1 unit each time. Thus, one gets X evaluated at 1990, 1990+1, 1990+2, . . . , and 1990+8, where we stop. This, together with the keystrokes to generate the other example of equally spaced data above, are shown on the middle and right screens above. Note the three dots on the right end of the displayed list. This indicates that the list takes up more than one line, and the right and left arrow keys can be used to scroll the other entries in the list. You can end a sequence generating command by storing the list to one of the built in lists, or a user defined list name. Here is another way to get the list `L1POW2` which we typed in earlier. I'll store the resulting list to `L1` this time and use the default value for the spacing.

`seq(2^X, X, 1, 4) [STO▶] L1 [ENTER].`

The third method for creating lists on the TI-83 that we will explore is an interactive mode for typing in the entries in a list. We'll use the statistical editor. The statistical editor allows you to create and look at several lists at one time. It displays the lists as columns in a table format. You can see any three consecutive columns at a time. The screen below shows the statistical editor displaying the contents of the lists `L1`, `L2`, and `L3`. The names of the lists being displayed are in the top row of the table. The third column, which shows `L3`, has a special **locked icon** in the top row. This indicates that the values in the third column are defined from some other list, and are hence locked to that list and probably should not be changed.

L1	L2	L3 #1
1800	5.3	6.2455
1810	7.2	6.8436
1820	9.6	7.6339
1830	12.8	8.6396
1840	17.1	9.9111
1850	22.8	11.4958
1860	31.4	13.4516

L1(1)=1800

2:Edit... 3:SortA(CALC TESTS 1:Edit... 2:SortA(ClrList L2,L1,LT IME2
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On the bottom line of the statistical editor shown above, we see a more detailed version of the entry in the cell currently highlighted. This line indicates that the cursor is currently looking at the first entry in the list `L1`, which is denoted by `L1(1)`. The value of the first entry in `L1`, is 1800. The number of digits displayed in the main table portion of the statistical editor is limited. To see a more accurate version of the data, use the arrow keys to move the cursor to the entry you would like to see, and it will be displayed with more detail on the bottom line.

Lists are loaded into the columns in the statistical editor in two different ways. The easiest method is to use the **SetUpEditor** command, which, as shown in the middle screen above, is the fifth entry on the [STAT] [EDIT] menu.

Loading Lists into the Statistical Editor

1. Start by deciding which lists you would like displayed in the editor. You can choose to display one through 20 lists. The lists you plan to use which contain unwanted old data, should be cleared with the **ClrList** command before loading them into the editor window. The **ClrList** command is shown in the middle screen above as the fourth entry on the [STAT] [EDIT] menu. Paste a copy of this command to the home screen, then enter (using either the [2nd] [L₁] keys, or from the [LIST] menu) the names of all lists you would like to clear, separated by commas. The right screen above shows the command that will clear out L₂, L₁ and the user defined list \underline{L} TIME2. You can delete entries in lists after they are loaded into the statistical editor, but it is faster to clear them before load time.
2. Paste a copy of the **SetUpEditor** command to the home screen and then enter the names of the lists (separated by commas) you would like loaded into the statistical editor. The TI-83 will remove all other lists from the statistical editor (these lists remain in the calculator's memory), and insert your lists, in the order you entered them, as the columns in the editor window. If you do not enter any names after the **SetUpEditor** command, the built in lists L₁ through L₆ will be loaded automatically.

A useful procedure for typing data into a list is to choose one of the built in lists (preferably one which does not contain important data); clear it's contents and load it (alone) into the statistical editor with the **SetUpEditor** command. Next, press [STAT] [ENTER] to start the statistical editor, and simply use the cursor and arrow keys to enter your data. When you are done, press [2nd][QUIT] to return to the home screen. Your data will now be in whichever list you loaded with the **SetUpEditor** command.

Basic Operations on Lists

Once you have a list entered into your calculator, there are many operations that one can perform on the list. Some of these operations are on the submenus of the [2nd][LIST] menu while others are entered directly from the home screen.

Viewing the Entries in a List

To see the entries in a list, enter the name of the list on the home screen (using the [2nd] [LIST] [NAMES] menu, or by typing it's name with the list indicator symbol or the keys which access the built in lists) and press [ENTER]. The entries in the list will be displayed in the home screen and you can use the arrow keys to scroll through the entries in the list. You can also use the **SetUpEditor** command with the single list name which you would like to view, and then start the statistical editor to view the entries in this list.

