Ch.1- Getting Started

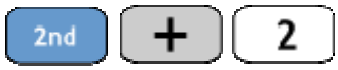
The TI-84® Calculator is similar to the TI-83® Plus family in many ways. The keys of the TI-84 correspond directly to the TI-83. The major differences are in processing speed, memory and the applications that are preloaded on the TI-84+

In order to use the programs referred to on this CD, you must have the following;

1) TI-84+ graphing calculator
2) TI-Connectivity Software installed
3) USB Cable for linking to the calculator

For further information contact Texas Instruments at www.ti.com

There are many programs that you will be downloading to your calculator. As the calculator's memory is finite, you may have to delete some programs prior to getting started. You can check your ram and archive memory by pressing



Notice the RAM FREE and ARC FREE (Archive) figures. Typically, your calculator will have higher figures than these indicating that your calculator has plenty of both types of memory. If your calculator was used prior to your purchase, there is the possibility that it is overloaded. If your RAM or ARCHIVE are low, you will want to completely reset the calculator before uploading the following programs.

To reset the calculator to its original factory condition, press 

Then press 

bringing you to this screen..

Uploading Statistics Programs

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Then press 

bringing you to this screen...

Uploading Programs to the TI-84+

Uploading the programs to the TI-84+ requires a few steps.

Step 1: Create a folder on your C: drive of your computer labeled **Stats Programs**.

Double-Click on My Computer
Double-Click on (Local Drive) C:
From the File menu, select New and click on Folder
Type in the name Stats Programs

Step 2: Put the Johnson/Kuby Student's Suite CD-ROM into the CD Rom drive of your PC.

Double-Click on My Computer
Double-Click on your CD drive containing the CD-ROM
Double-Click on the "Manual Install" folder
Double-Click on the "Lab Manuals" folder
Double-Click on the "Ti83-84 Manual" folder
You will find the zipped file "statprgm.zip" containing all the stats programs utilized for this course. Copy the file and put it into your "Stats Programs" folder created in the C: drive.
Use a zip utility program, such as Winzip, to unzip the file.

Step 3: Now the programs are unpackaged in the C:\Stats Programs folder. To transfer these over to the calculator requires the use of the TI-Connectivity software and USB cable available from Texas Instruments. On your computer:

Click on the TI-Connect Icon to open the program. Be sure that the TI-84+ is connected via the USB cable to the PC and make sure that the calculator is turned on.
Next Double Click on My Computer
Double Click (Local Drive) C:
Double Click on Stats Programs
Click on Edit, Select All
Right Click and select Copy
From the desktop, right click on TI-Connect and select Paste
The software will transfer each of the programs to the TI-84+

Step 4: The programs are archived and need to be unarchived and stored in RAM. On your calculator, press 

One by One, select each program listed with an asterisk (*) and press 

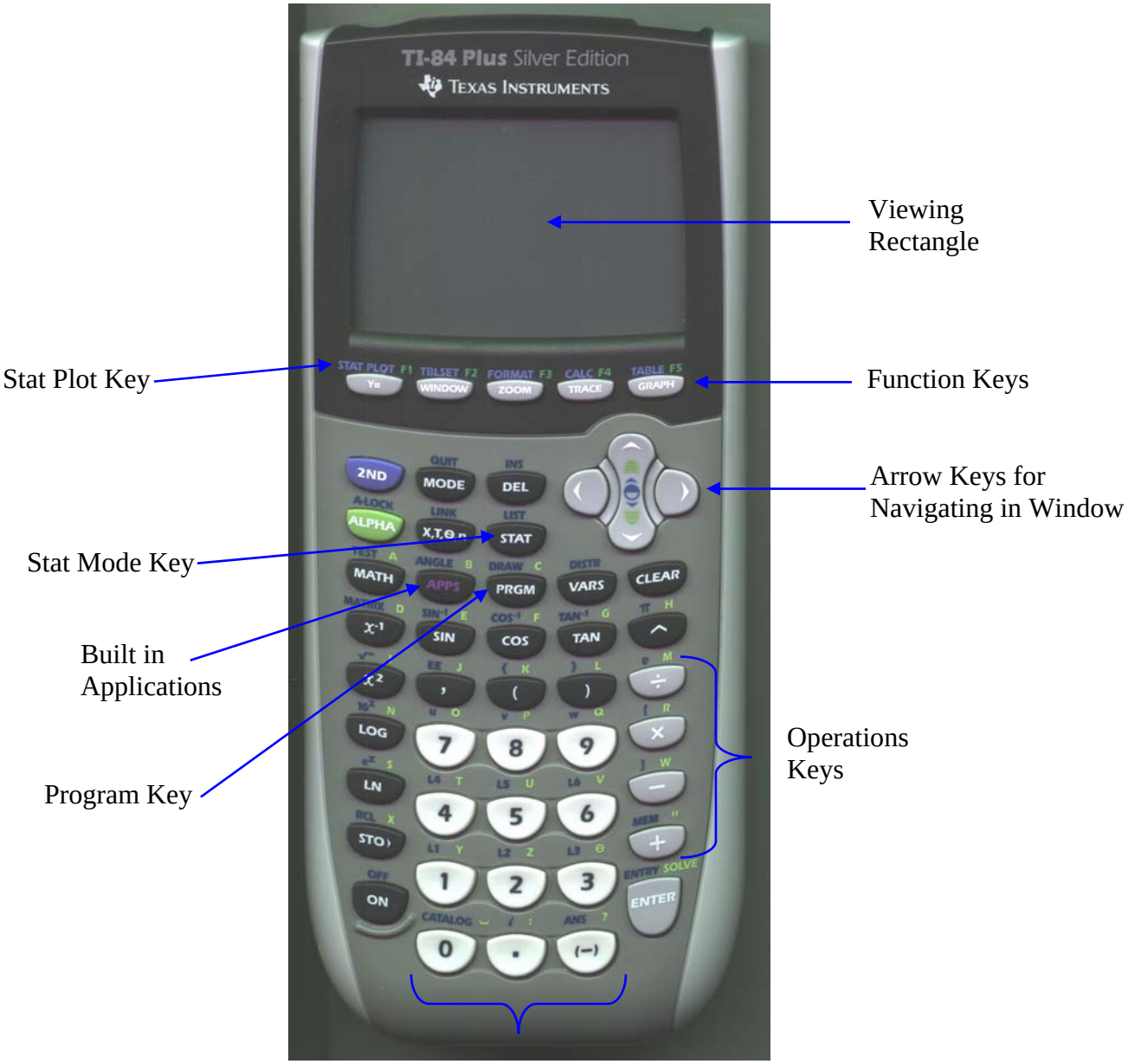
Repeat step 4 until each program is unarchived.

Step 5: Checking your programs. Click on 

. Your screen should now look like this.

Chapter 1

Introduction to the TI-84 Plus Graphing Calculator



Keypad

This chapter is a brief introduction to the TI-84 Plus. The basic commands, keystrokes, programs and operations used throughout *Elementary Statistics*, 10th edition will be described in detail. Refer to the picture above frequently as a visual aid to locating the various keys.

The keypad on the TI-84 Plus is virtually identical to the TI-83 Plus. However, the TI-84+ has more RAM, greater processing speed and additional applications. It also includes a USB cable for faster communication with your PC.

On, Off, Contrast

The 

key is used to turn the calculator on.

The key sequence 

is used to turn the machine off. There is also a battery saving feature built into the TI-84+ that will automatically turn the machine off after approximately 5 minutes of inactivity.

Press and hold 

then press 
to increase the contrast, making text easier to read.

Similarly, press and hold 

and then press 
to decrease the contrast and lighten the text.

Release either key when you have reached the desired screen contrast. As the contrast is adjusted there is a single digit, 0-9, that appears in the top right corner of the screen. This number is an indication of the screen contrast (the higher the number, the darker the screen), and can be used to gauge the energy level of the batteries in the calculator. While the TI-84+ does display a warning message if the batteries are low, if the contrast is set to 9 and the screen is still very light, this is also an indication that the four AAA batteries need to be replaced.

Note: Failing to replace the batteries immediately will result in having to replace the back up battery. This will also result in losing all of your programs, lists and data.
Note: When replacing the AAA batteries, be sure to change on battery at a time. Otherwise, your memory may be reset and you can lose all of your programs, lists, etc.

Last Entry, Last Answer:

Each entry, is automatically stored in the TI-84+ memory, even as entries scroll off the screen or the calculator is turned off. To recall a previous entry

press 

(ENTRY) To access earlier entries, repeat the keystrokes until the desired entry is displayed.

The variable ANS contains the value of the most recent calculation. In a series of calculations, it may be more efficient to press 

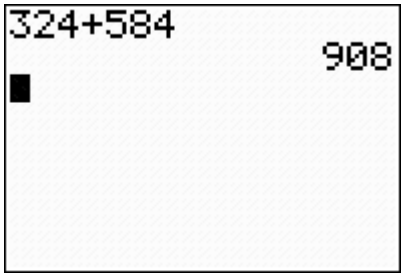
(ANS) rather than repeating the keystrokes that yielded that computation. For example, consider the following table.

Quarter	Quarterly Spending	Cumulative Spending
1st	$324	$324
2nd	$584	
3rd	$416	
4th	$375	

Solution:

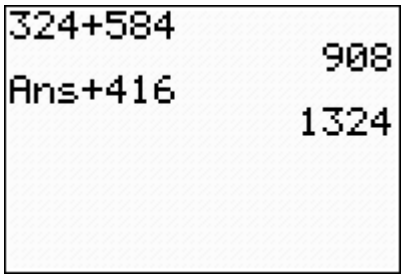
To get the 2nd quarter cumulative spending, press

. Your screen should look like this.

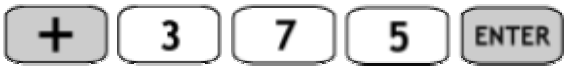


To get the 3rd quarter cumulative spending, you can either retype 908 + 416 or you can press

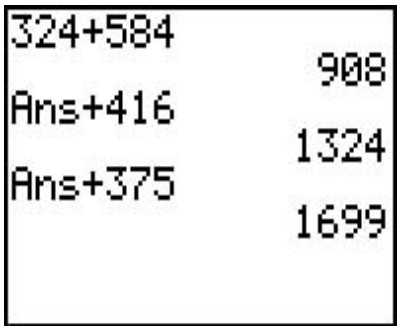
(ANS) which gives us the following screen



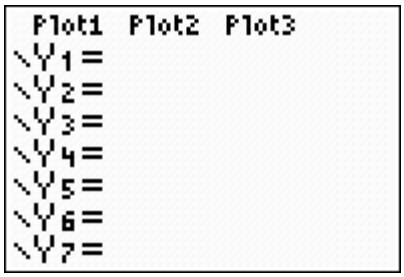
Note: Any time there is a previous answer stored in Ans, pressing an operation key will automatically bring up Ans into the working screen. For example. To compute the 4th quarter cumulative spending, press



to return the screen

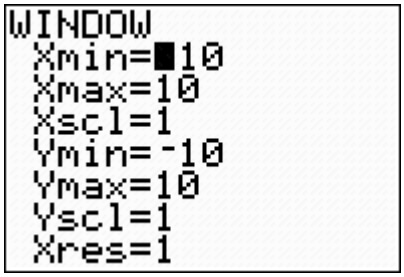


Graphing Functions: Graphing functions of the form y = f(x) are done in two steps. First, press Y= located just under the bottom left corner of the viewing rectangle. This brings you to the screen..



You can enter multiple functions and graph them all simultaneously. However, we typically only graph a single function at a time. Enter the function into Y_1 =

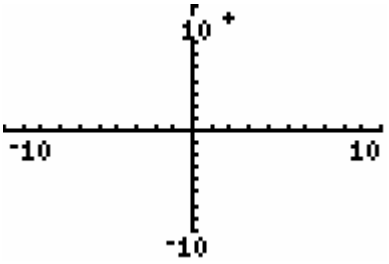
Next, we need to set the window. Press WINDOW which brings us to the window settings screen to specify the window portion that you want to view.



The window settings above are common settings. The Xmin and Xmax buttons specify the X-axis and the Ymin and Ymax buttons specify the Y-axis. These settings will graph your function on the following window..

Finally press GRAPH

Note: We can quickly set the window at these settings using the Zoom key. Press ZOOM, then arrow down to 6: ZStandard and press ENTER which graphs the function on the following axes

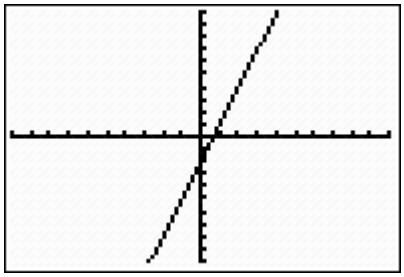


For example.

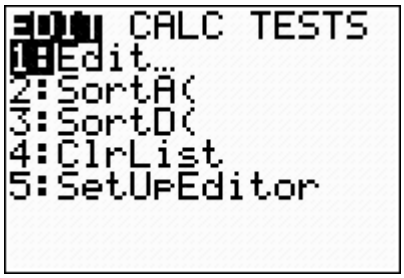
Graph the function y = 3x -2.

Press

Y= 3 X,T,Θ,n — 2 ZOOM 6 to obtain



Built-in Statistics: The TI-84+ has several built-in functions for analyzing data. These are located in the STAT menu. Press STAT

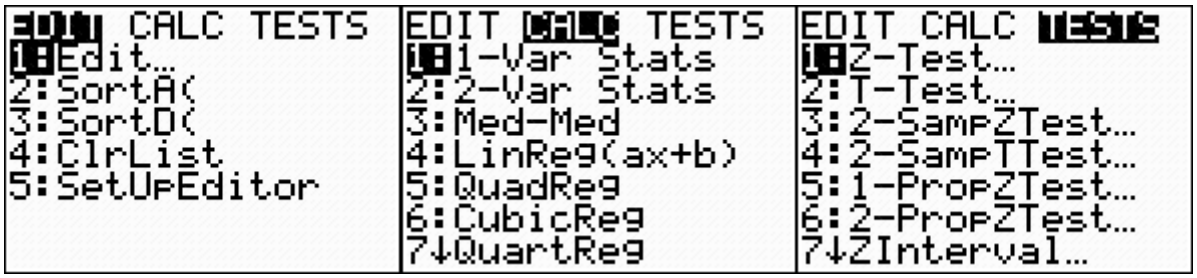


The EDIT Menu is where data is entered into lists. The CALC menu allows us to compute statistical measures on the data stored in the lists. Finally, the TEST menu allows us to construct confidence intervals and conducts tests of hypotheses. We will be using the TEST menu later in the course.

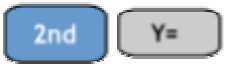
To move between menus just press the appropriate arrow key.

These are the 3 Menus in 

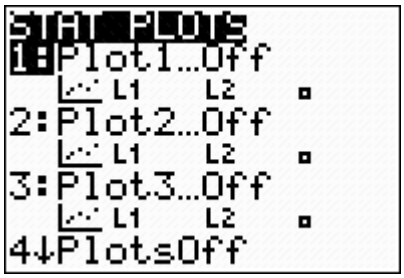
EDIT CALC TESTS



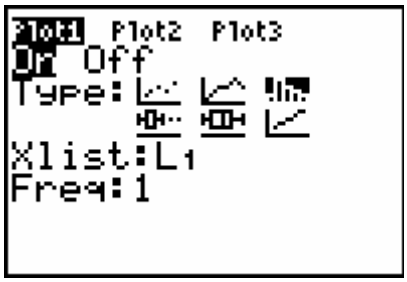
Plotting Statistical Data: The STATPLOT menu is used to set up various statistical plots.

Press 

(STATPLOT). Which brings us to the following screen



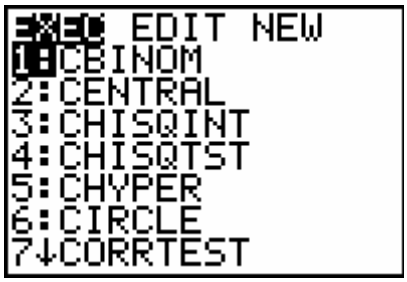
Again, the TI-84+ has the capability of plotting 3 statistical plots simultaneously. We will usually plot only one at a time. It is recommended that users only use Plot1. To set up Plot 1, press 



You navigate through the Plot1 menu by use of the appropriate arrow keys. Notice that the calculator has 6 plots listed under Type: In particular, the TI-84+ can plot scatterplots, frequency polygons, histograms, boxplots, and ogives. In Chapter 2 we will learn how to set up and use the STATPLOT menu

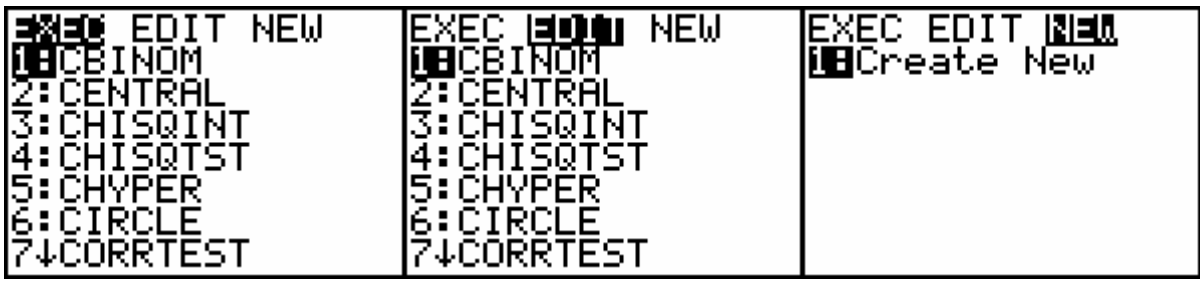
Programs: The CD accompanying the text includes programs for the TI-84+. At the end of this chapter, we will load these programs to our calculator for use later in the text. To see a list of programs already loaded onto your calculator, press PRGM. Your screen will probably look like this. This means that you have no programs loaded on the calculator.

After loading the programs in chapter 2, your PRGM screen will look something like this.



The EXEC menu is used to run a program. The EDIT menu is where programs are written or changed. The NEW menu allows us to create or write new programs. Here are the 3 menus

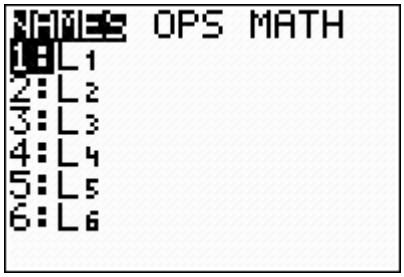
EXEC EDIT NEW



Lists: A TI-84+ list is a set of numbers or observations. A list can hold up to 999 numerical values and is the principal way to store data for analysis. Many of the built-in statistical functions and programs *operate* on or use data stored in a list or lists during execution. There are six simple built-in names for lists: L1, L2, L3, L4, L5, and L6. To quickly specify a

list, such as list L_1, press 2nd 1 (L_1).

You can also call up a list from the LIST menu. Press 2nd STAT (LIST) which brings you to the following screen..



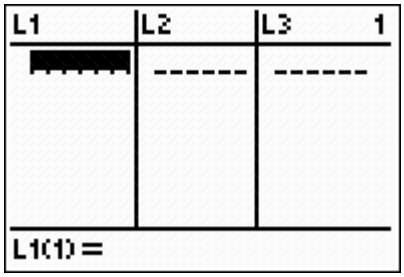
The NAMES, OPS and MATH submenus will be discussed later.

Working with Lists

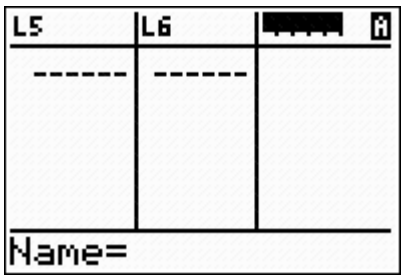
You can create lists with a descriptive name for easy identification. The name must be a string of up to 5 characters. The first character must be a letter which may be followed by letters and numbers. The number of lists is limited by the available memory. This is done primarily from the STAT EDIT menu.

For example, let's create a list called POUND

Press STAT ENTER to view the STAT LIST Editor

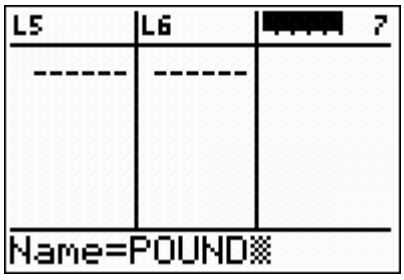


Next, Press (Up Arrow) and (Right Arrow repeatedly) to come to a blank list name.

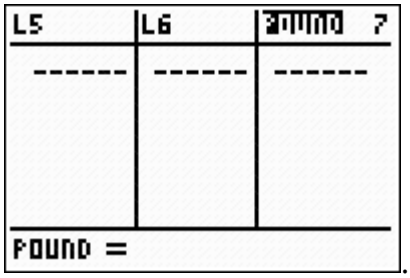


Notice the block A in the upper right corner of the viewing rectangle, this means that the editor requires a list name that begins with an alpha character.

Type the letters POUND. Your screen will look like this..



and then press ENTER. This returns the screen..



At this point you can arrow down into the POUND list to enter the data.

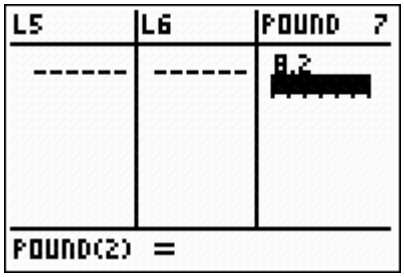
Note: Data that is input into a list is stored indefinitely. There is no special SAVE button to save data in a list. This data is stored until either cleared or deleted.