Extracting Elements from a List and Storing Specific Values to List Entries

To see a specific list element, enter the list name and the index of the element (1 for the first element, 2 for the second element, 3 for the third, etc.) inside parenthesis on the home screen. For example, L₂(4) refers to the fourth entry in the list L₂ and \underline{L} DATA(2) represents the second element in the list \underline{L} DATA. You can also store values to list entries with this technique. For example, 5 [STO▶] L₁(3) [ENTER], will set the third element in the list L₁ to be equal to 5.

Applying Functions to Each Entry in a List

Most operations on the TI-83 can be applied to each entry in a list with a single command. Entering $L_2 + 6$ [ENTER] for example, will add six to each entry in the list L_2 . The list L_2 will remain unchanged (it will contain the same entries before and after this command is executed), so if you need to save the result, you'll have to store the result in a new list variable. Thus, $2 * L_3$ [STO▶] L_4 , will double each entry in the list L_3 and save the doubled values in the list L_4 . One very useful technique for creating a list of values of some function is to create a list of input values in say L_1 , define the function whose values you desire as Y_1 (or any other Y-Variable) on the [Y=] screen, then enter a command like $Y_1(L_1)$ [STO▶] L_2 , on the home screen. For example, if $L_1 = \{1,2,3,4\}$ and $Y_1 = 2^X$, then $Y_1(L_1)$ will create the list $\{2,4,8,16\}$.

Operations like [+], [-], [×], and [÷], which require two numbers as inputs, can be applied to two lists, provided the lists have the same number of entries. The operation (plus, minus, etc.) will be applied to the first entries in the lists, then the second entries in the list, and so on. For example, $\{1,2,3\} * \{-1,0,2\} = \{1*-1, 2*0, 3*2\} = \{-1,0,6\}$ while $\{1,2,3\} + \{4,5,6\} = \{1+4, 2+5, 3+6\} = \{5,7,9\}$. You'll get an error message if you try something like $\{1,2,3\} * \{4,5\}$, since the two lists have a different number of entries.

Deleting Lists from Memory

If one utilizes lists frequently, your calculator can become cluttered with lists that are no longer needed. The names pile up on the [2nd][LIST][NAMES] menu, entries in these lists use valuable memory and an occasional cleaning up of lists is a good idea. The **ClrList** command on the [STAT] menu will delete all the entries in a list (as discussed above), but leaves the list name in memory and thus an entry on the [2nd][LIST][NAMES] menu also remains. To completely remove a list and its name from memory, press [2nd][MEM][2:Delete][4:List], and then scroll with the up and down arrow keys and press [ENTER] on the lines corresponding to the lists that you would like to delete.

Commands on the [2nd][LIST][OPS] Menu

The left and center screens below show the commands on the [2nd][LIST][OPS] menu. A brief description of each of these commands is included, and a more detailed look at the commands we will utilize is also included.

NAMES	OPS	MATH	NAMES	OPS	MATH
1:SortA<			6: cumSum<		
2:SortD<			7: List<		
3: dim<			8: select<		
4: Fill<			9: augment<		
5: seq<			0: List>matr<		
6: cumSum<			1: Matr>list<		
7: ↓List<			2: L		

1. **SortA**(With a single list-name, this command will sort the list so that smaller elements come before larger elements. The list will be put into ascending order (smallest to largest), and the list will be changed in memory. Thus, if $L_1 = \{3,2,7\}$ and one executes the command **SortA**(L_1), the list L_1 will become $\{2,3,7\}$, and the old list, $\{3,2,7\}$ is deleted. If two or more list-names are given to this command, for example, **SortA**(L_1, L_3), the first list will be changed to ascending order, and the same rearrangement will be performed on all other list-names given. Thus, if the

fourth entries in L_1 and L_3 were paired together, these same entries will remain paired together after executing **SortA**(L_1, L_3). If the first list contains input values $\{X_1, X_2, X_3\}$, and the second contains the corresponding output values $\{Y_1, Y_2, Y_3\}$, the **SortA** command will produce two new lists which can be viewed as sorted pairs (X, Y) , so that if the first list becomes $\{X_2, X_3, X_1\}$, the second list will become $\{Y_2, Y_3, Y_1\}$. All lists will be changed in memory, so the old unsorted lists are no longer available.