Input Data into a List

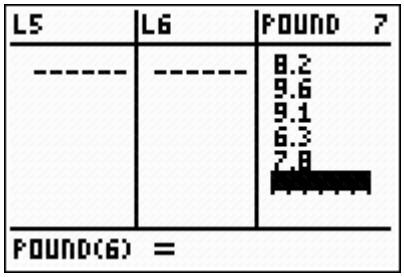
If you want to save the data in a list that you will recognize later, follow the steps immediately above to create the list name. To input data into a list, press STAT select EDIT by pressing ENTER, then use the) key to arrow over to the list you want to enter data into. For our POUND example, lets enter the following weights into POUND

8.2	9.6	9.1	6.3	7.8

Press 8 . 2 ENTER. This brings you to the screen..



Repeat with each of the 5 weights to obtain the list as shown below..



Notice that the cursor is at the 6th position. Since we entered 5 values this is a good way to check to make sure that we have entered the correct number of data values into the list.

Clearing Data from a List

To clear data from a list from within the STAT LIST Editor, press ▲ (up arrow) to highlight the list name, press CLEAR and then ▼. The contents of the list will be cleared.

NOTE: Pressing the DEL (Delete) key will delete the list and the listname from the STAT LIST Editor Screen.

The TI-84+ Graphing Calculator Guidebook has much more information about lists, including other ways they may be created and used. Most of the calculator programs presented in this supplement are illustrated using data stored in lists with descriptive names. However, it is not necessary to give each set of data a name. Rather use the L_1 list and clear it for doing homework problems and when taking quizzes and tests so as not to overcrowd the STAT LIST Editor with data.

Uploading Statistics Programs

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Then press 

bringing you to this screen...

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Step 2: Put the Johnson/Kuby Student's Suite CD-ROM into the CD Rom drive of your PC.

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Double-Click on the "Manual Install" folder
Double-Click on the "Lab Manuals" folder
Double-Click on the "Ti83-84 Manual" folder
You will find the zipped file "statprgm.zip" containing all the stats programs utilized for this course. Copy the file and put it into your "Stats Programs" folder created in the C: drive.
Use a zip utility program, such as Winzip, to unzip the file.

Step 3: Now the programs are unpackaged in the C:\Stats Programs folder. To transfer these over to the calculator requires the use of the TI-Connectivity software and USB cable available from Texas Instruments. On your computer:

Click on the TI-Connect Icon to open the program. Be sure that the TI-84+ is connected via the USB cable to the PC and make sure that the calculator is turned on.
Next Double Click on My Computer
Double Click (Local Drive) C:
Double Click on Stats Programs
Click on Edit, Select All
Right Click and select Copy
From the desktop, right click on TI-Connect and select Paste
The software will transfer each of the programs to the TI-84+

Step 4: The programs are archived and need to be unarchived and stored in RAM. On your calculator, press 

One by One, select each program listed with an asterisk (*) and press 

Repeat step 4 until each program is unarchived.

Step 5: Checking your programs. Click on 

. Your screen should now look like this.

Chapter 2

Descriptive Analysis and Presentation of Single-Variable Data

2.1 Graphic Presentation of Data

A **circle graph**, or **pie diagram**, is used to summarize qualitative or categorical data. The circle graph is commonly used in business settings, newspapers, and magazines to illustrate parts of a whole. A circle is divided to show the amount of data that belong to each category as a proportional part of a circle. The calculator program CIRCLE[1] may be used to construct a circle graph.

Example 2-1: The following table lists the number of cases of each type of operation performed at General Hospital last year. Display this data using a circle graph.

	Type of Operation	Number of Cases
1	Thoracic	20
2	Bones and joints	45
3	Eye, ear, nose, and throat	58
4	General	98
5	Abdominal	115
6	Urologic	74
7	Proctologic	65
8	Neurosurgery	23

[1] Program by Chuck Vonder Embse, *Eightysomething*, Volume 3, Number 2, Spring 1994

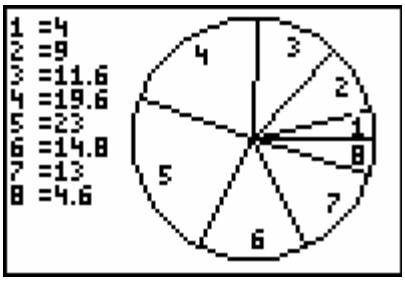
Step 1: Press STAT ENTER

Step 2: Enter the number of cases into list L_1

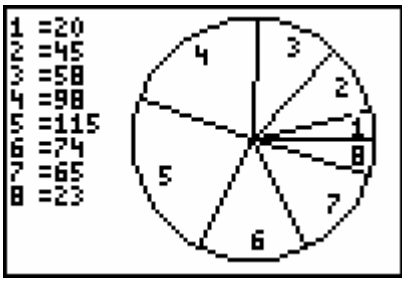
Step 3: Press PRGM ▼ (down arrow) to select CIRCLE. Press ENTER

Step 4: Press 2nd 1 (L_1) ENTER

Step 5: You will be prompted for 1: PERCENTAGES or 2: DATA. Since 1: PERCENTAGES is highlighted, press ENTER. The calculator returns the following pie chart



The numbers at the left indicate the percentage of the total for each type of operation. You can also select 2: DATA in Step 5. This yields the following..



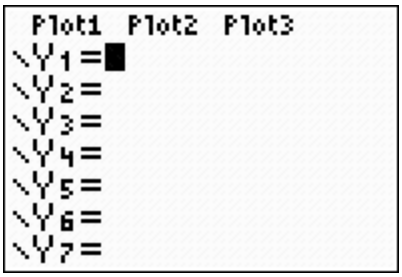
Here the numbers at the left are the frequency counts of each type of operation.

ASSIGNMENT: Do exercises 2.3, 2.4, 2.5 in your text

A **bar graph** is also used to graphically summarize categorical or attribute data. A rectangle is drawn corresponding to each category, or class, with height determined by the frequency. Bar charts are sometimes constructed so that the bars extend horizontally to the right. However, the TI-84+ displays bar charts with vertical bars.

Example 2-2: Using the Operations Data in the table above, let's construct a bar graph

Step 1: Press Y= . Your screen should look like this..



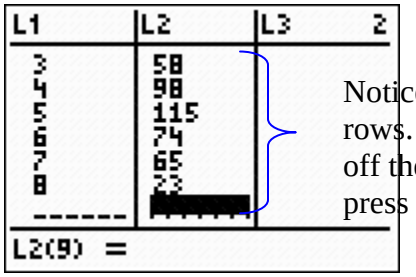
If there are are any functions in Y_1 through Y_7 use (down arrow) and press CLEAR to delete them.

Note: The TI-84+ will graph all of the functions that are listed in the [Y=] menu. Since we don't want to confuse the graph of the bar chart it is best to omit them.

Step 2: Clear the lists L_1 and L_2. Press [▲] [CLEAR] [▼] to clear L_1. Use the right arrow to move over to L_2 and repeat to clear L_2.

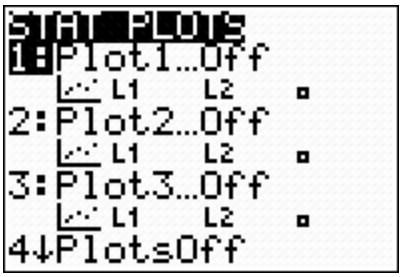
Note: Do not press Delete when the list name is highlighted. This command deletes the list from the stat list editor

Step 3: Press [STAT] [ENTER] enter the Operations Data into L_1 and L_2. (Refer to Chapter 1 for review if necessary) Your screen should look like this.

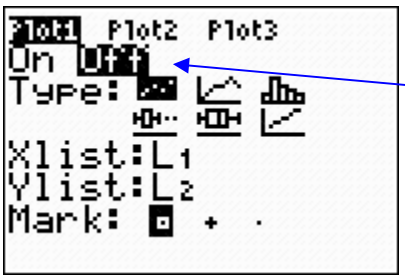


Notice that the list only displays 7 rows. Rows 1 and 2 have scrolled off the page. To view these rows, press the up arrow key

Step 4: Press [2nd] [Y=] (STAT PLOT). This brings you to the following screen



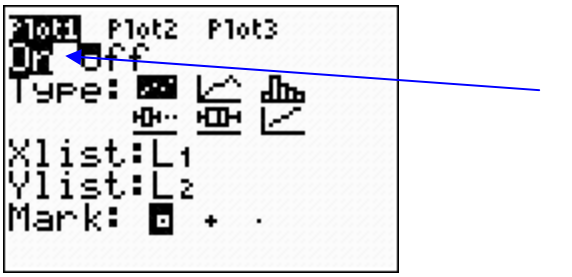
Step 5: Press [ENTER] to access the Plot 1 setup menu.



If **Off** is highlighted, this means that the plot is not turned On and will not graph

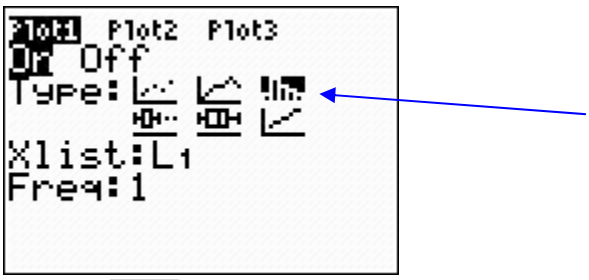
If Off is highlighted, this means that the plot is not turned On.

To turn it on press ◄ ENTER. This toggles Plot 1 to **On** as shown in the next screen..



This shows Plot 1 is **On**

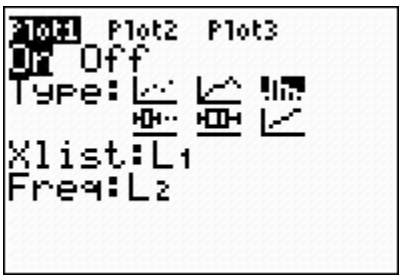
Step 6: Press ▼ to select the Type then press ► to select the bar chart and then press ENTER. Now the bar chart should be highlighted as in the following screen.



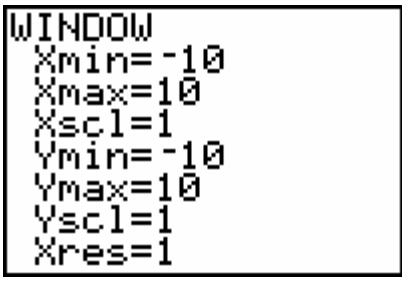
Bar Chart Plot is selected

Step 7: Press ▼ to select Xlist: If the Xlist is L_1, then go to step 8. Otherwise, press 2nd 1 (L_1).

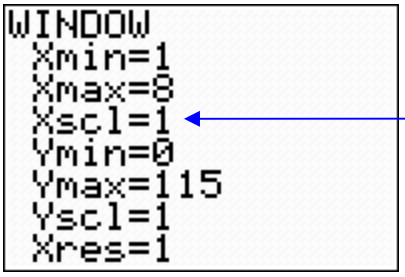
Step 8: Press ▼ to select Freq: Press 2nd 2 (L_2). Plot 1 is now set up. Your screen should look like this..



Step 9: Press WINDOW to bring you to the following screen..



Using  , change each of the settings to match the Operations Data. Your Window should look like this when you finish



The Xscl determines the width of each bar of the chart

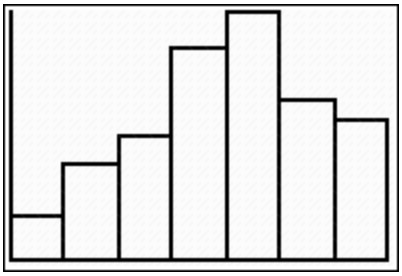
The Xmin represents the smallest data value in L_1 and Xmax is the largest value in L_1.

The Ymin is the minimum data value in L_2 and Ymax is the largest value in L_2

The Yscl doesn't really make a difference in the bar chart.

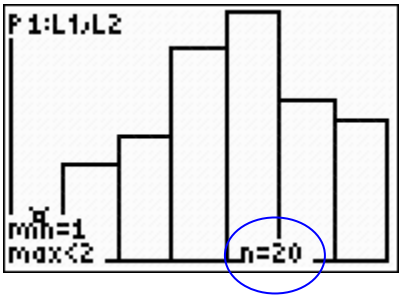
Step 10: Press 

. Your calculator will return the following bar graph.



To read the frequencies of each of the bars press 

. This will show you a frequency for the 1st bar corresponding to Thoracic Operations.



Use the appropriate right or left arrow keys to view the frequencies of each bar.

ASSIGNMENT: Do exercises 2.6 - 2.11 in your text

A **Pareto Diagram** is a bar graph with the bars arranged from the most numerous category to the least numerous category. The diagram includes a line graph displaying the cumulative percentages and counts for the bars. The Pareto diagram is used often in quality-control applications to identify the numbers and types of defects that happen within a product or service.

The calculator program PARETO may be used to display a Pareto diagram.

Example 2-3: The final daily inspection defect report for an assembly line at a local manufacturer is given in the table below. Construct a Pareto diagram for this defect report. Management has given the production line the goal of reducing their defects by 50%. What two defects should they give special attention to in working toward this goal?

Defect	Number
Dent	8
Bend	12
Blemish	56
Chip	23
Scratch	45
Others	6
Total	**150**

Step 1: Press STAT ENTER and clear lists L_1 and L_2

Step 2: Enter the data into list L_1

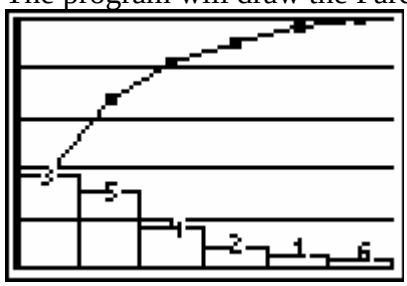
Step 3: Press PRGM and select PARETO

Step 4: When prompted for the list, press 2nd 1 ENTER

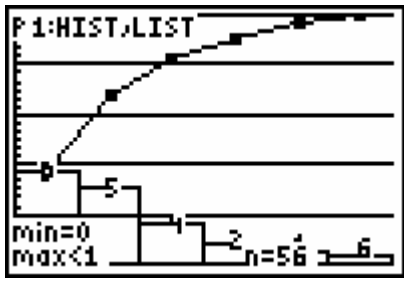
Step 5: When prompted for the Ymax: enter the Total # of Defects, in this case 150

Step 6: When prompted for the Yscl: you can enter any number and it doesn't change the appearance of the graph from the screen below. Each of the horizontal lines represents that scale. However, it is better to use TRACE to read the bar heights or cumulative frequencies on the line graph.

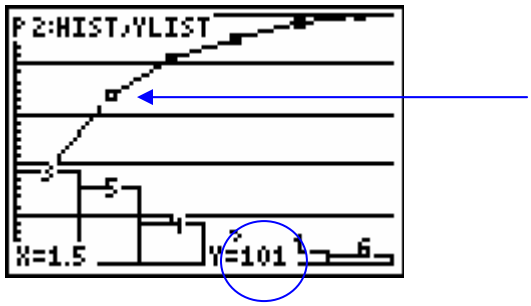
The program will draw the Pareto diagram as shown below



Press TRACE. The calculator displays this screen



The cursor is currently displaying the frequency in the first class - or the height of the first bar of the bar graph. Since the line is cumulative, press (Up Arrow) then (Right Arrow) to begin tracing the line.



Since the Pareto Graph displays the Blemishes and Scratches in the first two bars, this is all we need to consider in answering the question. The cumulative total of the first two classes or bars corresponding to Blemishes and Scratches is 101/150 ≈.673 . Thus 67.3% of the reported defects are due to blemishes and scratches. The assembly line crew should work to reduce these two defects in order to reach their goal.

ASSIGNMENT: Do exercises 2.12-2.16 in your text

A **dotplot** is another type of graph used to display the distribution of a data set. The display represents each piece of data with a dot positioned along a measurement scale. The measurement scale may be horizontal or vertical. The frequency of values is represented along the other scale. The calculator program DOTPLOT may be used to construct a dotplot.

Example 2-4: A random sample of 19 exam scores was selected from a large introductory statistics class. Construct a dotplot for the data given in the following table.

Exam Scores

76	74	82	96	66	76	78	72	52	68
86	84	62	76	78	92	82	74	88	

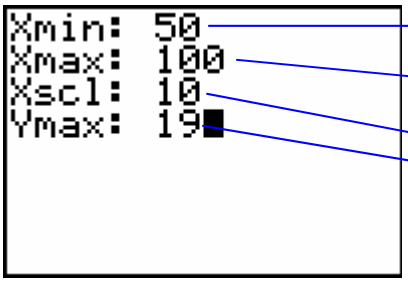
Step 1: Press STAT ENTER and input the 19 exam scores into list L_1

Step 2: Press PRGM and arrow down to select DOTPLOT, then press ENTER

Step 3: When prompted for LIST: Press 2nd 1 (L_1) and then press ENTER

Step 4: You will be prompted for Xmin, Xmax, Xscl, and Ymax as shown on the next screen.

Each time input the value and press ENTER



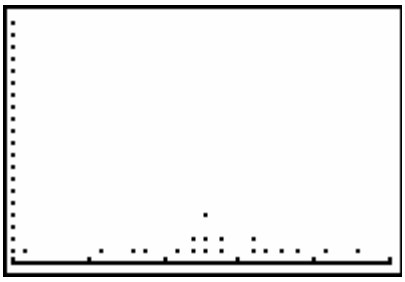
Input a Number less than smallest in data set

Input a Number greater than largest in data set

See Note Below

Note: The Xscl is set to 10 and this represents the width of each class or column of the dotplot. The Ymax should be set to the largest frequency in any one column of the dotplot. As the total frequency of all exam scores in the plot is 19, this is an effective lower bound. We will adjust these settings by trial and error once we have run the program and know what to expect as far as output.

After inputting the Ymax of 19 and pressing ENTER, the following screen displays..



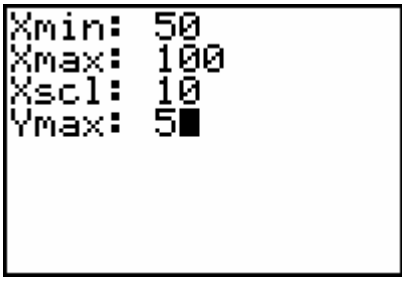
The Xscl of 10 seems appropriate, however, the Ymax setting should be changed.

Step 5: Press PRGM and arrow down to select DOTPLOT, then press ENTER.

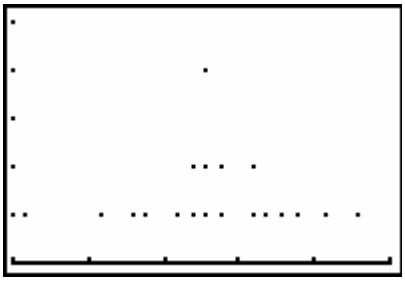
Step 6: When prompted for LIST: Press 2nd 1 (L_1) and then press ENTER

Step 7: You will be prompted for Xmin, Xmax, Xscl, and Ymax as shown on the next screen.

Each time input the value and press ENTER



DOTPLOT will now return the following screen..



Note: You will have to run DOTPLOT several times to get the settings so that the window displays the data appropriately.

ASSIGNMENT: Do exercises 2.17-2.22 in your text

A **frequency distribution** is a table or graph that summarizes data by classes or class intervals. In a typical *grouped* frequency distribution, there are anywhere from 5 to 20 classes of equal width. The table may contain columns for class number, class interval, tally (if constructing by hand), frequency, relative frequency, cumulative relative frequency, and class mark. In an

ungrouped frequency distribution each class consists of a single value.

The TI-84 is capable of constructing frequency distributions and graphing frequency histograms. Typically we graph the histogram and use TRACE to construct the frequency distribution.

Example 2-5: The hemoglobin *A* test, a blood test given to diabetics during their periodic checkups, indicates the level of control of blood sugar during the past two to three months. The data in the following table was obtained from 40 different diabetics at a university clinic treating diabetic patients.

Blood Test Results

6.5	5.0	5.6	7.6	4.8	8.0	7.5	7.9	8.0	9.2
6.4	6.0	5.6	6.0	5.7	9.2	8.1	8.0	6.5	6.6
5.0	8.0	6.5	6.1	6.4	6.6	7.2	5.9	4.0	5.7
7.9	6.0	5.6	6.0	6.2	7.7	6.7	7.7	8.2	9.0

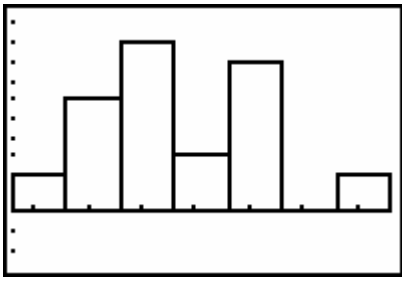
Step 1: Press STAT ENTER and input the blood test data into list L_1

Step 2: Press 2nd Y= (STAT PLOT) and then press ENTER to access the Plot 1

Step 3: Adjust the menu settings so that your screen looks like this

Step 4: We have two options for setting the window.

The first option is to let the calculator select the window and graph the histogram. Press ZOOM 9 (ZOOM STAT). The calculator will display the following histogram..

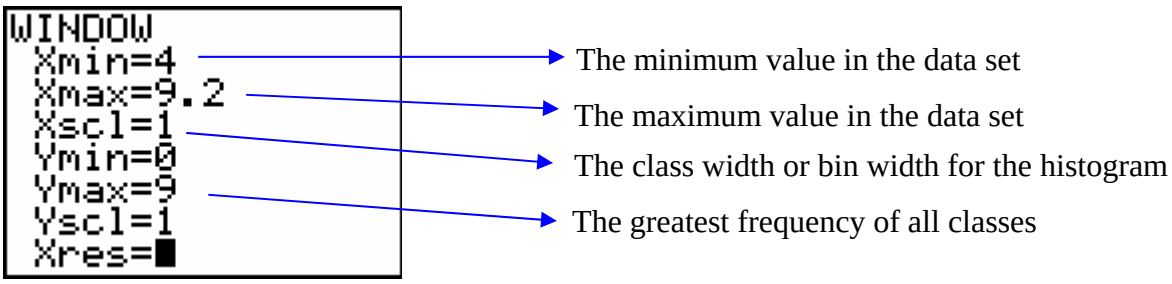


Notice that there are 7 classes of equal width. If this is acceptable then we can use TRACE to construct the classes and to find the frequency in each class.

OR,

The second option is to set the window manually.

Press WINDOW and adjust the settings so that the screen looks like this

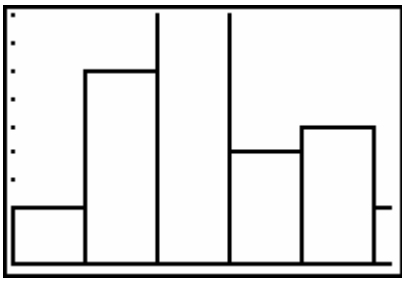


Note: To determine the Xscl or class width, find the range = Xmax - Xmin which is 5.2 in this case. Then decide on the number of classes and divide into the range. Finally, round this number up to get the Xscl. For this example. I choose six bars in the histogram or 6 classes.

Dividing $6\overline{)\,5.2}$ $\approx .9167$. Rounding up yields a Xscl of 1.

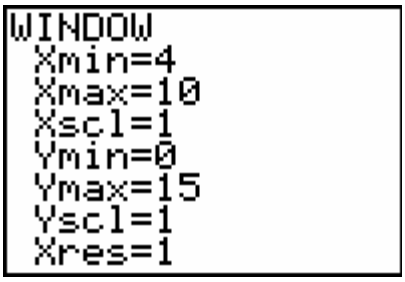
The Ymax is the highest frequency and is not known until the frequency histogram is graphed. Since there were 30 measurements in the original data set, this would be an effective upper bound for Ymax. However, since there will be 6 classes displayed, I chose 20 as a guess. This can be corrected quickly if the guess is too large or small.

Step 5: Press GRAPH to display the histogram as shown below

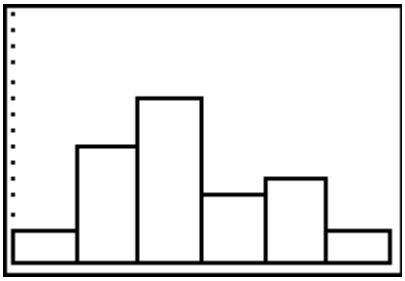


Step 6: In this example, the Ymax setting is set too low and should be adjusted to a larger value.

Similarly, the Xmax setting needs to be adjusted also. Press WINDOW and make the following corrections..

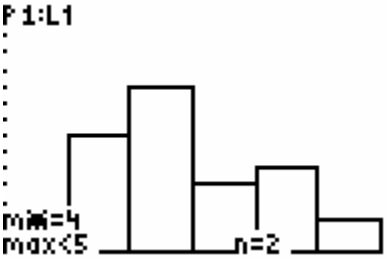


Step 7: Press GRAPH to display the histogram as shown below



To construct the grouped frequency distribution, continue with the following steps..

Step 8: Press TRACE . Your screen should look like this..



Step 9: Press) (Right Arrow) to view the rest of the classes and the corresponding frequencies in each class. Complete the table as below.

Classes	Frequencies
4-5	2
5-6	7
6-7	10
7-8	4
8-9	5
9-10	2
Total	30

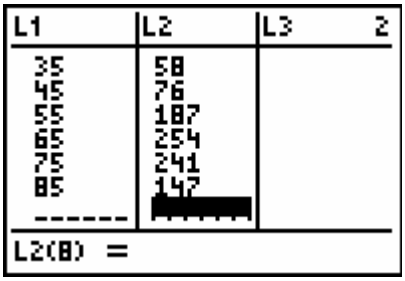
ASSIGNMENT: Do exercises 2.29-2.23 in your text

Example 2-6: Data from a recent survey of Roman Catholic nuns summarizes their ages as follows.

Class Midpoints	Age Classes	Frequencies
25	20 up to 30	34
35	30 up to 40	58
45	40 up to 50	76
55	50 up to 60	187
65	60 up to 70	254
75	70 up to 80	241
85	80 up to 90	147

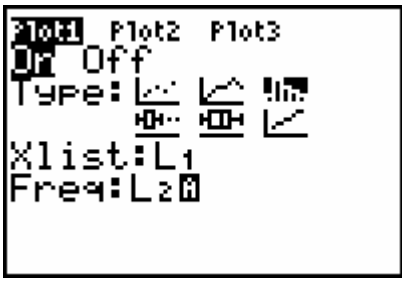
Construct a histogram for this data.

Step 1: Press STAT ENTER and input the class midpoints in list L_1 and corresponding frequencies in list L_2. Your screen will look like this..

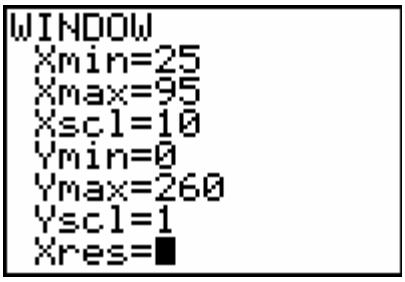


Step 2: Press 2nd Y= (STAT PLOT) and then press ENTER to access the Plot 1

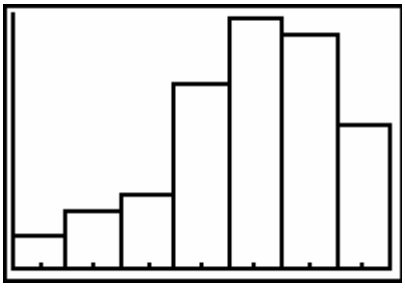
Step 3: Adjust the menu settings so that your screen looks like this



Step 4: Press WINDOW and adjust the settings so that the screen looks like this..



Step 5: Press GRAPH to display the histogram



ASSIGNMENT: Do exercises 2.39, 2.41 in your text

An **ogive** is a plot of cumulative frequency or cumulative relative frequency versus class limit. A horizontal scale identifies the upper class boundaries. Every ogive starts on the left with a relative frequency or frequency of zero at the lower class boundary of the first class and ends on the right with a cumulative relative frequency of 1, or cumulative frequency of *n* (the number of observations in the data set).

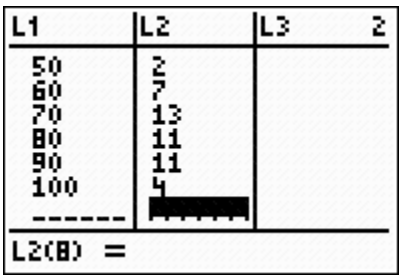
Example 2-7: The final exam scores of 50 elementary statistics students were selected and the following grouped frequency distribution was obtained.

Classes	Frequencies	Cumulative Frequency
35-45	2	
45-55	2	
55-65	7	
65-75	13	
75-85	11	
85-95	11	
95-105	4	
Total	50	

Construct the cumulative frequency histogram or ogive for this distribution.

Step 1: Press STAT ENTER, input the class midpoints into list L_1 and frequencies into list L_2

Your screen should look like this

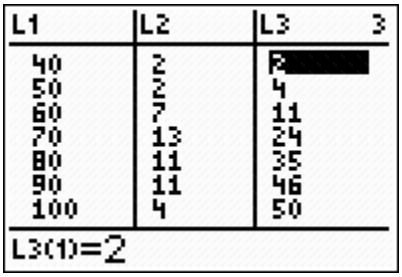


Step 2: Press 2nd MODE (QUIT) CLEAR to get to a blank home screen

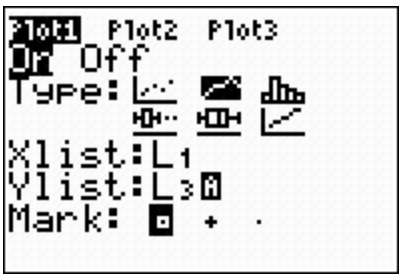
Step 3: Press 2nd STAT, select OPS and then select **6: cumSum** and press ENTER

Step 4: Press 2nd 2 (L_2) STO▶ 2nd 3 (L_3) to compute the cumulative frequencies in list L_3.

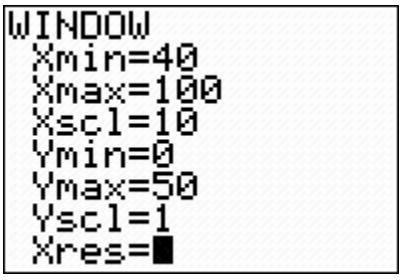
To view these cumulative frequencies press STAT ENTER. Check your screen matches this..



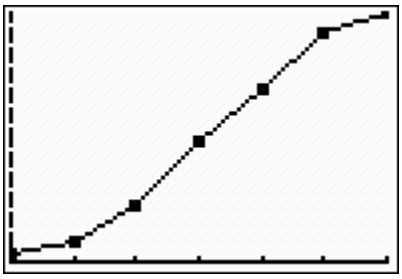
Step 5: Press 2nd Y= ENTER and change your settings of the Plot 1 Menu accordingly



Step 6: We need to adjust the windows settings. Press WINDOW and adjust the settings so that the screen looks like this..



Step 7: Finally, Press GRAPH to obtain the following ogive



ASSIGNMENT: Do exercises 2.51, 2.53 in your text

Measures of Central Tendency

The Mean - The mean is the arithmetic average of the values of the data set. It is used to represent the "average" or center of the data as a representative value. There are several ways to find the mean on the TI-84. Consider the following example;

Example 2-8: A set of data consists of 6, 3, 8, 6 and 4. Find the mean

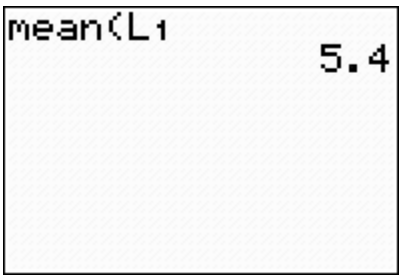
Method 1

Step 1: Press STAT ENTER and input the data values into list L_1

Step 2: Press 2nd MODE CLEAR to get to a blank home screen

Step 3: Press 2nd STAT (LIST), select M**ATH**, select **3: mean** and press ENTER

Step 4: Press 2nd 1 (L_1) and press ENTER. The calculator returns the answer..



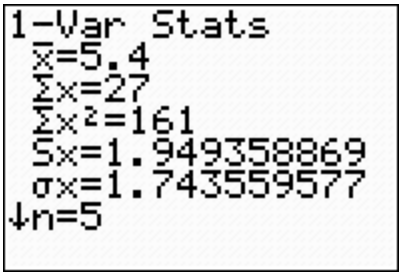
Method 2

Step 1: Step 1: Press STAT ENTER and input the data values into list L_1

Step 2: Press 2nd MODE CLEAR to get to a blank home screen

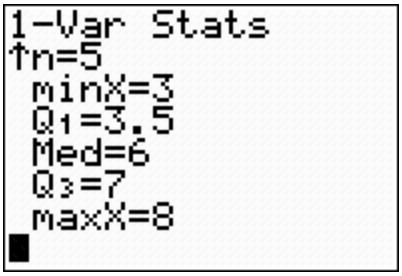
Step 3: Press STAT, select **CALC**, select **1: 1-Var Stats** and press ENTER

Step 4: Press 2nd 1 (L_1) and press ENTER. The calculator returns the answer..



This second approach shows the mean, $\bar{x}$ = 5.4. It also displays other measures as well. Notice S_x which represents the sample standard deviation, σ_x which represents the population standard deviation are also found on the same page.

Also note the down arrow in the bottom left hand part of the view screen. By pressing the down arrow a few times we obtain the rest of the 1-Var Stats summary..



The Quartiles, Median and minimum and maximum values are all displayed

* We will use Method 2 for most of our calculations throughout the rest of this manual.

ASSIGNMENT: Do exercises 2.58, 2.60, 2.61 in your text

The Median - When the data set is sorted, the "middle" value is termed the median. In a data set with an odd number of values, there is a middle value. In a data set with an even number of values, the average of the two "middle-most" values is the median. The TI-84 displays the median in the 1-Var Stats summary.

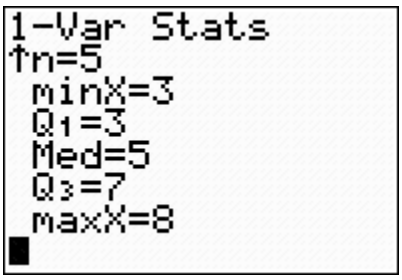
Example 2-9: Find the median for the data set 6, 3, 8, 5, 3

Step 1: Press STAT ENTER and input the data values into list L_1

Step 2: Press 2nd MODE CLEAR to get to a blank home screen

Step 3: STAT ▶ ENTER 2nd 1 ENTER

Step 4: Press ▼ repeatedly to scroll down to the median. The calculator returns the value



ASSIGNMENT: Do exercises 2.62, 2.63, 2.67 in your text

Mode & Midrange

The Mode & Midrange can be found using the program CENTRAL

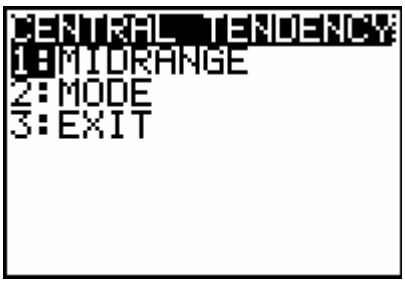
Example 2-10: Find the Mode & Midrange of the data set 3,3,5,6,8

Step 1: Press STAT ENTER and input the data values into list L_1

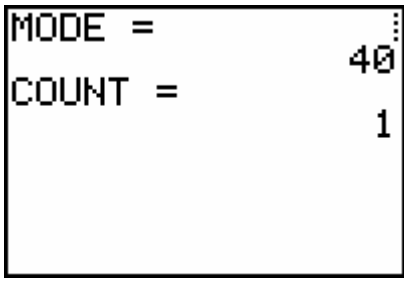
Step 2: Press PRGM, and then press ▼ to select CENTRAL, then press ENTER

Step 3: When prompted for LIST, press 2nd 1 (L_1)

Step 4: Select 1: MIDRANGE, 2: MODE or 3: Exit as shown on the following screen



Depending on your selection, the calculator returns the following screens



ASSIGNMENT: Do exercises 2.65-2.67 in your text

Example 2-11: Recruits for a police academy were required to undergo a test that measures exercise capacity. Exercise capacity (in minutes) was obtained for each of 20 recruits and is given in the following table. Find the mean, median, mode and the midrange of the data.

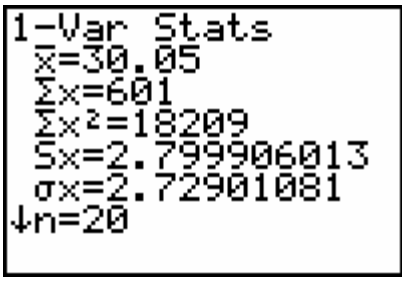
Exercise Capacity									
25	27	30	33	30	32	30	34	30	27
26	25	29	31	31	32	34	32	33	30

First, to find the mean and median use the 1-Var Stats summary

Step 1: Press STAT ENTER and input the Exercise Capacity values into list L_1

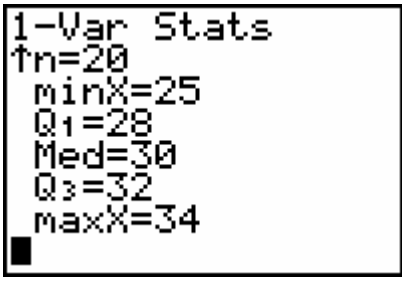
Step 2: Press 2nd MODE CLEAR to get to a blank home screen

Step 3: STAT) ENTER 2nd 1 ENTER. The following screen will be returned



Thus the mean is $\bar{x} = 30.05$

Step 4: Press  several times to display the median



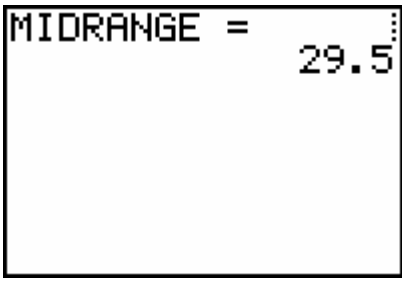
So, the median is 30

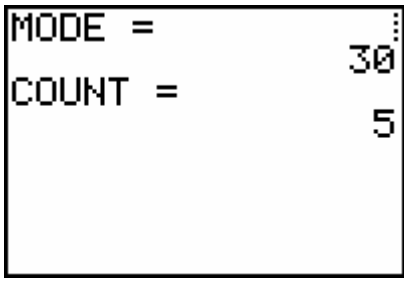
To find the midrange and mode use the CENTRAL Program

Step 1: Press  , and then press  to select CENTRAL, then press 

Step 2: When prompted for LIST, press  (L_1)

Step 3: Select 1: MIDRANGE, 2: MODE or 3: Exit as shown on the following screens





ASSIGNMENT: Do exercises 2.67-2.74 in your text

Measures of Dispersion

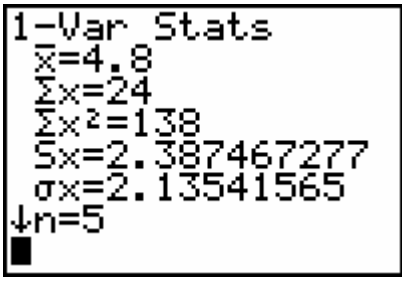
These measures indicate spread or variation of data. Data sets with identical means and medians can have different measures of spread. We will learn how to compute the range, standard deviation and variance on the TI-84+

Example 2-12: Find the range, standard deviation and variance for the data set 6, 3, 8, 5, 2

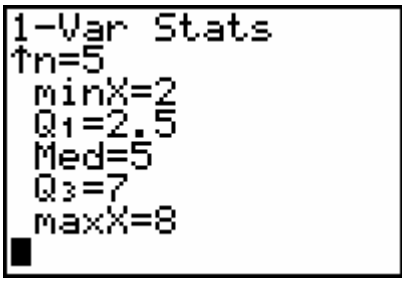
Step 1: Press [STAT] [ENTER] and input the data values into list L_1

Step 2: Press [2nd] [MODE] [CLEAR] to get to a blank home screen

Step 3: [STAT] [▶] [ENTER] [2nd] [1] [ENTER]. The following screen will be returned



The sample standard deviation, denoted s = 2.387. The sample variance is the square of the standard deviation or $s^2 = (2.387)^2 = 5.698$. Finally, the range of data set is the difference of the maximum and minimum. Press [▼] repeatedly, the calculator will return the following screen.



Thus, the range is 8 - 2 = 6

ASSIGNMENT: Do exercises 2.85, 2.89-2.94 in your text

We may compute the estimated mean, standard deviation and variance of a grouped frequency distribution

Example 2-13: A farmer conducted an experiment in order to judge the value of a new diet for his animals. Using the weight gain (in grams) for chicks fed on a high-protein diet given in the

following table, find the mean, variance, and standard deviation.

Weight Gain	Frequency
12.5	2
12.7	6
13.0	22
13.1	29
13.2	12
13.8	4

Step 1: Press 

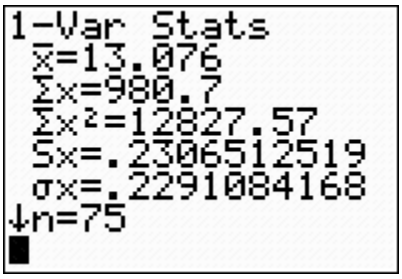
and input the Weight Gain data into list L_1 and the corresponding frequencies into list L_2

Step 2: Press 

to get to a blank home screen

Step 3: Press 

to obtain the following screen.



The mean, $\bar{x} = 13.076$

The sample standard deviation, s = .231

The sample variance is $s^2 = .231^2 = .053$

Measures of Position on the TI-84+

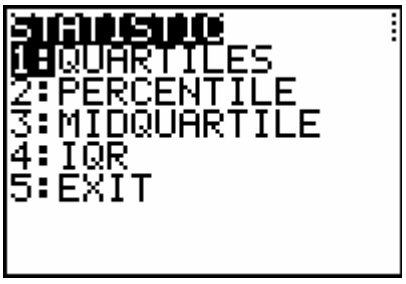
There are four measures of position that we will compute using the POSITION Program on the TI-84+. These are the quartiles, percentiles, midquartiles and innerquartile range (IQR).

Example 2-14: An experiment was conducted in order to test how quickly certain fabrics ignite when exposed to a flame. The following table lists the ignition times for a certain type of synthetic fabric. Find the quartiles, the midquartile, the interquartile range, and the 88th percentile.