2. **SortD**(This command is similar to **SortA**, except that the first, or only list will be put into descending order, largest to smallest.
3. **dim**(Gives or sets the dimension (number of elements or length) of a list. This is an extremely useful command that will be described in more detail below.
4. **Fill**(Used to fill a list with a single value, **Fill**($0, L_1$) will make every entry in the list L_1 equal to zero.
5. **seq**(Used to create lists of values of an equation. Some of the uses of this command are discussed above and others will be introduced below.
6. **cumSum**(Returns a list of cumulative sums. The k-th entry in the resulting list will be the sum of the first k entries in the input list, so that **cumSum**($\{1, 1, 2, 3\}$) will return the list $\{1, 1+1, 1+1+2, 1+1+2+3\} = \{1, 2, 4, 7\}$.
7. **Δ List**(Returns a list of the differences between successive entries in the input list. This command is extremely useful for checking whether data values come from a linear equation. The command **Δ List**($\{1.2, 1.5, 1.9, 2.4\}$) will return the list $\{1.5-1.2, 1.9-1.5, 2.4-1.9\} = \{0.3, 0.4, 0.5\}$. Note that the dimension (length or number of entries) of the resulting list is one less than the dimension of the input list. If the list L_1 contains X values, and the list L_2 contains the corresponding Y values, the list **Δ List**(L_2) / **Δ List**(L_1) will contain the "slopes" of the data pairs.
8. **Select**(Used to interactively select data points from plots.
9. **augment**(The command **augment**(**list1, list2**) will return a new list that is list1 followed by list2, so that **augment**($\{1, 2, 3\}, \{5, 7\}$) will return $\{1, 2, 3, 5, 7\}$.
0. **List \blacktriangleright matr** Turns several lists into a matrix.
- A) **Matr \blacktriangleright List** Turns a matrix into several lists.
- B) \blacktriangleleft The list name indicator symbol.

A Closer Look at a Few List Operations

The **dim**, **seq** and **Δ List** commands will prove to be very valuable for us and we take a closer look at some of the uses of these commands here. The dimension command, **dim**, represents the number of elements in a given list, which can also be thought of as the length of the list. This command can be used to delete elements from the end of a list, add elements, each taking the value of zero, to the end of a list, and to calculate when to stop a given list operation. When you store a numeric value to the dimension of a list, you create a new list (the old one is destroyed) which has exactly that many elements. Thus, the command 5 [STO \blacktriangleright] **dim**(L_1), will make the list L_1 have exactly 5 entries. If L_1 had more than 5 entries, the sixth, seventh, etc. entries will be deleted. If L_1 had fewer than 5 entries, then enough zeros will be appended to the end of L_1 to make L_1 have exactly 5 entries. You can effectively clear all entries in a list by using the command 0 [STO \blacktriangleright] **dim**(listname), and you can add one extra element (a zero) to the end of a list with the

command $\text{dim}(\text{listname}) + 1$ [STO▶] $\text{dim}(\text{listname})$. When combined with the **seq** command, the **dim** command can be used to carry out many calculations on successive entries in a list. For example, if the list L_1 contains the population of a certain country for the years 1990, 1991, ..., 1998, you can create a list of the relative growth rates of this population,

$$(\text{population in year } X + 1) / (\text{population in year } X)$$

with the command

$$\text{seq}(L_1(X+1) / L_1(X), X, 1, \text{dim}(L_1) - 1)$$

where $L_1(X+1)$ represents the "next years population" and $L_1(X)$ represents the current years population. You need to stop the relative growth rate computations when $X+1$ represents the index for the last entry in the list, or equivalently when $X+1 = \text{dim}(L_1)$, or $X = \text{dim}(L_1) - 1$. A handy fact to remember is that for any (nonempty) list, say L_1 , $L_1(\text{dim}(L_1))$ is the last entry in the list. Therefore, the command above creates the list

$$\{L_1(2) / L_1(1), L_1(3) / L_1(2), L_1(4) / L_1(3), \dots, L_1(\text{last entry}) / L_1(\text{second to last entry})\},$$

which is a list of the relative growth rates of the entries in L_1 . Used in combination with the sequence command and individual list entries $L_1(X)$, the dimension command can be very powerful.

We will find several opportunities to utilize the ΔList command and one should consider $\Delta\text{List}(L_1)$ to be a list of the "change in values" of the quantities in L_1 . For example, if L_1 contains the height, in cm, of a sunflower plant after 1 day, 2 days, 3 days, etc., then the 3rd entry in $\Delta\text{List}(L_1)$ represents the change in height of the sunflower from day 3 to day 4. Sometimes we will want our list of changes to have the same dimension as the list it came from (for example, to plot the list of changes in heights of our sunflower against time, day1, day2, day3, etc.). One can add a meaningless last entry (with value zero) to the list of changes with the following commands:

- Compute the changes and save them: $\Delta\text{List}(L_1)$ [STO▶] L_2 [ENTER];
- Make the list of changes and the original list have the same length: $\text{dim}(L_1)$ [STO▶] $\text{dim}(L_2)$, which adds an entry to the end of L_2 , OR $\text{dim}(L_2)$ [STO▶] $\text{dim}(L_1)$, which deletes the last entry from the original list.