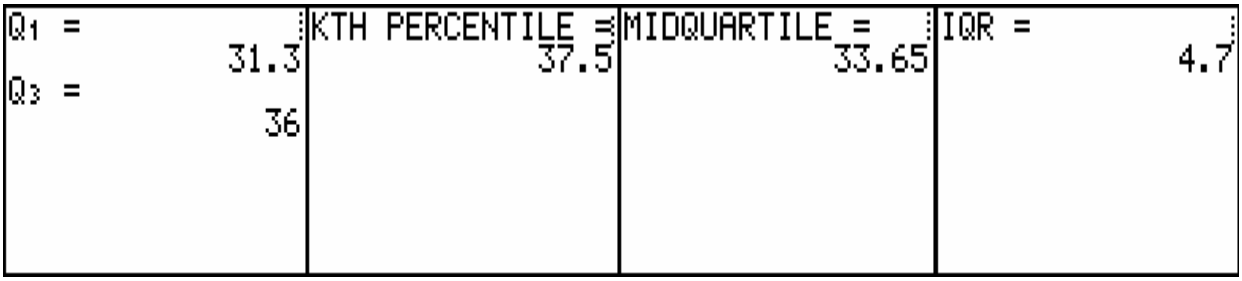
Ignition Times								
30.1	31.5	34.0	37.5	30.1	31.6	34.5	37.5	30.2
31.6	34.5	37.6	30.5	32.0	35.0	38.0	31.0	32.4
35.0	39.5	31.1	32.5	35.6	31.2	33.0	36.0	31.3
33.0	36.5	31.3	33.0	36.9	31.4	33.5	37.0	

Step 1: Press STAT ENTER and input the Ignition Times data into list L_1

Step 2: Press PRGM and then select POSITION and press ENTER. You should have the following screen



Step 3: Select the option you want to compute and press ENTER. The 4 screens are shown below.



ASSIGNMENT: Do exercises 2.105 - 2.109 in your text

A **5-number summary** is sometimes used to describe a set of data and is composed of:

(1) Min, the smallest value in the data set,
(2) Q_1, the first quartile (also called P_{25} , or the 25^{th} percentile),
(3) Med, the median, Q_2 or 50^{th} percentile
(4) Q_3, the third quartile (also called P_{75} , or the 75^{th} percentile), and
(5) Max, the largest value in the data set.

The 5-number summary is displayed with the other measures of central tendency on the 1-Var Stat summary.

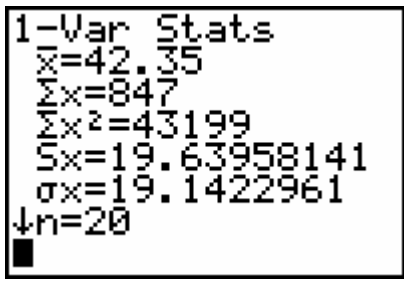
Example 2-15: A manual dexterity test was given to 20 intoxicated individuals. The times (in minutes) to complete the test are listed in the table below. Compute the 5-number summary for the data

21	30	51	28	34
44	47	33	32	33
42	65	35	10	55
49	99	34	33	72

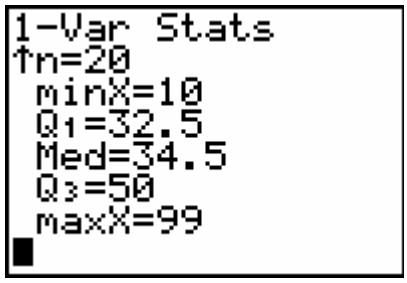
Step 1: Press STAT ENTER and input the minutes data into list L_1

Step 2: Press 2nd MODE CLEAR to get to a blank home screen

Step 3: STAT ▶ ENTER 2nd 1 ENTER. The following screen will be returned



Step 4: Press ▼ repeatedly to obtain the screen



ASSIGNMENT: Do exercise 2.111 in your text

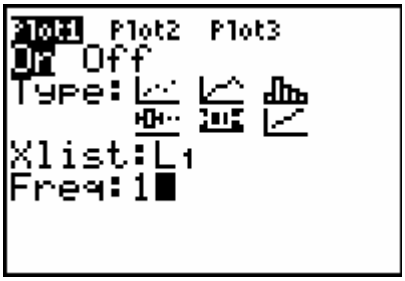
A **box-and-whisker display**, or boxplot, is a graphic representation of the 5-number summary. The five numerical values (Min, Q_1, Med, Q_3, Max) are located on a horizontal scale. A box is drawn with edges at the quartiles and a line is drawn at the median. A line segment (whisker) is drawn from Q_1 to the smallest value, and another line segment is drawn from $Q_3$to the largest value. This regular box-and-whisker display is a built-in statistical plot.

Example 2-16: Using the Minutes data from the previous example construct a boxplot of the data.

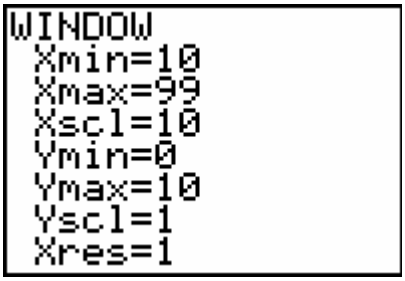
Step 1: Press STAT ENTER and input the minutes data into list L_1.

Step 2. Press 2nd Y= (STAT PLOT) and press ENTER to access the Plot1 menu.

Step 3: Set the menu as shown below

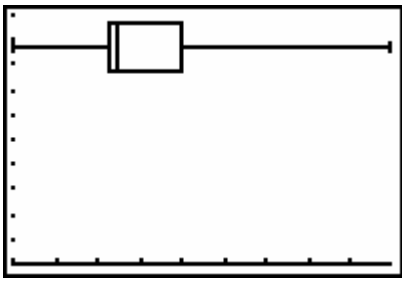


Step 4: Set the window. Press WINDOW and adjust the settings to look like the following..



Notice the Xmin is the minimum value and Xmax is the maximum value in the data set. The Xscl can be set at any convenient value for reading the boxplot. Boxplots only measure in the horizontal direction, thus you can always set Ymin = 0, Ymax = 10 and Yscl = 1

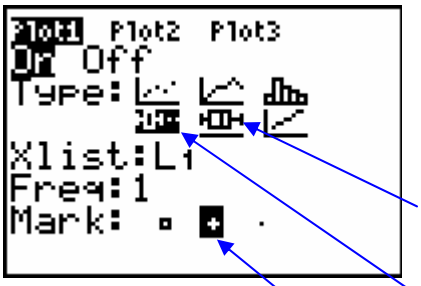
Step 4: Press GRAPH to obtain the following screen



The TI-84+ Plus will also display a modified boxplot showing potential outliers.

Step 1: Press 2nd Y= ENTER to enter the Plot 1 menu

Step 2: Adjust your screen to the following

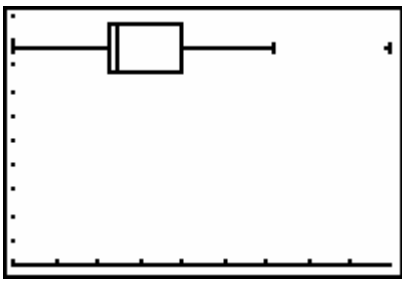


Regular Boxplot

Modified Boxplot

Marks Outliers

Step 3: Press GRAPH to display the modified boxplot



Notice + sign indicates potential outlier

Step 4: Press TRACE, then press) to list the five number summary and to find the outlier.

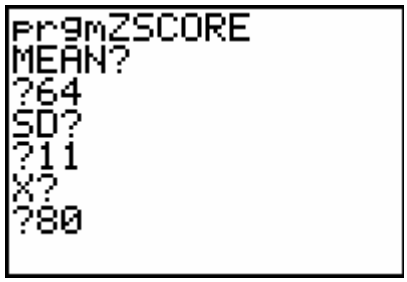
ASSIGNMENT: Do exercises 2.111, 2.112, 2.114, 2.115, 2.118 in your text

The **z-score**, or **standard score,** for a specific value is a measure of relative standing in terms of the mean and standard deviation. The program ZSCORE on the TI-84 will convert X (raw scores) into Z scores.

Example 2-17: The mean score on a calculus midterm was 64 with a standard deviation of 11. Sally scored 80. What was her z-score? i.e. how many standard deviations above the mean did Sally score on her midterm?

Step 1: Press PRGM select **:ZSCORE** and press ENTER

Step 2: The calculator will prompt you for the mean, standard deviation and raw score X. Input the values 64, 11 and 80 respectively as shown below..



Step 3: Press ENTER to obtain the following z-score rounded to two decimal places

Note: To obtain additional z-scores press ENTER and ZSCORE automatically begins again.

ASSIGNMENT: Do exercises 2.119-2.123, 2.125, 2.127-2.128 in your text

Chebyshev's Theorem on the TI-84+

The Program **CHEBY** can be used to find intervals and percentages using Chebyshev's Theorem.

Example 2-18: A certain brand of shoes have a mean cost of $58 with a standard deviation of $6. What minimum percentage is guaranteed by Chebyshev's Theorem to lie within $42.52 to $73.48?

Solution:

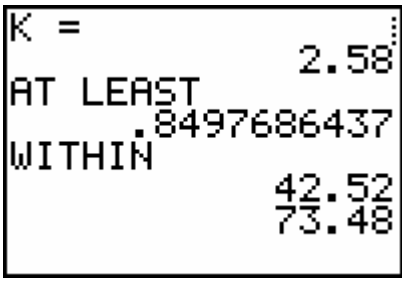
Step 1: First determine if this interval is symmetric with respect to the mean of 58. Since 73.48 - 58 = 15.48 and 58 - 42.52 = 15.48, there is symmetry.

Step 2: We need to determine the value k. k = 15.48/6 = 2.58

Step 3: Press PRGM ▼ to select CHEBY and press ENTER twice. This brings you to the next screen.

Step 4: Press ▼ to select 2: STATS and press ENTER

Step 5: Input the appropriate values for the mean, standard deviation and k. The calculator returns the following..



Thus, at least 85% of this brand of shoe will lie in the price range ($42.52 , $73.48)

ASSIGNMENT: Do exercises 2.192, 2.205, 2.206 in your text

Example 2-19: A sample of earnings per share data for 30 fortune 500 companies is listed below.

1.97	.60	4.02	3.20	1.15	6.06
4.44	2.02	3.37	3.65	1.74	2.75
3.81	9.70	8.29	5.63	5.21	4.55
7.60	3.16	3.77	5.36	1.06	1.71
2.47	4.25	1.93	5.15	2.06	1.65

Using Chebyshev's Theorem, calculate the range of the data that is within k = 2.5 standard deviations of the mean.

Solution:

Step 1: Press STAT ENTER and input the earnings data into list L_1

Step 2: Press 2nd MODE CLEAR

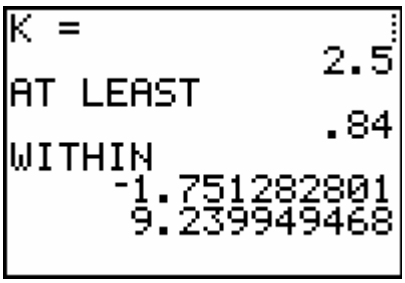
Step 3: Press PRGM ▼ to select CHEBY and press ENTER twice. This brings you to the next screen.

Step 4: Press ENTER to select 1: LIST

Step5: When prompted for LIST: press 2nd 1 ENTER. This brings you to the next screen..

Step 6: Since this data represents a sample, press ENTER

Step 7: When prompted for the value of k, press 2 . 5 ENTER. The calculator returns the following..



Thus, the interval in which at least 84% of the data lies based on this sample is (-1.75, 9.24)

ASSIGNMENT: Do exercises 2.207-2.208 in your text

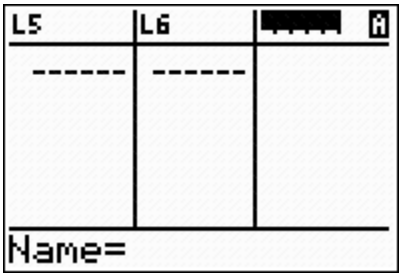
Using the TI-84+ to Test Data for Normality

Example 2-20: The final exam scores for an elementary statistics exam are listed in the table below. Test the data for normality.

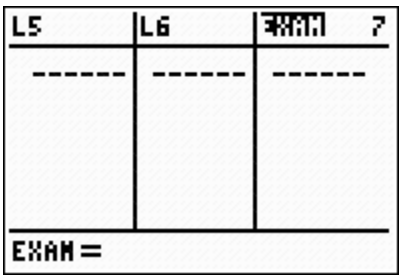
60	47	82	95	88	72	67	66	68	98
90	77	86	58	64	95	74	72	88	74
77	39	90	63	68	97	70	64	70	70
58	78	89	44	55	85	82	83	72	77
72	86	50	94	92	80	91	75	76	78

Step 1: Press STAT ENTER

Step 2: Press ▲ to highlight listname L_1 and then press ▶ repeatedly until you come to a blank column as shown in the screen below.



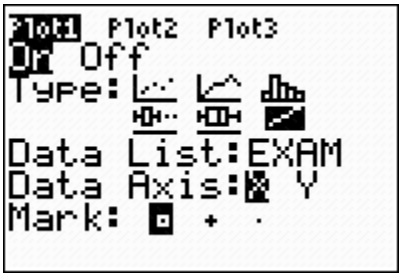
Step 3: Notice the Alpha Character is locked (A in upper right corner). Thus we can type the list name EXAM using the green alpha keys and then press ENTER your screen should look like this..



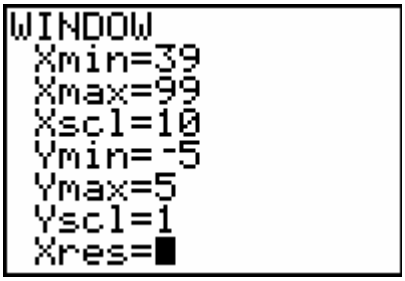
Step 4: Press ▼ and input the exam scores into the list EXAM.

Step 5: Press 2nd MODE (Quit) CLEAR to get to a blank homescreen and to exit the edit mode.

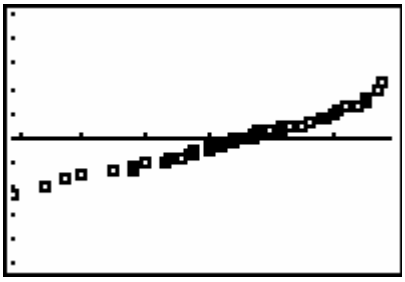
Step 6: Press 2nd Y= ENTER and adjust the Plot 1 settings accordingly



Step 7: Press WINDOW and adjust your window settings to match those below



Step 8: Press GRAPH to obtain the following plot



When the data appears to be linear, this indicates that the data is approximately normal.

ASSIGNMENT: Do exercise 2.207 in your text

Using the TI-84+ to generate random data

The program SAMPLE can be used to generate random numbers between two bounds with or without replacement.

Example 2-21: The California State Lottery Super Jackpot Plus® is a game in which players choose or let the computer randomly generate 5 numbers between 1-47. This random generation is sometimes called a "Quick-Pick". Simulate the random draw of a "Quick-Pick"

Step 1: Press PRGM, select **:Random** and press ENTER

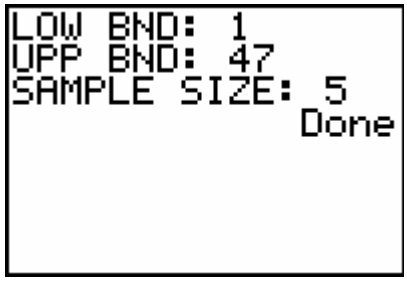
Step 2: When prompted for LOW BND: input 1 and press ENTER

Step 3: When prompted for UP BND: input 47 and press ENTER

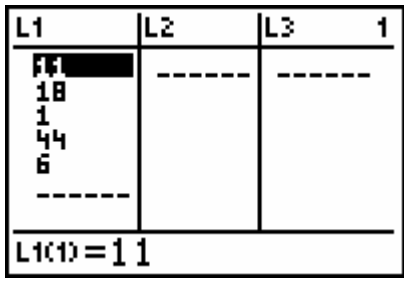
Step 4: When prompted for SAMPLE SIZE: input 5 and press ENTER

The calculator will prompt you to select sampling with or without replacement

Step 5: Since 1: W/OUT REPLACE is highlighted, select ENTER. The following screen is obtained..



Step 6: Press STAT ENTER to see the list. Since the numbers are randomly generated, the list that is obtained each time will be different.



ASSIGNMENT: Do exercises 2.213-2.216 in your text

Chapter 3

Descriptive Analysis and Presentation of Bivariate Data

When bivariate data results from two qualitative (attribute or categorical) variables, the data is often arranged on a *cross-tabulation* or *contingency table*. The calculator program **CROSSTAB** may be used to summarize data in a cross-tabulation and to obtain row, column, and total percentages.

Example 3-1: Thirty students from a college were randomly identified and classified according to two variables: (1) gender (M/F) and (2) major (Liberal Arts LA, Business Administration BA, Technology T), as shown in the following table. Summarize this data in a 2 x 3 cross-tabulation table.

Student	Gender	Major		Student	Gender	Major
1	M	LA		16	M	BA
2	F	BA		17	M	LA
3	M	LA		18	M	BA
4	F	LA		19	F	LA
5	M	BA		20	M	T
6	M	T		21	M	BA
7	F	LA		22	F	BA
8	M	T		23	M	T
9	F	BA		24	F	LA
10	F	BA		25	M	T
11	M	T		26	M	BA
12	M	LA		27	F	LA
13	F	LA		28	F	T
14	M	T		29	M	BA
15	F	T		30	M	LA

Step 1: Code the data as follows. For gender M=1, F=2. For major LA=1, BA=2, T=3.

Note: The coded data for each list must begin with 1 and use only consecutive positive integers.

The coded data looks like this..

Student	Gender	Major		Student	Gender	Major
1	1	1		16	1	2
2	2	2		17	1	1
3	1	1		18	1	2
4	2	1		19	2	1
5	1	2		20	1	3
6	1	3		21	1	2
7	2	1		22	2	2
8	1	3		23	1	3
9	2	2		24	2	1
10	2	2		25	1	3
11	1	3		26	1	2
12	1	1		27	2	1
13	2	1		28	2	3
14	1	3		29	1	2
15	2	3		30	1	1

Step 2: Press STAT ENTER enter the 30 Gender codes into list L_1 and the 30 Major Codes into list L_2

Step 3: Press 2nd MODE CLEAR to get to a blank homescreen and to exit the EDIT mode

Step 4: Press PRGM, select :CROSSTAB and press ENTER

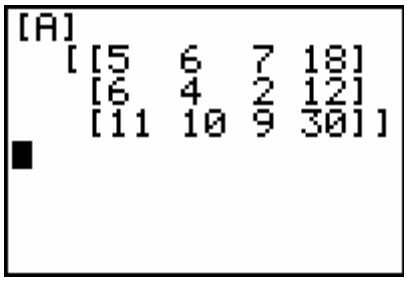
Step 5: When prompted for ROWS: press 2nd 1 (L_1) and press ENTER

Step 6: When prompted for COLS: press 2nd 2 (L_2) and press ENTER

The calculator will store the cross tabulation tables in Matrices [A], [B], [C] and [D]

The cross-tabulation table with the frequency for each cross category of the two variables along with marginal totals is stored in the matrix [A]. The cross-tabulation table showing row percentages is stored in the matrix [B], column percentages in the matrix [C], and overall percentages based on the grand total in the matrix [D]. All of these percentage matrices also contain marginal totals. Each matrix may be viewed on the Home Screen or in the matrix editor

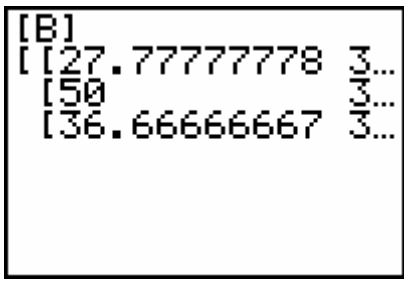
Step 7: Press 2nd x^{-1} (MATRIX), select [A] and press ENTER. Matrix [A] is displayed



Interpretation of the entries in the matrix [A].

		Major			
		LA	BA	T	Row Totals
Gender	Male	5	6	7	18
	Female	6	4	2	12
	Column Totals	11	10	9	30

Step 8: Press CLEAR then press 2nd x^{-1} (MATRIX), select [B] and press ENTER. Matrix [B] is displayed below. Press ▶ to scroll over and see the other entries

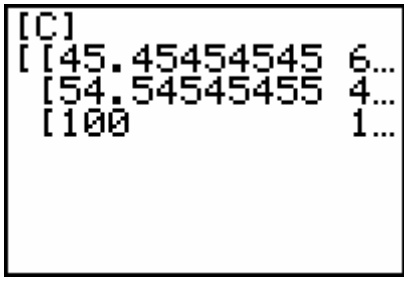


Interpretation of the entries in the matrix [B].

		Major			
		LA	BA	T	Row Total
Gender	Male	27.78%	33.33%	38.89%	100%
	Female	50%	33.33%	16.67%	100%
	Column Totals	36.67%	33.33%	30%	100%

Each entry is % of row total. For example, the percentage of Male, Liberal Arts Majors is 5/18 = 27.78%

Step 9. Press CLEAR then press 2nd x^{-1} (MATRIX), select [C] and press ENTER. Matrix [C] is displayed below..

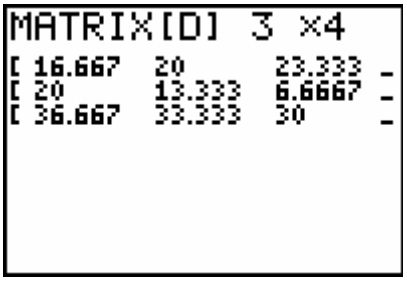


Interpretation of the entries in the matrix [C].

		Major			
		LA	BA	T	Row Total
Gender	Male	45.45%	60.00%	77.78%	60%
	Female	54.54%	40.00%	22.22%	40%
	Column Totals	100.00%	100.00%	100%	100%

Here the entries correspond to a percentage of the column total. For example, Male Liberal Arts majors compose 5/11 = 45.45% of the column total.

Step 10: Press CLEAR then press 2nd x^{-1} (MATRIX), select [D] and press ENTER. The calculator returns Matrix [D] below



Interpretation of the entries in the matrix [D].

		Major			
		LA	BA	T	Row Total
Gender	Male	16.67%	20.00%	23.33%	60%
	Female	20.00%	13.33%	6.67%	40%
	Column Totals	36.67%	33.33%	30%	100%

Here the entries correspond to a percentage of the grand total. For example, Male Liberal Arts majors compose 5/30 = 16.67% of the grand total.

ASSIGNMENT: Do exercises 3.4-3.7, 3.33, 3.83 in your text.

The cross-tabulation tables like those constructed in the Example above may be displayed in side-by-side bar graphs using the **GROUPBAR** program on the TI-84+

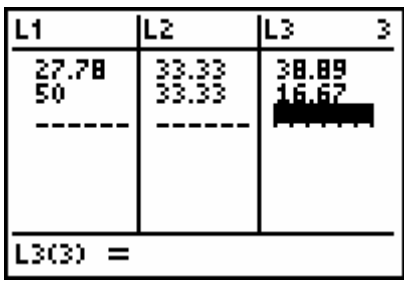
Example 3-2: Construct a bar graph displaying the row percentages for the gender-major data given in the above example.

Step 1: Using the TI-84+ Program CROSSTAB obtain the row % data

		Major		
		L_1	L_2	L_3
Gender	Male	27.78%	33.33%	38.89%
	Female	50%	33.33%	16.67%

Step 2: Press 

and enter the percentages into lists L_1, L_2 and L_3 as shown below.



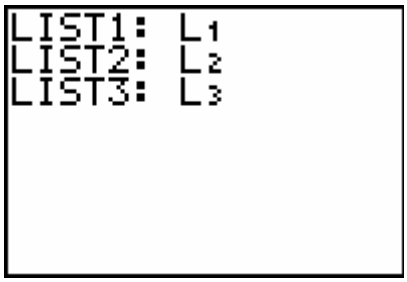
Step 3: Press 

, select GROUPBAR and press 

Step 4: When prompted for the number of groups, select 3 - since there were 3 majors - and press ENTER

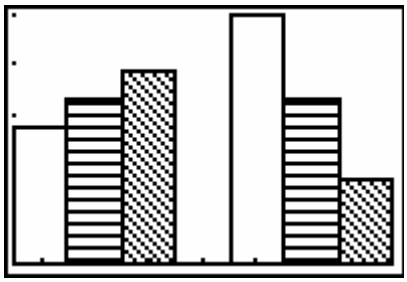
Step 5: When prompted for LIST1: press 2nd 1 (L_1) and press ENTER

Step 6: Similarly, press 2nd 2 (L_2) and 2nd 3 (L_3) when prompted. Your screen will look like this..



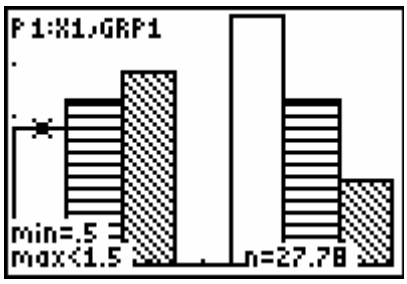
Step 7: When prompted for Ymax, input the highest percentage of the 3 groups. In this case, input 50 and press ENTER .

Step 8: When prompted for Yscl, input 10 and press ENTER. The following will be displayed..



Note: Unshaded bars correspond to the first major (LA), horizontal shaded bars correspond to the second major (BA), and diagonal shaded bars correspond to the third major (T).

To read the bar chart, press TRACE . The following will display..



Thus, the percentage of Male, Liberal Arts Majors is 27.78% of the total number of Males (row total).

ASSIGNMENT: Do exercises 3.83b. in your text.

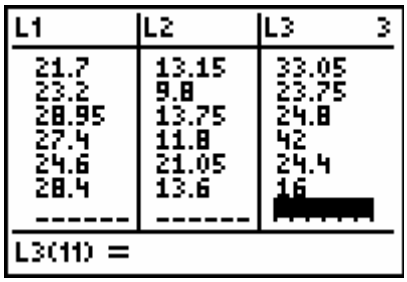
Multiple Boxplots on the TI-84+

The TI-84+ is capable of plotting up to 3 simultaneous boxplots at the same time for comparison.

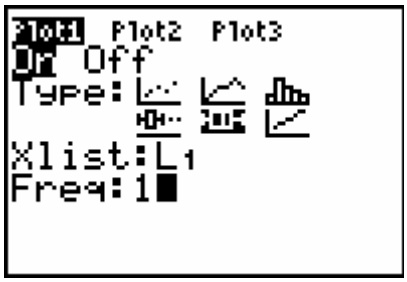
Example 3-3: The long distance charges for randomly selected phone numbers using one of three different carriers are given in the following table. Construct a boxplot for each sample and display the graphs side-by-side. Compare the distributions.

Company A		Company B		Company C	
20.30	23.20	6.95	9.80	38.40	23.75
19.80	28.95	14.75	13.75	55.40	24.80
22.70	27.40	9.25	11.80	38.80	42.00
24.50	24.60	12.15	21.05	16.75	24.40
21.70	28.40	13.15	13.60	33.05	16.00

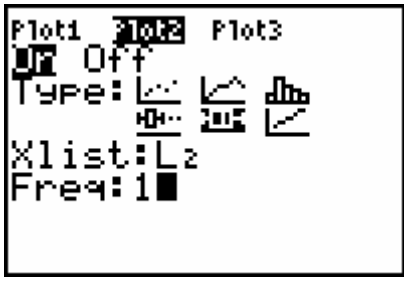
Step 1: Press STAT ENTER and input the Company A data into list L_1, Company B data into L_2 and Company C data into list L_3 as shown below.



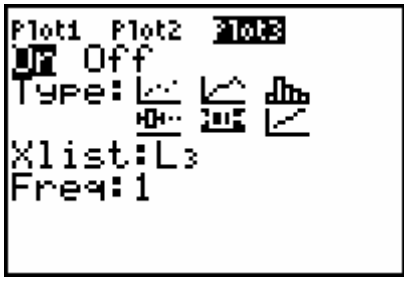
Step 2: Press 2nd Y= (STAT PLOT) and press ENTER to access the Plot1 menu. Change the settings of Plot 1 to match those on the screen below.



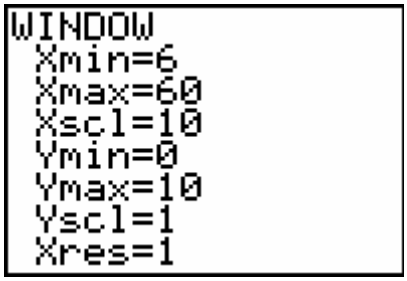
Step 3: Press ▲ repeatedly to highlight Plot1 in the top left corner of the view screen then press ▶ to highlight Plot2 and press ENTER to access the Plot2 menu. Again change the settings to match those below.



Step 4: Press ▲ repeatedly to highlight Plot1 in the top left corner of the view screen then press ▶ twice to highlight Plot3 and press ENTER to access the Plot3 menu. Change the settings to match those below.

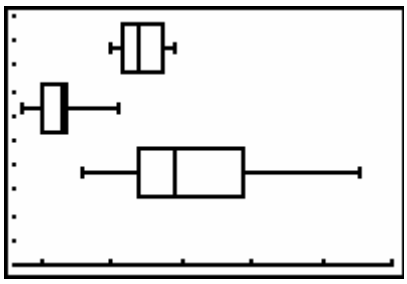


Step 5: Press WINDOW and set the window as in the screen below.



Note: The Xmin and Xmax settings are set to reflect the minimum and maximum values of the data found in lists L_1, L_2 and L_3. The minimum value in this example was 6.95 whereas the maximum value was 55.4.

Step 6: Press GRAPH to obtain the following screen



The boxplots are arranged in descending order. The top boxplot corresponds to list L_1 or Company A, the middle boxplot corresponds to list L_2 or Company B and the bottom boxplot corresponds to list L_3 or Company C.

Both Company A and Company B have compact distributions, in comparison with Company C. Most of the data for Company B is smaller than Companies A and C. The data for Company C has more variability and larger values.

ASSIGNMENT: Do exercises 3.10b. in your text.

Bivariate Data and Scatterplots

If bivariate data consists of two quantitative variables, the values are often expressed mathematically as ordered pairs (x, y). The first value, x, is the input, or independent, variable, and the second value, y, is the output, or dependent variable. This bivariate data may be presented graphically on a **scatterplot**: a plot of all ordered pairs of bivariate data on a coordinate axis system. The input variable x is plotted on the horizontal axis, and the output variable y is plotted on the vertical axis. A scatterplot or diagram, is a TI-84+ built-in statistical plot.

Example 3-4: In Mr. Chamberlain's physical fitness course, several fitness scores were taken. The following sample gives the numbers of push-ups and sit-ups done by ten randomly selected students. Construct a scatterplot of the data

Student	Push-Ups	Sit-Ups
	x	y
1	27	30
2	22	26
3	15	25
4	35	42
5	30	38
6	52	40
7	35	32
8	55	54
9	40	50
10	40	43

Step 1: Press 

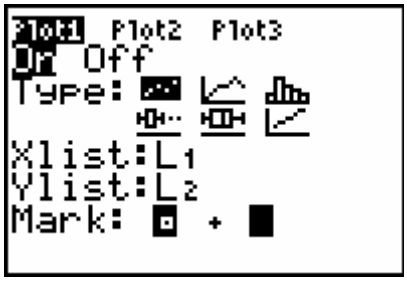
and enter the Push-Ups into list L_1 and Sit-Ups into list L_2

Step 2: Press 

to turn all of the stat plots off that were used in the previous example.

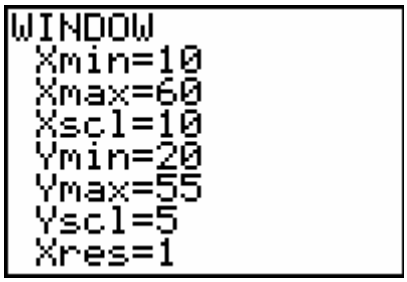
Step 3: Press 

to access the Plot1 menu. Change the settings to match those below.



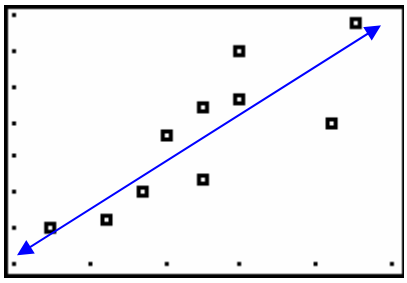
Step 4: Press 

and adjust the settings to match those below..



Note: The Xmin and Xmax settings are set to reflect the data in the list L_1 and the Ymin and Ymax settings for the data in L_2

Step 5: Press GRAPH to obtain the following scatterplot of the data.



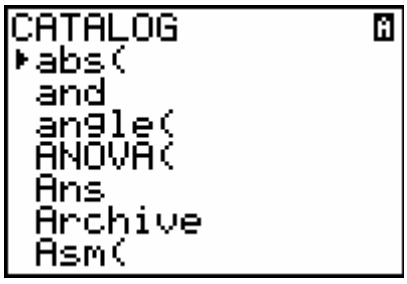
This data appears to have a positive linear relationship, meaning, that as the number of push-ups increases so does the number of sit-ups.

ASSIGNMENT: Do exercises 3.11, 3.15-3.20, 3.28 in your text.

The **coefficient of linear correlation**, or **Pearson's product moment correlation coefficient**, *r* is a numerical measure of the strength of the linear relationship between the two variables. For values of r close to +1, this indicates a strong positive linear relationship. For values of r close to -1, this indicates a strong negative linear relationship. The TI-84+ can compute the correlation coefficient.

Example 3-5: Compute the Pearson product moment correlation coefficient (r) for the physical fitness data in the previous example.

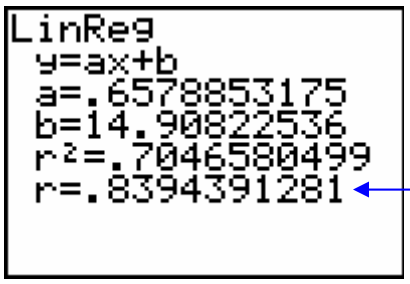
Step 1: Press 2nd 0 (CATALOG). You should see the following screen.



Step 2: Press ⌄ repeatedly until you come to DiagnosticsOn as shown in the next screen,

Step 3: Press ENTER and then ENTER again. The calculator will display the following screen.

Step 4: Press STAT, select CALC, then select LinReg(ax+b) and press ENTER, this puts the LinReg function into the screen, finally press ENTER to obtain the following screen..



The correlation coefficient, r, is displayed at the bottom of the screen.

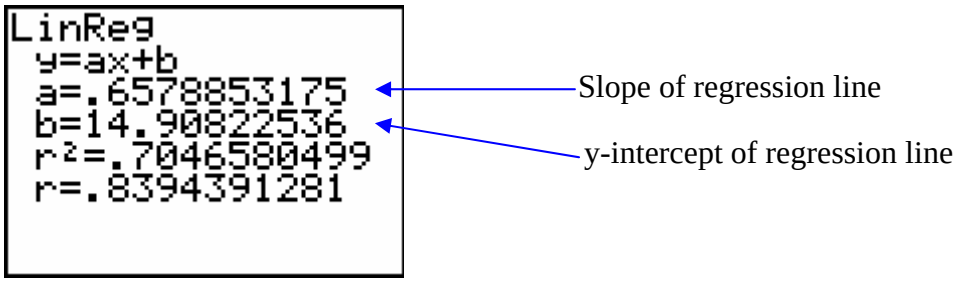
As this value of r is somewhat close to +1, it would indicate a positive linear relationship between push-ups and sit-ups.

ASSIGNMENT: Do exercises 3.33, 3.35, 3.36, 3.40, 3.43-3.45, 3.47, 3.58 in your text.

Line of Best Fit and Linear Regression

The line of best fit or linear regression line is the line that best approximates the linear relationship between then independent variable (x) and dependent variable (y). This line can be used to predict values of the dependent variable between values in the data set (interpolation) and outside of the data set (extrapolation). The TI-84+ computes the slope (a) and y-intercept (b) of the line of best fit. It is also possible to graph this line on the screen superimposed with the scatterplot.

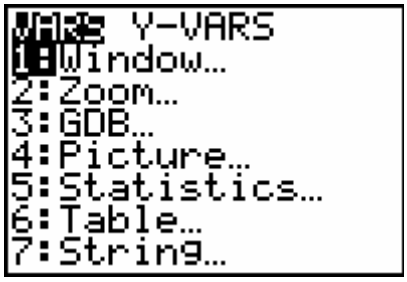
Step1: Press STAT, select CALC, then select LinReg(ax+b) and press ENTER, this puts the LinReg function into the screen, finally press ENTER to obtain the following screen..



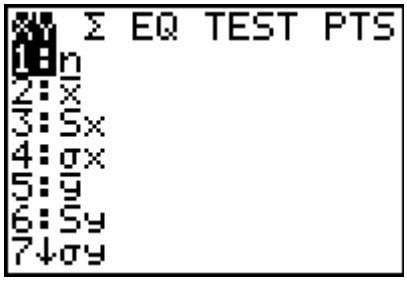
Thus the equation of the line of best fit is given by y = .6578853175x + 14.90822536. Without having to retype all of this information, we can graph this line on the TI-84 automatically by completing the following steps..

Step 2: Press Y= CLEAR to clear out any functions

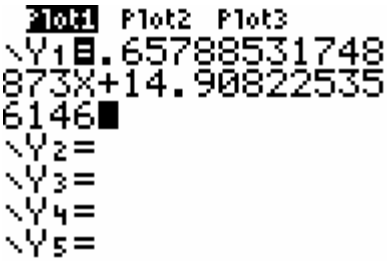
Step 3: Press VARS, this brings you to the following screen..



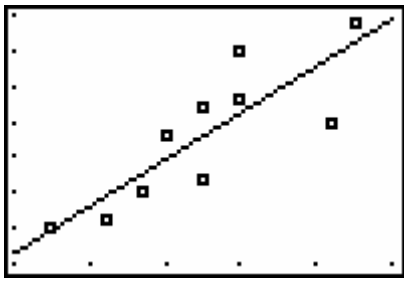
Step 4: Select 5: Statistics and press ENTER to obtain the following screen..



Step 5: Press ▶ to select EQ (Equation), select 1: RegEQ and press ENTER. This puts the regression equation into the graph editor as shown in the next screen.

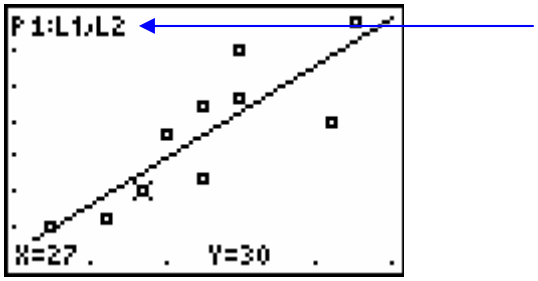


Step 6: Press GRAPH to obtain the following screen..



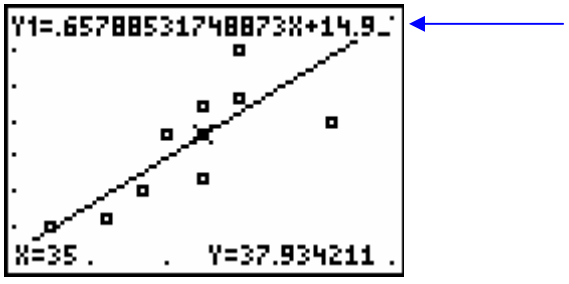
To read the data in the plot above, we can use TRACE

Step 7: Press TRACE . Your screen should look like this..



This indicates the ordered pair of the point on the scatterplot

At this point, pressing ▶ will cause the cursor to jump from one point to the next in the scatterplot. If you would like to trace along the regression line, press ▲.



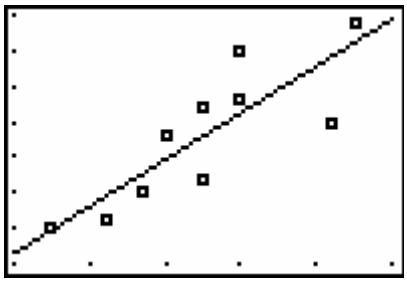
This indicates that you are tracing along the regression line

Prediction

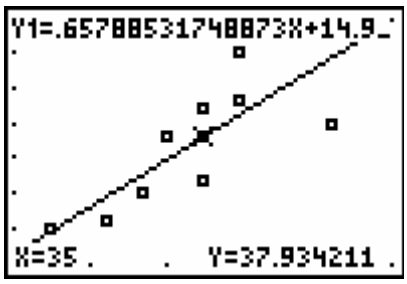
Values of the dependent variable can be predicted by the equation of the line found above.

Example 3-6: Predict the number of Sit-Ups done by a student who did 40 Push-Ups.

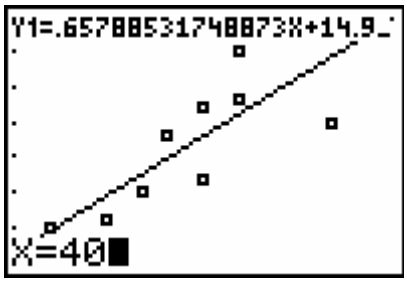
Since 40 Push-Ups is within the range of the independent variable (x), this prediction is known as an interpolation. To answer the question, we graph the scatterplot for the physical fitness data and the line of best fit as above. We have the following plot..



Step 1: Press TRACE ^ to obtain the following

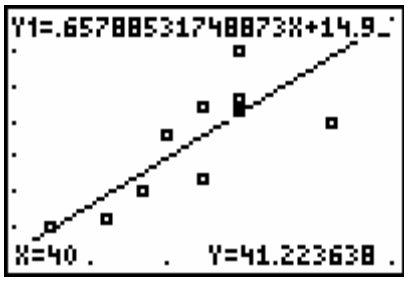


Step 2: Without pressing any other key, press 4 0 to obtain the following..



Notice that the X=40 is now displayed in place of the X=35 above.

Step 3: Press ENTER. The calculator returns the following..



Thus, 41.22 Sit-Ups are predicted for a student that does 40 Push-Ups.

ASSIGNMENT: Do exercises 3.59-3.65, 3.70, 3.73 in your text

Example 3-7: The heights and weights of 8 randomly selected college women are listed in the table below.

Height (x)	65	65	62	67	69	65	61	67
Weight (y)	105	125	110	120	140	135	95	130

A. Find an equation to predict the weight of a college woman based on her height (the equation of the line of best fit)

B. Determine the coefficient of linear correlation and the coefficient of determination.

C. Graph the Scatterplot and Regression Line

D. Predict the weight of a college woman that is 65 inches tall.

Solution:

A. Find an equation to predict the weight of a college woman based on her height (the equation of the line of best fit)

Step 1: Press 

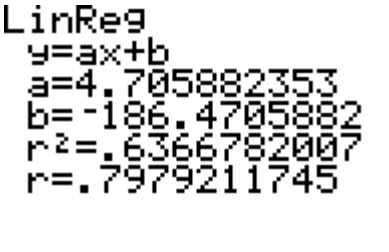
and input the heights into list L_1 and weights into L_2.

Step 2: Press 

, select CALC, select 4: LinReg(ax+b) and press 

, then press 

again. Your screen should look like this..