Commands on the [2nd][LIST][MATH] Menu

Shown below are the commands that are available through the [MATH] sub-menu of the [2nd][LIST] menu.

NAMES	OPS	W:G:1:4	NAMES	OPS	W:G:1:4
1	min<		2	max<	
2	max<		3	mean<	
3	mean<		4	median<	
4	median<		5	sum<	
5	sum<		6	prod<	
6	prod<		7	stdDev<	
7	stdDev<		8	variance<	

Each of these commands can take a single list-name as input, as in **min**(listname), and the first two can also be used with two list-names. Here is a brief description of these commands.

1. **min** Given a single list, this command will return the smallest or minimal entry in the list, so **min**({2, 5, 0.2}) will return 0.2. If one gives this command two lists (of the same dimension), it will return a list of the minimal entries from list1 or list2, first comparing the two first elements, then the second elements, etc. Thus, **min**({2,5,3}, {0,7,1}) will result in the list {0,5,1}, because 0 is the smallest first entry, 5 is the smallest second entry and 1 is the minimal third entry.
2. **max** Similar to **min**, except the larger or maximal elements are returned.
3. **mean** This command will return the average or mean of all entries in the input list.
4. **median** Returns the median value of the list, roughly the "middle" element of the list in sorted order.
5. **sum** This command will sum or add all the entries in a list and return the total.
6. **prod** This command will multiply all entries in a list together and return the product.
7. **stdDev** Gives the standard deviation of the elements in the input list.
8. **variance** Gives the variance of the elements in the input list.

You may find occasional uses for **min**, **max**, and **sum**, while **mean**, and **stdDev** will be used a lot.

The Statistical Editor on the TI-83

The statistical list editor on the TI-83 is a table, where you can enter, edit and define lists. Up to 20 lists can be accessed at one time, and any three consecutive lists can be viewed on the screen. The lists are displayed as columns in the middle section of the statistical editor window, which is accessed by pressing [STAT][ENTER], or equivalently [STAT][1:Edit]. As discussed above, lists can be pre-loaded into the statistical editor with the **SetUpEditor** command on the [STAT] menu, and the pre-loaded lists can be cleared (delete all entries) with the **ClrList** command, which is also located on the [STAT] menu. By clearing each of the built in lists and then executing the **SetUpEditor** command with no parameters (as shown in the left screen below), a clear statistical editor window is displayed by pressing [STAT][ENTER] (see the middle screen below).

ClrList L1,L2,L3 ,L4,L5,L6 Done	L1 L2 L3 1	L5 L6 DATE ?
SetUpEditor Done		1935 1943 1953 1958 1960 1961 1962
	L1() =	DATE = {1935, 1943, ...

The middle screen above shows the three regions of the statistical editor screen. The top line displays the names of the lists which are loaded, and way over to the right, the column number (1 in this case) of the current column is displayed. The current column is changed using the arrow keys to move the cursor between columns. The bottom line of the statistical editor screen is the entry area. All data entry occurs on this line and the appearance of the data entry area changes, depending on what context the statistical

editor is currently in. The middle region of the statistical editor screen (which is empty in the screen shot above) displays the first several digits of the data in each of the displayed column lists. If you've loaded less than 20 lists into the editor, you can insert another list in an empty column (toward the right side of the table) or you can insert a new column and shift the other columns to the right. To add a list to an empty column, move the cursor with the arrow keys into the top line of the editor screen in the empty column, and then enter a valid list name. You can enter list names directly, by typing their names with the [ALPHA] keys; by selecting them from the [LIST][NAMES] menu; or by keying in the name of a built in list with the keypad. Once you move the cursor into the top line of an empty column, the **NAME=** prompt will appear in the entry line and the **alpha-lock** mode will be set. After entering the name of a list, press [ENTER] and the list (which can be a new, undefined name) with all of its entries (if there are any) will appear. The right screen above shows the result of entering the name of a user defined list named DATE (which may not exist on your calculator) and pressing enter. Note that when the cursor is on the top line, the entry line shows the list name and as many of its entries as will fit on the screen.