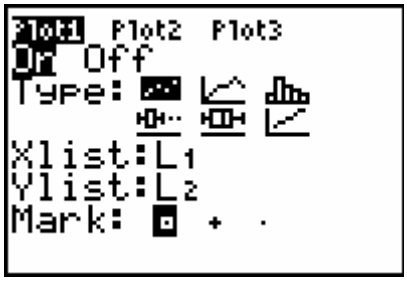
Thus, the equation of the regression line is given by y = 4.705882353x -186.4705882

B. Determine the coefficient of linear correlation and the coefficient of determination.

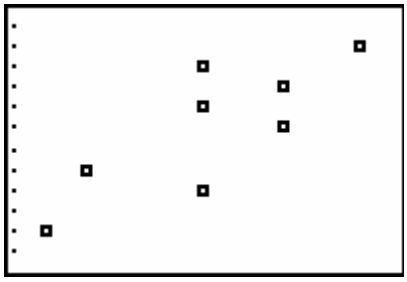
The correlation coefficient r = .7979211745 and coefficient of determination r^2 = .6366782007

C. Graph the Scatterplot and Regression Line

Step 1: Press 2nd Y= ENTER to access the Plot1 menu. Change the settings to those below.

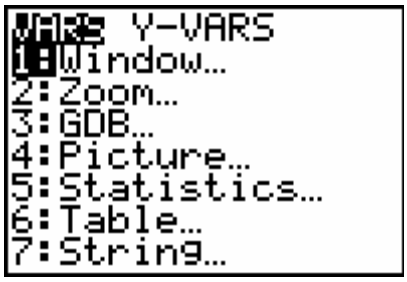


Step 2: Press WINDOW and change your settings to reflect the height and weight data in lists L_1 and L_2. You may also press ZOOM, select 9: Zoom Stat and press ENTER. To obtain the following scatterplot..

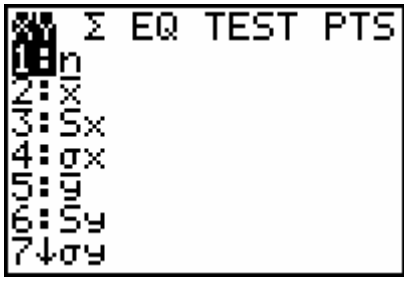


Step 3: Press Y= CLEAR to clear out any functions

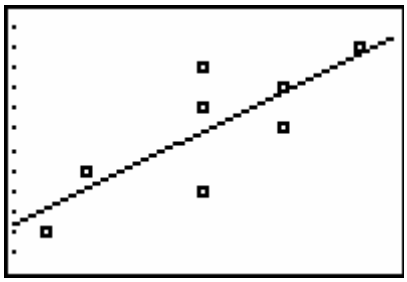
Step 4: Press VARS, this brings you to the following screen..



Step 5: Select 5: Statistics and press ENTER to obtain the following screen..

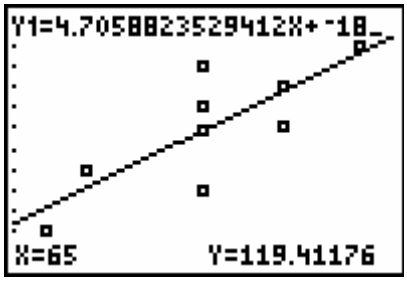


Step 6: Press ▶ to select EQ (Equation), select 1: RegEQ and press ENTER. This puts the regression equation into the graph editor as shown in the next screen.



D. Predict the weight of a college woman that is 65 inches tall.

Step 1: Press TRACE ▲ 6 5 ENTER to obtain the following screen



Thus, a woman who is 65 inches tall is estimated to weigh 119.41 pounds.

ASSIGNMENT: Do exercises 3.74-3.77, 3.88, 3.89, 3.94, 3.96 in your text.

Chapter 4

Probability

To compute probability on the TI-84+, we need to learn about some basic operations.

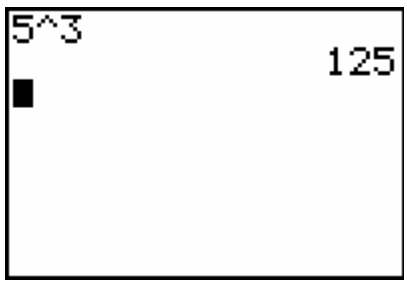
Exponents:

To use exponents we simply enter the number and then 

Example 4-1: Compute 5^3

Step 1: From a blank home screen Press 

The calculator will return the value 125 as shown below.



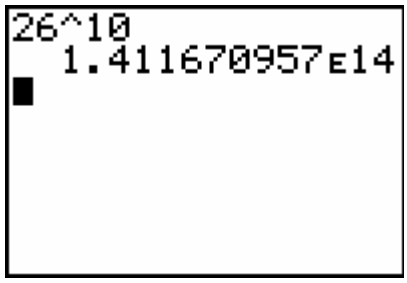
Example 4-2: Compute 26^{10} on the calculator.

Step 1: Press 

to obtain a blank home screen

Step 2: Press 

Your screen will look like this



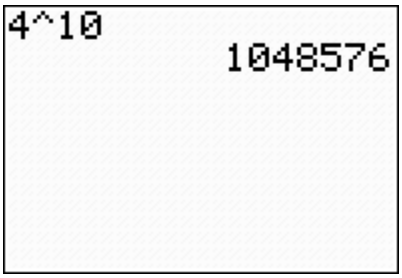
Note: When the number is too large to display on the screen, the calculator switches to scientific notation. The number 1.411670957E14 means 1.41 x 10^{14}

Example 4-3: A 10 Question, Multiple Choice test is given with 4 choices for each question. How many ways are there to randomly answer the test?

Solution: There are 4 choices for Question 1 and 4 choices for Question 2 and so on. Thus, there are 4 x 4 x 4 x …. x 4 = 4^{10} ways to randomly answer the test.

Step 1: Press [2nd] [MODE] [CLEAR] to go to a blank working screen

Step 2: Press [4] [^] [1] [0] [ENTER] to obtain the following screen



Fractions

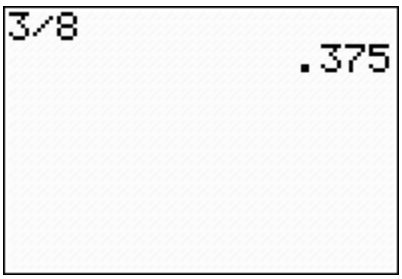
To compute fractions on the TI-84+, we use [÷]

Example 4-4: The probability of getting 2 heads and 1 tail when tossing a coin 3 times is

P(2 Heads) = $\frac{3}{8}$. Compute this decimal.

Step 1: Press [CLEAR] to get a clear home screen

Step 2: Press [3] [÷] [8] [ENTER]. The calculator returns the following screen..

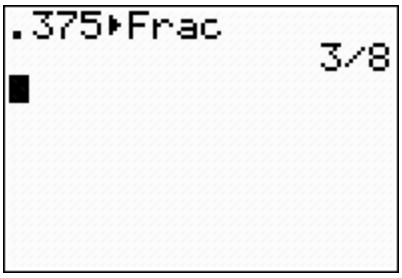


Repeating or terminating decimals can also be changed back into fractions in lowest terms.

Example 4-5: Convert the decimal .375 into a fraction

Step 1: Press CLEAR

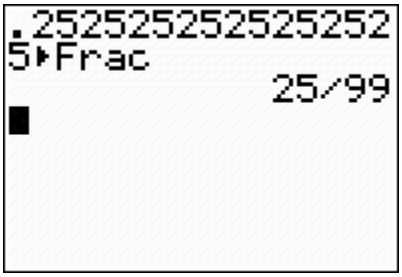
Step 2: Press . 3 7 5 MATH ENTER ENTER. The calculator returns the following screen..



Example 4-6: Convert the repeating decimal .2525252525252525….. into a fraction

Step 1: Press CLEAR

Step 2: Press . 2 5 2 5 2 5 2 5 2 5 2 5 2 5 2 5 MATH ENTER ENTER. The calculator returns the following screen..



Factorials, Permutations and Combinations

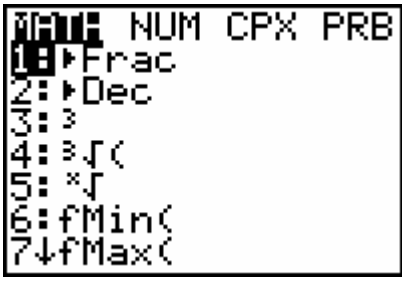
These counting/probability functions are all found in the same place on the TI-84+.

Example 4-7: A 5-Question Matching test is given with 5 Answers. Each answer is to be used only once. How many ways are there to randomly answer the test?

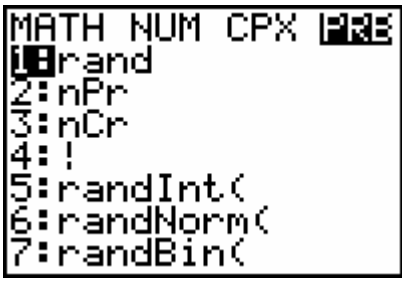
Solution: There are 5 ways to answer Question 1 and then only 4 ways to answer Question 2 and so forth. So, there are 5 x 4 x 3 x 2 x 1 = 5! ways to randomly answer the test. To compute this on the calculator

Step 1: Press CLEAR to go to a blank working screen

Step 2: Press 5 MATH which brings you to this screen

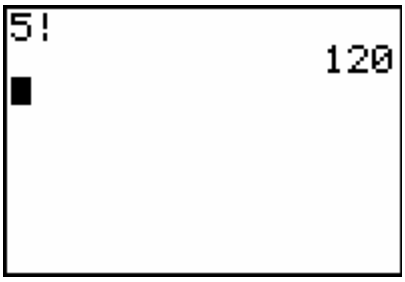


Step 3: Press ▶ to select **PRB**. Your screen should look like this..



Step 4: Select **4: !** or press ▼ 3 times and then press ENTER. Your screen will display the following..

Step 5: Press ENTER to display the answer to 5! As shown in the screen below..



Note: Here is a summary of the keystrokes necessary to compute 5!

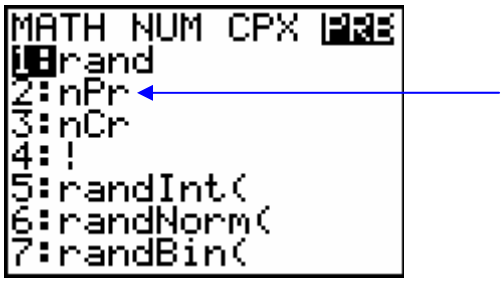
ASSIGNMENT: Do exercises 5.45 in your text.

Permutations are orderings or arrangements. They are the counting technique that we utilize when order is important in counting the number of outcomes to an experiment.

Example 4-8: How many ways are there to award 5 different prizes to amongst 8 competitors at random?

Solution: Since the prizes are different, each different assignment of a prize needs to be considered. Thus, order matters and we use a permutation to count.

The nPr function is located in the MATH , PRB menu as shown below



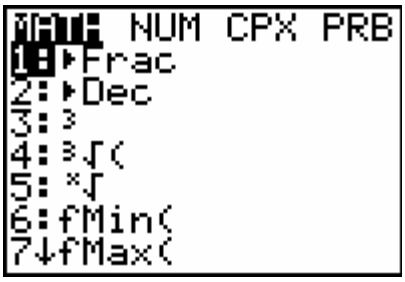
Step 1: Press 

to begin at a blank home screen

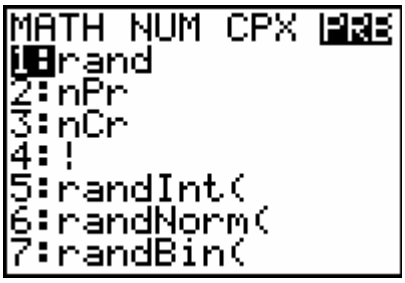
Step 2: Press 

, then press 

, this takes you to the MATH menu as in the example before.

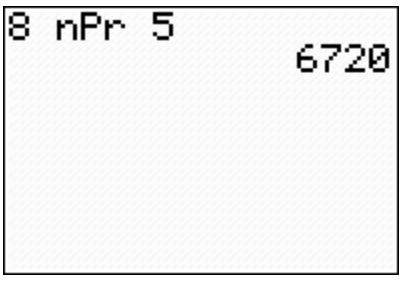


Step 3: Press) three times, or (to access the PRB submenu as in the screen below..



Step 4: Press ˅ once, or press 2 to select 2: nPr and then press ENTER.
This puts the nPr function into the working screen as shown below..

Step 5: Finally, press 5 ENTER and the calculator returns the number ${}_8P_5$ below



Note: Here is a summary of the keystrokes necessary to compute ${}_8P_5$

8 MATH (˅ ENTER 5 ENTER

Combinations are subsets or samples. They are the counting technique utilized when order isn't important.

Example 4-9: Suppose that there are 8 products in a product line and a consumer would like to randomly select or choose 5 of these. How many ways can this be done?

Solution: Since we are sampling or choosing 5 products from among 8 at random, order is not important in the problem. Thus we utilize combinations. The answer is ${}_8C_5$

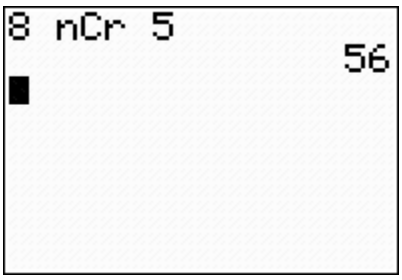
nCr is found in the Math, PRB menu. Using the calculator complete the following

Step 1: Press 

to work in a blank home screen

Step 2: Press 

. The calculator displays the answer..



ASSIGNMENT: Do exercises 5.46 in your text.

Simulations and Random Numbers

The TI-84+ has built in simulation features and is capable of simulating die rolling experiments and coin toss experiments

Example 4-10: A pair of dice is to be rolled. Let X be the sum of the two dice. Find the probability of getting a sum of 7. i.e. Find P(X = 7)

Solution: For each roll there are six possible outcomes. Since we are rolling two dice, there are then 6 x 6 = 36 total possible outcomes for this experiment. These are listed below.

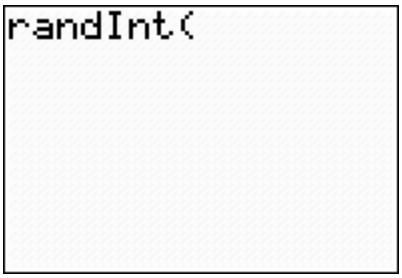
1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

Notice the diagonal contains the possible sums of 7. There are 6 out of 36. Thus, the probability is P(X=7) = $\frac{6}{36} = .1667$

ASSIGNMENT: Do exercises 4.5, 4.6, 4.24, 4.37 in your text.

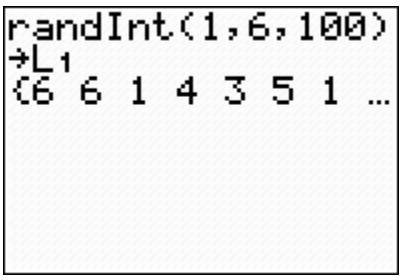
We can simulate this theoretical experiment using the random integer feature of the TI-84+.

Step 1: Press CLEAR MATH (5 to get the random integer function as shown below



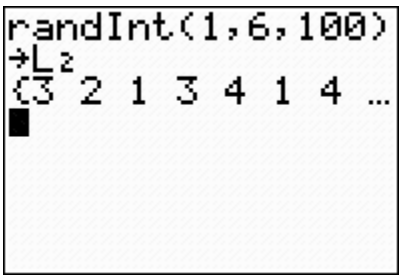
Step 2: Press 1 , 6 , 1 0 0) STO▸ 2nd 1 (L_1) ENTER.

Note: randInt randomly generates 100 numbers between 1 and 6 inclusive. These are then stored in list L_1. Your screen should look like this..



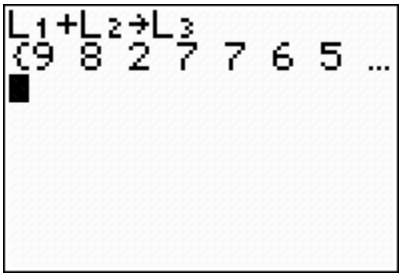
Step 3: Repeat Step 1, this time storing the values to list L_2

Step 4: Press [1] [,] [6] [,] [1] [0] [0] [)] [STO▸] [2nd] [2] (L_2) [ENTER].



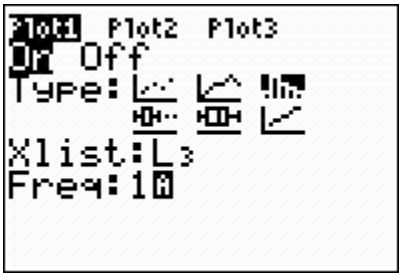
Step 5: Since we want the sum of the two dice, press [2nd] [MODE] [CLEAR] to go to a blank working screen.

Step 6: Press [2nd] [1] [+] [2nd] [2] [STO▸] [2nd] [3] [ENTER]. Your screen should look something like this.

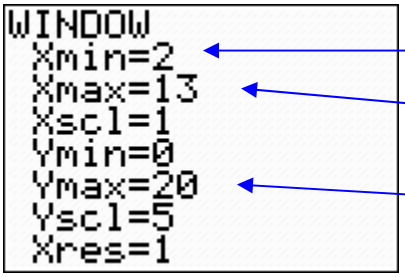


Note: Since the numbers are randomly generated, no two L_3 lists will match. Thus, your screen will differ in the second row from this.

Step 7: Now we wish to view the frequency distribution for the random variable X, which stood for the sum of the two tosses. Press [2nd] [Y=] (STAT PLOT) [ENTER]. Set your Plot1 menu as in the screen below.



Step 8: Press WINDOW and adjust the settings to match those below..

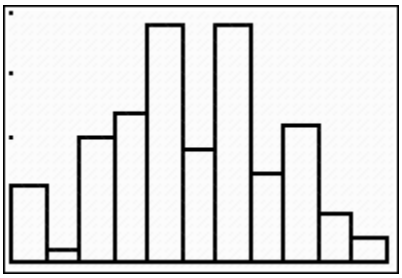


The minimum sum of two dice

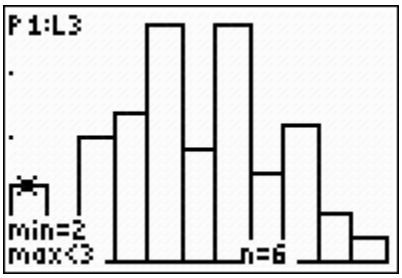
The maximum sum of the two dice plus 1

The maximum frequency expected in any one class. 1/6 x 100 = 16.67

Step 8: Press GRAPH. The calculator will display a frequency distribution similar to this one.



Step 9: Press TRACE and ▶ to obtain the frequencies for each of the classes. As shown in the next screen.



The frequency distribution is obtained

X (Sum)	2	3	4	5	6	7	8	9	10	11	12
Freq	6	1	10	12	19	9	19	7	11	4	2

Thus, while the theoretical probability P(X=7) = .1667, our empirical or observed probability is 9/100 or .09

Example 4-11: A coin is flipped three times. Let X be the number of heads you get in the 3 tosses of the coin. Then X can take on the values 0 (All 3 Tails), 1 (1 Head and 2 Tails) or 2 (2 Heads and 1 Tail) or 3(All 3 Heads). There are 8 possible outcomes to the experiment. They are listed below

TTT	HTT	HHT	HHH
	THT	HTH	
	TTH	THH	
X=0	X=1	X=2	X=3

The theoretical probability distribution for this experiment is given by..

X	0	1	2	3
P(X)	1/8	3/8	3/8	1/8

So, P(X=1) = 3/8

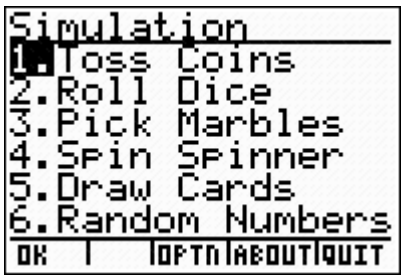
The TI-84+ includes a Probability Simulation for this experiment under 

.

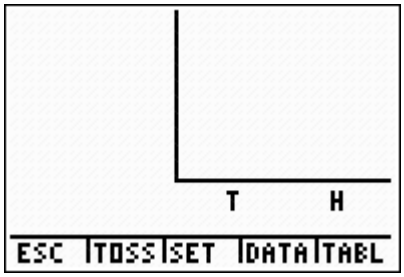
Step 1: Press 

, select Prob Sim and press 

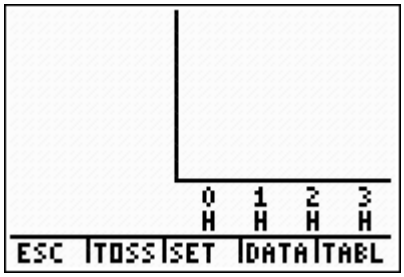
When we press any key, we get the following menu



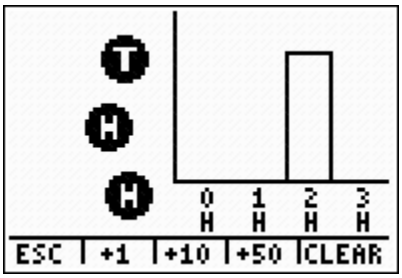
Step 2: Select **1: Toss Coins** and press ENTER. The next screen appears..



Step 3: Press ZOOM (SET) and this brings us to the set up screen for the coin toss simulation. Change the settings to mirror those below..