You can insert a new column by moving the cursor into the top line of the editor screen and pressing [2nd][INS], followed by entering the name of a list (as above) and then [ENTER]. The new list will appear in the current column and the old list will shift one column to the right. If all 20 columns contain list names, you will have to delete one list before adding another. Simply move the cursor into the top line of the column you wish to delete and press [DEL]. The list in that column will disappear, and all columns to the right will shift over. The removed list remains in your calculator, it is simply not displayed in the statistical editor screen anymore.

While it is most convenient to clear old data from lists before you load them into the statistical editor, you can delete the entries in a list after it's loaded as well. To delete all entries from a list in the editor, move the cursor to the top row (the row containing the names of the lists) in the column you wish to delete and press [CLEAR][ENTER]. You can delete individual entries in a list by moving the cursor to the entry you would like to remove and pressing [DEL]. You can insert a new entry in a list by moving the cursor to the location where you would like the new entry and pressing [2nd][INS]. A zero will be inserted. If you immediately type a new entry, it will replace the zero. The old entry will shift down. To edit an entry, move the cursor to the cell containing the entry you wish to change and type the new entry. If you press [ENTER] while the cursor is in a cell containing a list entry (before you start to type in the new entry), that entry will appear on the entry line, and the full editing features (arrow keys, insert, delete, etc.) of the TI-83 will be available to modify the entry. Press the up or down arrow key, or [ENTER] when you are through editing the entry. If, in the middle of editing an entry you decide not to change the entry, pressing [CLEAR][ENTER] will restore the old value. You can enter expressions (like $3*4^2$ or $2*L_1(3) + 5$) and variables while editing entries, but only the result of evaluating the expression will be stored (not the formula that created the resulting value). If you want to edit several entries in a column, you can move the cursor into the top name row and press [ENTER]. This will display the name of the list and all of the entries on the bottom entry line. You can use the arrow and editing keys to modify any of the entries in the list. Press [ENTER] when you've altered as many entries as you desire, and the new edited values of the list will appear in the column.

Column Operations and Attaching Formulas

One of the desirable features of a spreadsheet is that one can use formulas to define the entries in an entire row or column of the spreadsheet. This makes it easy to subtract one column from another, or double all entries in a given row. The TI-83 statistical editor does not allow row operations, but many column operations can be performed. There are two different ways to define an entire column in the editor with a formula. One method is to simply define the values of a list with a formula. This will create the list but not preserve the formula. The second method is called *attaching a formula to a list*, which preserves the formula used. To understand the difference, suppose we have our statistical editor setup with only L_1 through L_6 loaded. The list L_1 contains the five values shown in the left screen below. All other lists are empty. We want to find an equation that will reproduce these values, and a friendly mathematician suggests using the equation $Y = 0.6 * X + 1.2$, as X runs through the values 0,1,2,3 and 4. We can enter a formula that will display these values in the second column, using the first type of column operation. The command

$$\text{seq}(0.06 * X + 1.2, X, 0, 4, 1)$$

will generate the numbers suggested by the mathematician, so we need to define column 2 to be this formula. Move the cursor into the top name line of column 2 and type in this formula. As you enter the formula, it will be displayed on the bottom entry line. The first thing you must do to start this formula is to paste a copy of the sequence command, from the [2nd][LIST][OPS] menu, to the entry line, by pressing [2nd][LIST][\blacktriangleright][5]. Type in the remaining parts of the formula and press [ENTER]. A screen showing a partially typed formula, and the result after pressing [ENTER] are shown below.

L1	L2	L3	1
1.2			
1.256			
1.3145			
1.3758			
1.44			
L1(6)=			

L1	L2	L3	2
1.2			
1.256			
1.3145			
1.3758			
1.44			
L2 = seq(0.06 * X +			

L1	L2	L3	2
1.2	1.2		
1.256	1.26		
1.3145	1.32		
1.3758	1.38		
1.44	1.44		
L2(1) = 1.2			

- In order to define a column in terms of a formula, you must enter the formula from the name row of the column, not from a row containing actual entries.