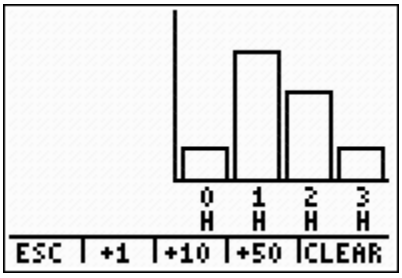


Step 4: Press WINDOW (TOSS), the calculator will Toss a pair of coins once.. Your screen will look similar to this..

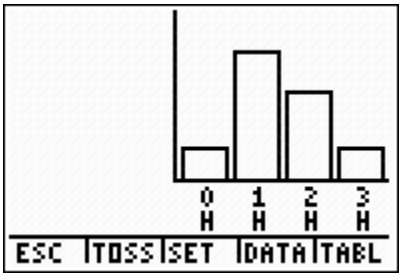


Note: Your outcome will probably differ as this is a random event.

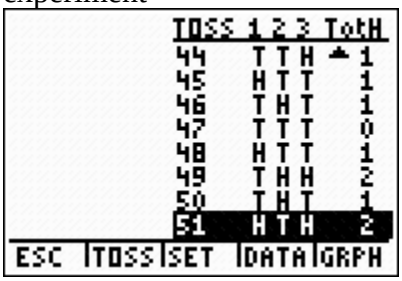
Step 5: Press TRACE (+50) to continue the experiment 50 more times. When the simulation is finished, your screen will look something like this..



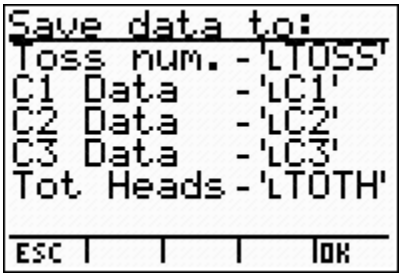
Step 6: To view the data press Y= (ESC) once. This brings you to this screen



Step 7: Press GRAPH (TABL) to display the outcomes of each of the 51 trials of the experiment



Step 8: To save this data to lists, press TRACE (DATA), and then press GRAPH (OK). The Data from this experiment is saved under the following lists accessible in the LIST menu.



ASSIGNMENT: Do exercises 4.5, 4.6, 4.24, 4.37 in your text

Chapter 5 Discrete Probability Distributions

Mean, Standard Deviation, Variance of a Discrete Probability Distribution

The TI-84+ can be used to find the mean (μ), standard deviation (σ) and variance (σ^2) of a discrete probability distribution.

Example 5-1: A manager would like to know the average number of items that customers purchase from his shop. He obtains the following probability distribution. X is the number of items purchased.

X	0	1	2	3
P(X)	0.18	0.36	0.27	0.19

Find μ, σ, and σ^2 for this probability distribution:

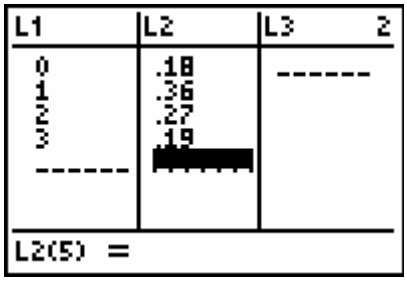
Solution: The manager would like to know the average number of items purchased which is the mean μ. To find this and the other measurements on the TI-84+, complete the following steps..

Step 1: Press 

to begin with a blank working screen

Step 2: Press 

, put the values of X into list L_1 and the values of P(X) in list L_2. Your screen should look like this..



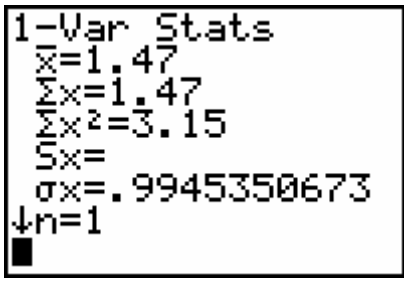
Step 3: Press 

(QUIT) to exit the STAT Editor

Step 4: Press 

. Your screen should look like this..

Step 5: Press [2nd] [1] [,] [2nd] [2] [ENTER]. The calculator returns the answers



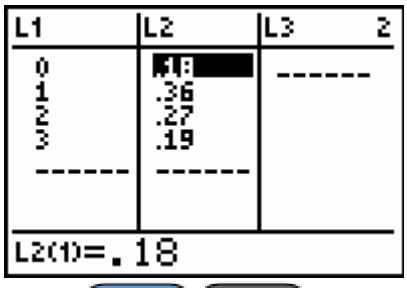
Thus, $\mu = 1.47$, $\sigma = .995$ To find σ^2, we raise $.995^2 = .990$ Thus, the store manager has found that, on average, customers purchase about 1.5 items.

ASSIGNMENT: Do exercises 5.28, 5.30-5.36, 5.38, 5.40 in your text.

Graphing Probability Distributions as Histograms

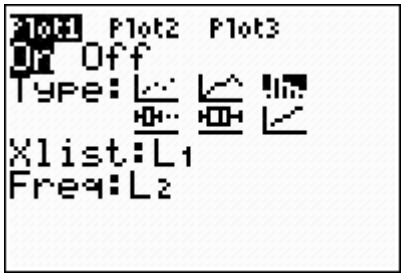
Example 5-2: For the #Items Purchased example above, graph the probability distribution

Step 1: Press [STAT] [ENTER], be sure that the data is entered into lists L_1 and L_2 as in the screen below..



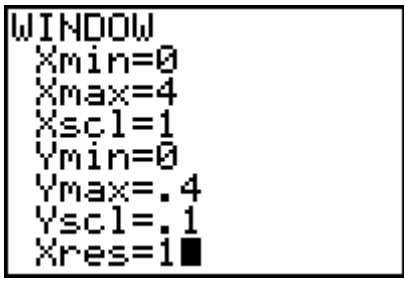
Step 2: Press [2nd] [MODE] to exit the STAT Editor

Step 3: Press 2nd Y= ENTER to access the Plot1 menu. Change the settings to match those in the screen below.

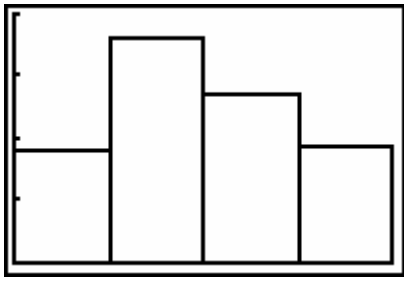


Note: Notice that the Xlist: is set to list L1 which are the values of the random variable X, and Freq: is set to L2 which are the probabilities.

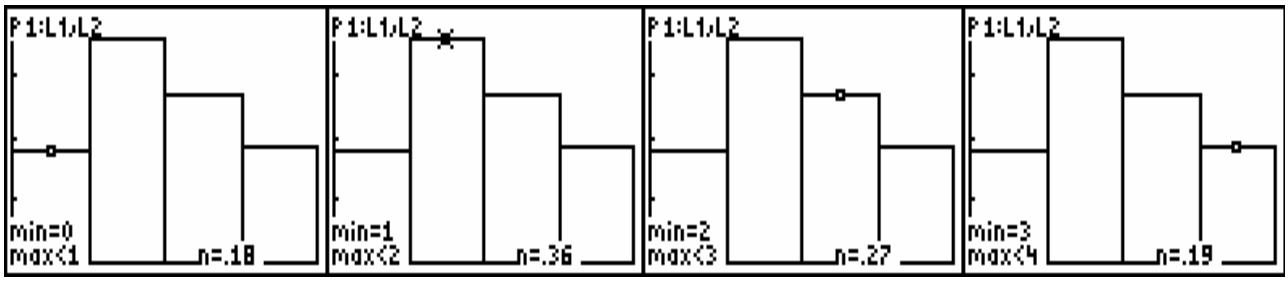
Step 4: Press WINDOW and change the window to reflect the data. Your settings should be close to those below..



Step 5: Press GRAPH. The calculator displays the probability histogram for the #Items purchased data



Step 6: To view the classes and/or probabilities, press TRACE and ▶ several times.



ASSIGNMENT: Do exercises 5.14, 5.16, 5.17, 5.18 in your text.

Example 5-3: A coin is tossed 4 times.

(1) List S, the sample space for this experiment
(2) Construct the probability distribution for this experiment
(3) Find the probability of getting 3 Heads
(4) Graph the probability histogram for this experiment
(5) Find μ, σ, and σ^2 for the probability distribution

Solution: Since the coin is tossed 4 times, there are $2^4 = 16$ total outcomes in the sample space.

(1) List S, the sample space for this experiment

TTTT	TTTH	TTHH	THHH	HHHH
	TTHT	HHTT	HTHH	
	THTT	THTH	HHTH	
	HTTT	HTHT	HHHT	
		THHT		
		HTTH		
X = 0	X = 1	X = 2	X = 3	X = 4

If we let X be the # of heads out of the 4 tosses, then the probability distribution for this experiment is given below..

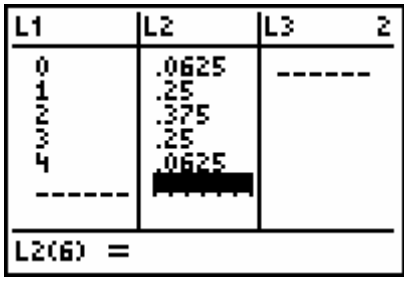
(2) Construct the probability distribution for this experiment

X	0	1	2	3	4
P(X)	1/16	4/16	6/16	4/16	1/16

3) Find the probability of getting 3 Heads. i.e. Find P(X = 3) = 4/16 or .25

4) Graph the probability histogram for this experiment

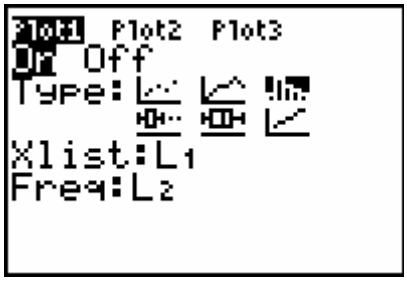
Step 1: Press STAT and enter the values of X into List L_1 and the probabilities P(X) into list list L_2. Your screen should look like this..



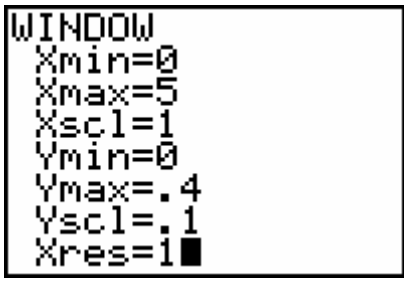
Note: When entering the data into L2, you can enter the numbers as fractions, the calculator automatically changes them to decimals

Step 2: Press 2nd MODE CLEAR to go to a blank homescreen and to exit the STAT EDIT Mode

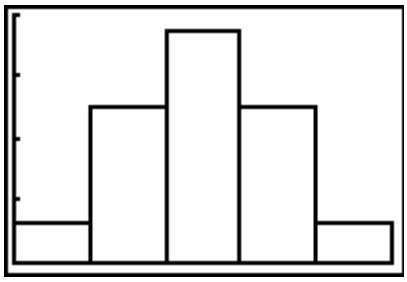
Step 3: Press 2nd Y= ENTER to enter the Plot1 menu, change the settings to look like the following screen..



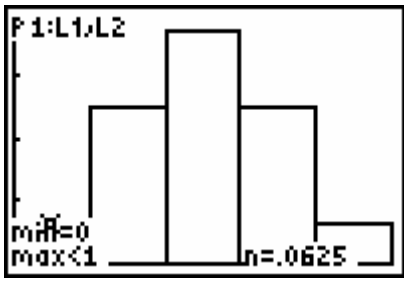
Step 4: Press WINDOW and change your settings to match those in the display below



Step 5: Press GRAPH, the calculator displays the following probability histogram..



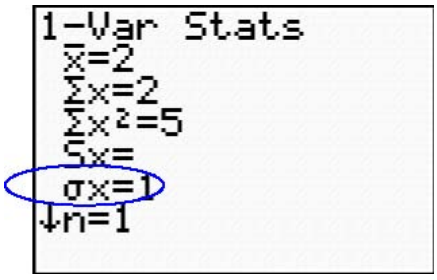
Step 6: To read the histogram, press TRACE and then ▶ Repeatedly..



5) Find μ, σ, and σ^2 for the probability distribution

Step 1: Press STAT ▶ ENTER

Step 2: Press 2nd 1 , 2nd 2 ENTER. The calculator displays μ and σ for this probability distribution..



Step 3: To get σ^2 we take $1^2 = 1$ in this case

ASSIGNMENT: Do exercises 5.13, 5.19, 5.28 in your text.

The Binomial Distribution

The binomial distribution is a probability distribution with 3 additional requirements.

- There are a finite number of independent trials (n) sometimes referred to as Bernoulli Trials

- There are only two outcomes per trial, success and failure. The probability of success is denoted p, failure q
- The probability of success is fixed for all n trials.

The TI-84+ has the capability of computing binomial probabilities directly through a built in function . Additionally, the Program CBINOM can be used to compute cumulative binomial probabilities

Example 5-4: Toss a coin 4 times and let X be the # of heads in the four tosses.

1) Generate the binomial probability distribution on the calculator using binompdf.

2) Find the probability of getting 3 heads. i.e. Find P(X=3)

3) Find the probability of getting at least 2 heads. i.e. Find P(X $\geq$ 2)

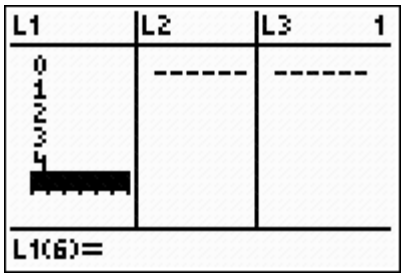
Solution: Since there are four trials of the experiment, n = 4. The probability of getting a head on any toss is 1/2 and so p = 1/2. Coin tosses are independent of one another, and for each trial there are only two possible outcomes, heads or tails. Thus, this is a binomial probability experiment.

(1) Generate the binomial probability distribution on the calculator using binompdf.

Step 1: Press STAT 4 ENTER to clear all lists

Step 2: Press STAT ENTER

Step 3: Input the values of the random variable X into list L_1. Your screen should look like this..

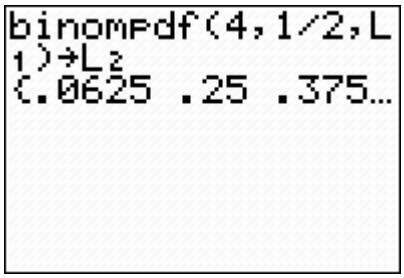


Step 4: Press 2nd MODE CLEAR to exit the STAT Editor and return to a blank working screen

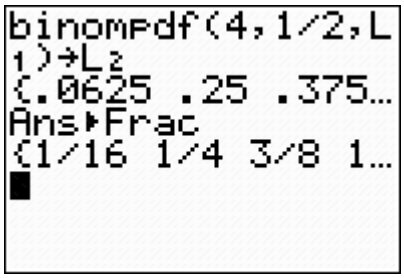
Step 5: Press 2nd VARS (DIST), and then ▼ to select **binompdf** and then press ENTER. The calculator will put the binomialpdf function into your working screen as shown below..

The syntax is binompdf(N, P, X) where N is the # of trials. P is the probability of success and X is the value of the random variable that we wish to compute. In this case, we wish to compute binompdf on all of the values of the random variable in list L_1

Step 6: Press 4 , 1 ÷ 2 , 2nd 1) STO 2nd 2 ENTER. The calculator returns the following screen..



Step 7: To display the probabilities in fraction form, press MATH ENTER ENTER.



Step 8: To view all of the data, press ▶ to scroll through all of the values listed or press STAT ENTER to view the data in the list.

Thus, we obtain the probability distribution as we constructed by hand in the previous example.

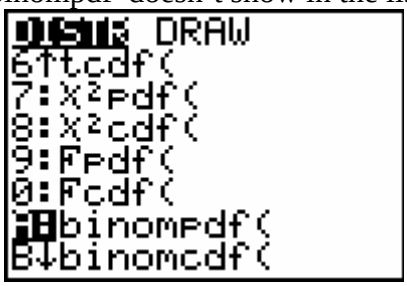
X	0	1	2	3	4
P(X)	1/16	1/4	3/8	1/4	1/16

(2) Find the probability of getting 3 heads. i.e. Find P(X=3)

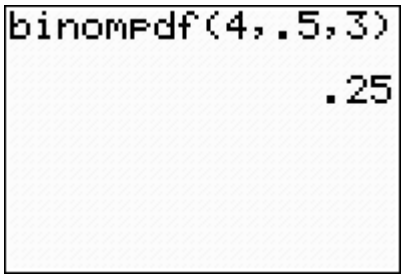
Clearly, from the table above, P(X = 3) = 1/4. To find the probability of a single event on the calculator, follow these steps..

Step 1: Press 2nd VARS , ⌄ to select **0: binompdf(** and press ENTER

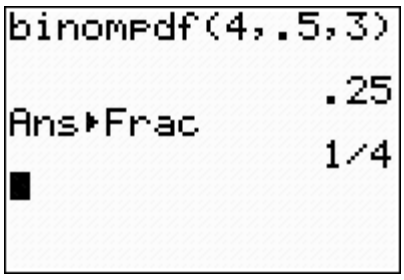
Note: binompdf doesn't show in the list so you have to scroll down to find it.



Step 2: 4 , . 5 , 3) ENTER . The calculator returns the answer as a decimal..



Step 3: Again, to change this answer to a fraction we press MATH ENTER ENTER



(3) Find the probability of getting at least 2 heads. i.e. Find P(X ≥ 2)

This is a cumulative probability. It means finding the probability of two or more heads out of the four tosses. From the table above, we can add the probabilities

P(X≥2) = $\frac{3}{8}+\frac{1}{4}+\frac{1}{16}=\frac{11}{16}=.6875$ However, the program CBINOM is better equipped to compute cumulative events such as this one.

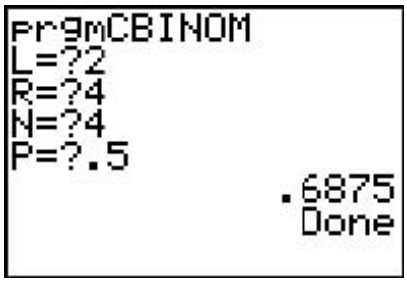
Step 1: Press PRGM then ▼ to select CBINOM and press ENTER, then press ENTER again

Step 2: When prompted for L=? input the left bound by pressing 2 ENTER. Your screen will look like this..

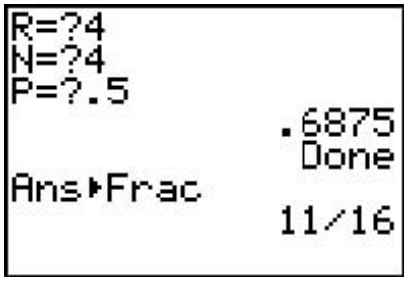
Step 3: When prompted for R=? input the right bound by pressing 4 ENTER

Step 4: Next, you are prompted for N=? input the number of trials (N) by pressing 4 ENTER

Step 5: Finally, when prompted for P=? input the probability of success (P) by pressing . 5 ENTER. The calculator will return the answer..



Step 6: Once again, to display the answer as a fraction, press MATH ENTER ENTER. The calculator will return the following..



ASSIGNMENT: Do exercises 5.57, 5.58, 5.61-5.63, 5.66 in your text.

Example 5-5: The manager of Steve's Food Market guarantees that none of his cartons of a dozen eggs will contain more than 1 bad egg. If a carton contains more than 1 bad egg, he will replace the whole dozen and allow the customer to keep the original eggs. If the probability that an individual egg is bad is .05, what is the probability that the manager will have to replace a given carton of 12 eggs.

Solution: Assuming independence, this is a binomial experiment. For each egg, there are only two possibilities, good or bad. The probability that each egg is bad is the same, .05. Thus we can find the solution to the above problem two ways.

Method 1 - Since there are 12 eggs in the carton, we would like to know the probability of getting 2 or more bad eggs or P(X≥2). Using the binomcdf function built into our calculator..

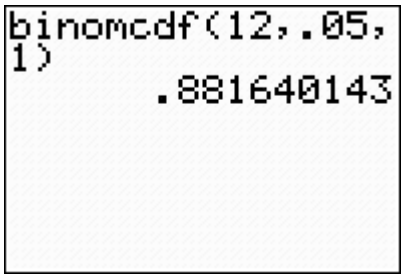
Step 1: Press 

, then press 
to select **A: binomcdf** and press 

Step 2: The binomcdf function computes the probability of the random variable from X = 0 to X = k where you specify k. Since we want to find the cumulative probability P(X≥2) we can find the cumulative probability P(0≤X≤1) and then subtract from 1.

Step 3: Press 

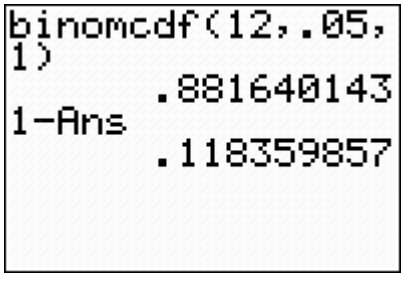
. The calculator displays the cumulative binomial probability from X=0 to X=1.



Step 4: Press 

(ANS) then press 

. The calculator displays the answer..



Thus, the probability that Steve will have to replace a given carton of eggs is

about 11.8%.

Method 2: Using CBINOM

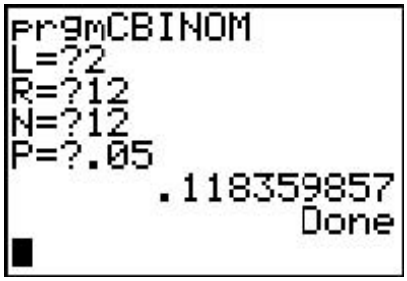
Step 1: Press PRGM , use ▼ to select CBINOM and press ENTER .