As the right screen above shows, the second column entries are pretty close to the actual values in column 1. The calculator now has $L_2 = \{1.2, 1.26, 1.32, 1.38, 1.44\}$. There is no way to retrieve the sequence command that generated this list. Now, we'll calculate the error in our predicted values using both a plain formula and an attached formula. Since the predicted values in column 2 are all at least as large as the actual values in column 1, let's define the error to be our predicted values minus the true values. That can be computed by subtracting column 1 from column 2, or in list operation terms, $L_2 - L_1$. Move the cursor to the name row of column 3 and enter the formula $L_2 - L_1$. You should see the left screen below. At this point, L_3 is nothing but a list of five numbers. The calculator does not know that these numbers came from subtracting L_1 from L_2 . Since we can only see three columns at once in the editor window, delete the second column by moving the cursor to the name row of the second column and pressing [DEL]. You should note that you can define a formula for a column in the statistical editor using any lists, not just those that are loaded in the editor. The calculator still has the list L_2 in

memory and it need not be visible, nor even loaded, to be used to define another column. Your calculator should look like the middle screen below.

L1	L2	L3	#	L1	L3	L4	#				
1.2	1.2	0	3	1.2	0	-----	2				
1.256	1.26	.00404		1.256	.00404						
1.3145	1.32	.00547		1.3145	.00547						
1.3758	1.38	.00416		1.3758	.00416						
1.44	1.44	0		1.44	0						
L3(t)=0				L3 = 0, .00403783...				L4(t)=0			

Notice the entry line of the middle screen above, it shows that L₃ is just a list of numbers, since curly brackets and the values of the entries appear on this line while the cursor is in the name row. Now we'll create the same list of error values in the new third column by attaching a formula to L₄. By defining this column with an attached formula, the calculator will remember the formula used to define L₄, and if any of the quantities mentioned in this formula change, L₄ will be updated to incorporate these changes. When you want the calculator to remember the formula and automatically update the entries in a column, you simply enter the formula inside double quotes (the [ALPHA] function of the [+] key). Move the cursor to the name row cell of column 3 containing L₄. Press [ALPHA]["]L₂ - L₁ [ALPHA]["] [ENTER] to attach the formula to L₄. See the right screen above. When a column is defined with an attached formula, a lock icon appears in its name row. You can also see (and edit) the formula used to create the list by moving the cursor into the columns name row (see the left screen below). To illustrate the difference between using a plain formula to generate a row, and attaching the formula, we'll modify an entry in L₁. Use the arrow keys to move the cursor onto the 3rd entry of L₁, as shown in the middle screen below. Now change this entry to 1.3 by typing [1][.][3][ENTER] (see the right screen below).

L1	L3	L4	#	L1	L3	L4	#				
1.2	0	0	3	1.2	0	0	1				
1.256	.00404	.00404		1.256	.00404	.00404					
1.3145	.00547	.00547		1.3	.00547	.02					
1.3758	.00416	.00416		1.3758	.00416	.00416					
1.44	0	0		1.44	0	0					
L4 = "L2 - L1"				L4(3) = 1.314534138...				L4(4) = 1.375837620...			

Notice how the error entry in L₄ changed to 0.02, while the entry in L₃ did not change. The formula is actually attached to the list L₄, not just in the statistical editor, but in the calculator's memory. We could have achieved the same result by entering

"L₂ - L₁" [STO] L₄

from the home screen. Attaching formulas to lists can be a big time saver. For example, we could test several formulas to match the entries in column 1 above by simply generating new versions of the list L₂. The errors would automatically appear in the list L₄. However, attaching formulas also has some drawbacks. It causes the statistical editor screen to update slower and is a frequent cause of calculator errors. If we were to add another entry to L₁, we would get an error because the new versions of L₁ and L₂ no longer have the same number of entries. In this case, we wouldn't even be able to view the statistical editor screen, without first fixing this error. One way to respond to such errors is to choose the **2:Goto** option of the error message and write down the attached formula. When the screen appears with the attached formula, press [CLEAR][ENTER]. This will remove the attached formula, but keep all the old values in the list in question.

It becomes important to be able to detach a formula from a list and the calculator provides several methods for doing this.

- In the statistical editor, move the cursor to an element in the list with an attached formula. Press [ENTER] and then edit the entry, pressing [ENTER] again when you are done editing. The formula will no longer be attached, and you can actually just retype the same value, if you would like to preserve the values in the list. As a safety feature, you cannot delete, nor directly edit (without first pressing [ENTER]) an element in a list with an attached formula.
- In the statistical editor, move the cursor to the name row of the column with the list in question and press [CLEAR][ENTER]. The formula will no longer be attached but the values will remain in the list.
- From the home screen, store a value to a list element. For example $0[\text{STO}\blacktriangleright]L_4(1)$. This will destroy one value of the list.
- From the home screen, use the **ClrList** command on the list which has a formula attached. This will remove the attached formula and delete all the entries in the list.
- You can also respond to an error message with the **2:Goto** method mentioned above.