Step 2: When prompted for L=? Press 2 ENTER

Step 3: When prompted for R=? Press 1 2 ENTER

Step 4: When prompted for N=? Press 1 2 ENTER

Step 5: When prompted for P=? Press . 5 ENTER . The calculator displays the result directly as shown below.



ASSIGNMENT: Do exercises 5.64-5.65, 5.67, 5.70 in your text.

Example 5-6: There are many reasons for mortgage foreclosures. According to a recent financial survey, disability causes 48% of all mortgage foreclosures. Suppose 25 random mortgage foreclosures are audited by a large lending institution. Find the probability of the following events.

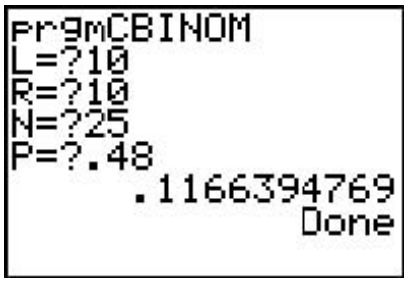
(1) Exactly 10 foreclosures are due to disability. i.e. P(X=10)
(2) At least 14 are due to disability. i.e. P(X≥14)
(3) At most 12 are due to disability. i.e. P(X≤12)
(4) More than 8 are due to disability. i.e. P(X > 8)
(5) P(8≤ X < 12)

Solution: As mentioned above, finding cumulative probabilities is generally easier with the CBINOM program

(1) Exactly 10 foreclosures are due to disability. i.e. P(X=10)

Step 1: Press PRGM , select CBINOM and press ENTER

Step 2: When prompted, input the following values and press ENTER each time. The calculator displays the probability of the single event P(X=10) as shown in the next screen..

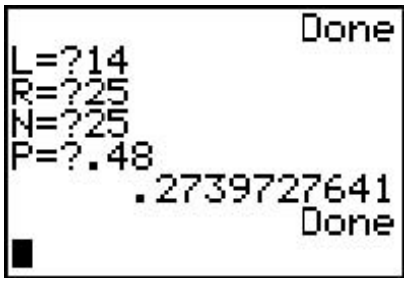


Note: To run the CBINOM program again, just press ENTER . The program will prompt you for the L,R,N,P again.

(2) At least 14 are due to disability. i.e. P(X≥14)

Step1:Press ENTER

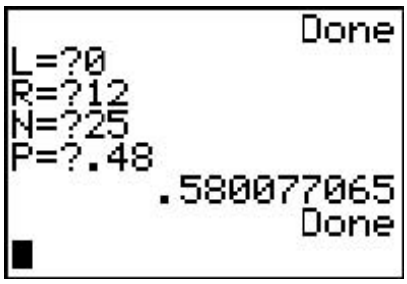
Step 2: When prompted enter the following values for L,R,N and P



(3) At most 12 are due to disability. i.e. P(X≤12)

Step 1: Press ENTER

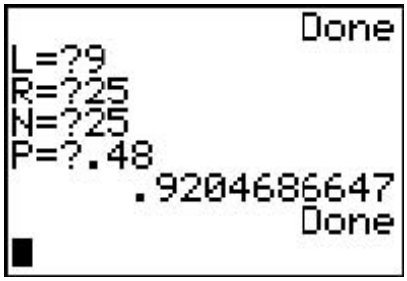
Step 2: When prompted input the following values for L,R,N and P



(4) More than 8 are due to disability. i.e. P(X > 8)

Step 1: Press ENTER

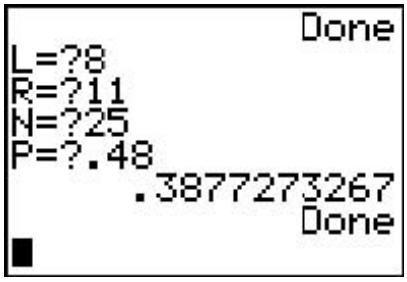
Step 2: When prompted input the following values for L,R,N and P



(5) P(8 ≤ X < 12)

Step 1: Press ENTER

Step 2: When prompted input the following values for L,R,N and P



ASSIGNMENT: Do exercises 5.71-5.75 in your text.

Chapter 6

Normal Probability Distributions

In this chapter we will use the TI-84+ to find normal probabilities and to display the normalpdf or normal probability function.

Example 6-1: Use the TI-84+ to display the graph of the following normal probability functions:

(1) $\mu = 0, \sigma = 1$ (The Standard Normal probability function)

(2) $\mu = 2, \sigma = 3$

(3) $\mu = 2, \sigma = 4$

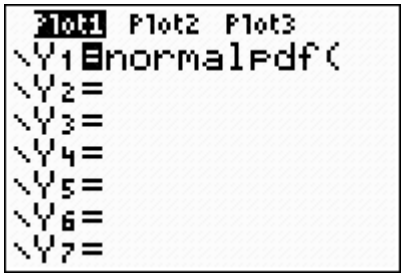
(1) Display the graph of the Standard Normal Distribution. i.e. $\mu = 0, \sigma = 1$

The TI-84+ function normalpdf is used to evaluate a normal probability distribution function at any value *x*. The syntax is normalpdf(X, μ, σ). The mean, μ, is the center of the distribution and the standard deviation, σ, determines how spread out the data is and how high the graph peaks (kurtosis).

Step 1: Press 

, then press 

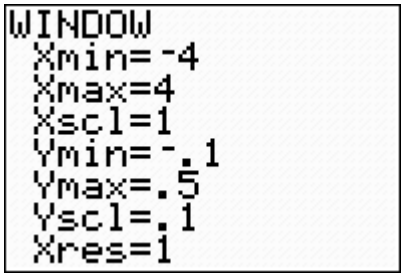
. Your screen will look like this..



Step 2: Press 

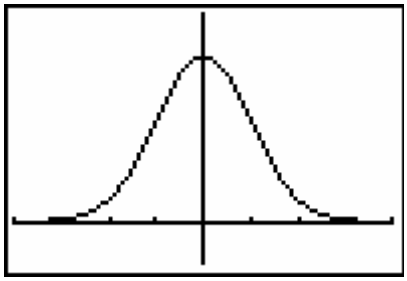
Step 3: Press 

and adjust your settings to match the following



Note: The Xmin and Xmax values are set to the Mean ± 4 Standard Deviations. Since the Mean is 0, ± 4 Standard Deviations gives us Xmin = -4 and Xmax = 4. Xscl is always set to 1.

Step 4: Press GRAPH. Your screen should look like this..



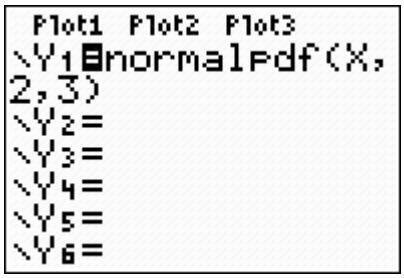
Note: If you have stat plots turned to ON, you will need to turn these off.

Press 2nd Y= 4 ENTER

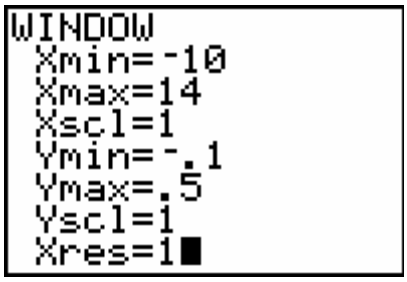
(2) Display the graph of the normalpdf with $\mu = 2$, $\sigma = 3$

Step 1: Press Y= 2nd VARS ENTER

Step 2: Change the settings to match the following

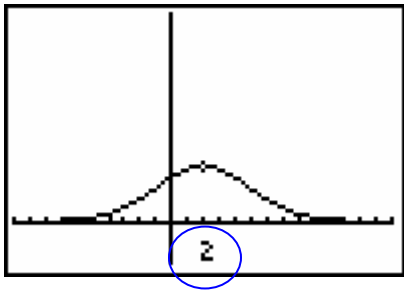


Step 3: Press WINDOW and adjust your settings to match the following



Note: Xmin is set to $\mu-4\sigma = 2 - 4(3) = -10$. Xmax is set to $\mu+4\sigma = 2 + 4(3) = 14$. Xscl is set to 1

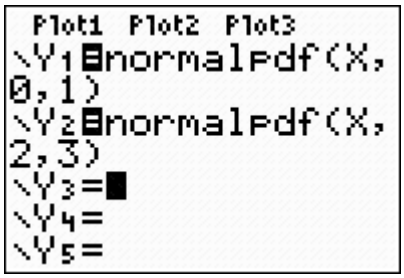
Step 4: Press GRAPH. Your screen should look like this..



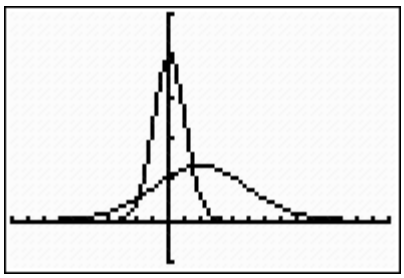
Note: The mean is $\mu = 2$. This is the center of the graph of this normal probability function.

We can compare the two graphs by graphing them simultaneously on the same window.

Step 5: Press Y=. Change Y_1 and Y_2 as shown below



Step 6: Press GRAPH. The calculator displays both normal probability functions below.

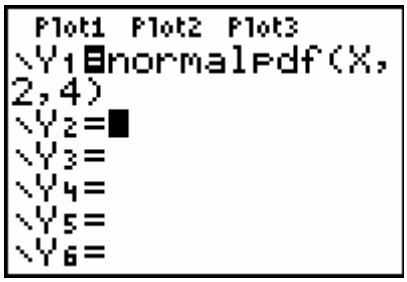


Note: Notice that Y_1 = normalpdf(X,0,1) is centered at X=0 and is considerably steeper than Y_2 = normalpdf(X,2,3). This is due to the fact that it has a smaller standard deviation. Also, Y_2 = normalpdf(X,2,3) is shifted to the center at X=2

(3) Display the graph of the normalpdf with $\mu = 2$, $\sigma = 4$

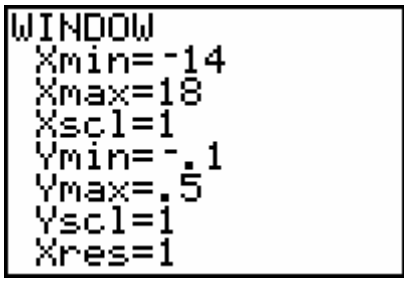
Step 1: Press 

Step 2: Change the settings to match the following



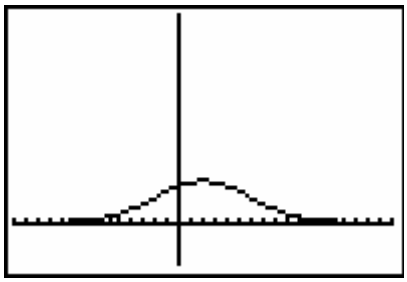
Step 3: Press 

and adjust your settings to match the following

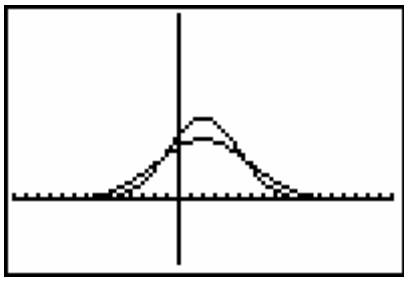


Step 4: Press 

. Your screen should look like this..



Comparing this graph to the previous graph shows what effect the greater standard deviation has on the graph.



Note: The curve that peaks higher (greater kurtosis) has the smaller standard deviation.

Finding Standard Normal Probabilities using the TI-84+

The standard normal distribution is a normal distribution with mean $\mu = 0$ and standard deviation $\sigma = 1$. Another way to determine if you are working with standard normal probabilities is when the letter Z is used for the random variable.

Example 6-2: Find the following standard normal probabilities:

1) P(-1.42 < Z < 1.35)
2) P(Z > 1.35)
3) P(Z < -1.2)

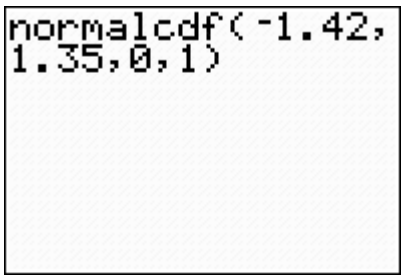
Solution:

1) P(-1.42 < Z < 1.35)

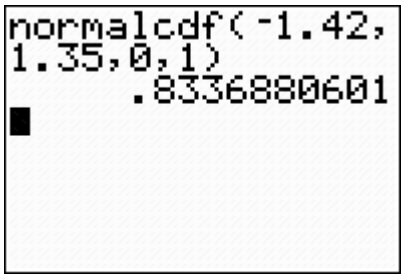
Step 1: Press 2nd VARS, then press ▼ to select 2: normalcdf, then press ENTER. Your screen should look like this..

Step 2: The syntax for normalcdf is (Low,Up,μ,σ) where L is the left value, R is the right value, μ and σ are the mean and standard deviation respectively. In this example, Low = -1.42, Up = 1.35, $\mu = 0$ and $\sigma = 1$. Input these values,

Press (−) 1 . 4 2 , 1 . 3 5 , 0 , 1). Your screen should look like this



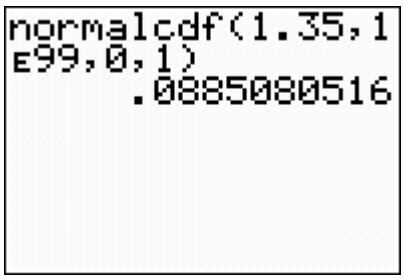
Step 3: Press ENTER. The calculator returns the probability (area under the standard normal curve from Z=-1.42 to Z =1.35)



2) P(Z > 1.35)

Step 1: Press 2nd VARS 2 (normalcdf)

Step 2: Press 1 . 3 5 , 1 2nd , 9 9 , 0 , 1) ENTER (EE). The calculator displays the result

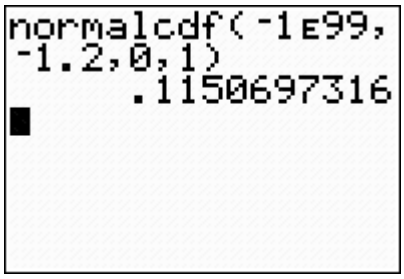


Note: -1E99 is considered the smallest number the TI-84+ can work with and 1E99 is the largest, effectively $-\infty$ and ∞. -1E99 is the calculator's way of showing scientific notation or -1×10^{99}. Similarly, 1E99 means 1×10^{99}. Since this problem had no right value as an upper bound (P(Z >1.35) we use 1E99 as the right value, meaning $+\infty$

3) P(Z < -1.2)

Step 1: Press 2nd VARS 2 (**normalcdf**)

Step 2: Press (−) 1 2nd , (EE) 9 9 , (−) 1 . 2 , 0 , 1) ENTER. The calculator returns the result



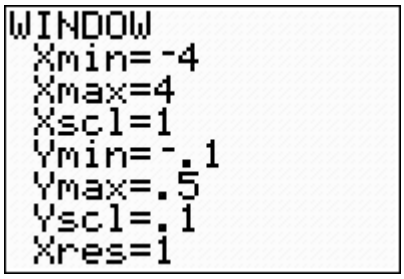
ASSIGNMENT: Do exercises 6.5-6.26 in your text.

Using the ShadeNorm function on the TI-84+

The ShadeNorm Program built into the TI-84+ draws the normalpdf and computes the area under the curve which is appropriately shaded. The syntax is ShadeNorm(Low, Up, μ, σ) where the values are identical to normalcdf.

Example 6-3: Verify the empirical rule which is sometimes referred to as the 68 - 95- 99.7 rule. Find the areas under the standard normal distribution corresponding to μ±1σ, μ±2σ and μ±3σ

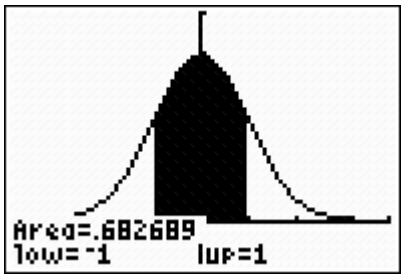
Step 1: Press WINDOW and adjust the settings to those below..



Step 2: Press Y= and press CLEAR to clear any functions in the menu.

Step 3: Press 2nd VARS, then press ▶ to highlight **DRAW**, then select **1:ShadeNorm** and press ENTER

Step 4: Press (−) 1 , 1 , 0 , 1) ENTER. The calculator displays the graph and the area under the standard normal distribution from z = -1 to z = 1

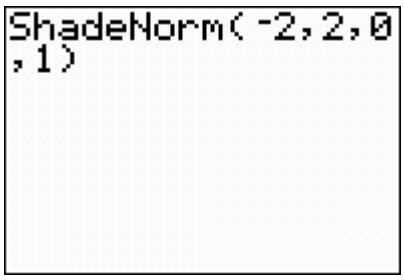


Note: Each time we want to use ShadeNorm, we must first clear any drawings.

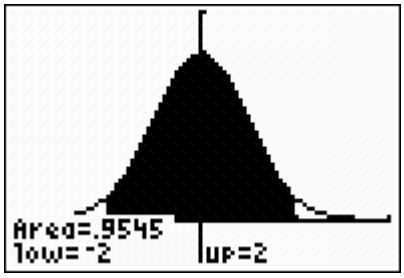
Step 1: Press 2nd PRGM (DRAW), select **1: ClrDraw** and press ENTER

Step 2: Press 2nd VARS, then press) to highlight **DRAW**, then select **1:ShadeNorm** and press ENTER

Step 3: Input the appropriate values into the ShadeNorm(. Press (−) 2 , 2 , 0 , 1). Your screen will look like this..



Step 4: Press ENTER. The calculator displays the following..

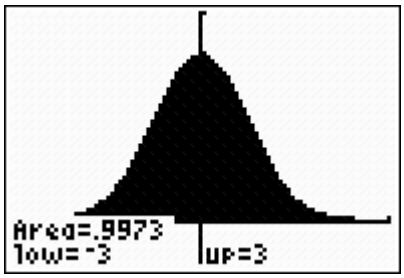


Finally, to compute and shade the area under the normal curve from z = -3 to z = 3

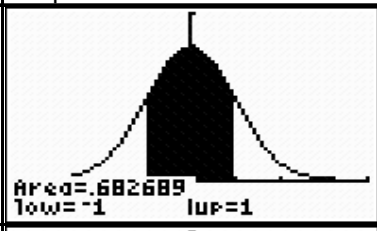
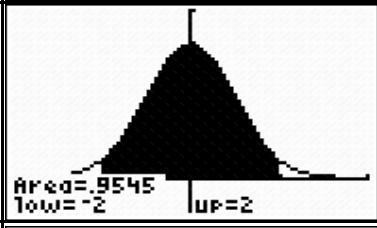
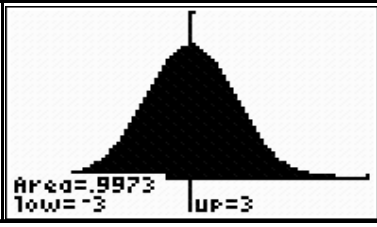
Step 1: Press 2nd PRGM (DRAW), select **1: ClrDraw** and press ENTER

Step 2: Press 2nd VARS, then press) to highlight **DRAW**, then select **1:ShadeNorm** and press ENTER

Step 3: Press (−) 3 , 3 , 0 , 1) ENTER. The calculator displays the result below..



The Empirical Rule (68-95-99.7 Rule)

Interval	ShadeNorm(	Graph	Probability
μ±1σ	ShadeNorm(-1,1,0,1)		0.6827
μ±2σ	ShadeNorm(-2,2,0,1)		0.9545
μ±3σ	ShadeNorm(-3,3,0,1)		0.9973

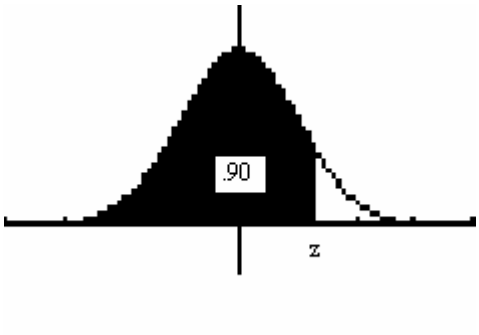
ASSIGNMENT: Do exercises 6.27-6.29 in your text.

Finding Z-Scores on the TI-84+ using the inverse normal distribution function or invNorm

The TI-84+ includes the invNorm function which allows us to find z-scores. The syntax for invNorm is (A, μ, σ) where A represents the total area to left of the z-score that we wish to compute.

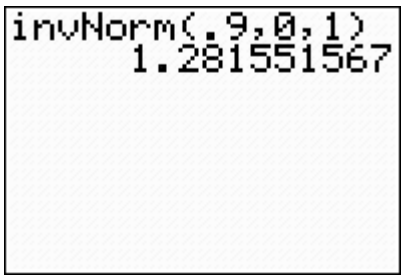
Example 6-4: What is the z-score such that 90% of the area under the normal curve is to its left?

Solution: Graphically, you are trying to find the z-score in the picture below..



Step1: Press  (DIST), then press  to select **3: invNorm** and press 

Step 2: Press . 9 , 0 , 1) ENTER. The calculator returns the following screen.



Thus, the z-score that gives 90% of the area to its left is approx. 1.282.

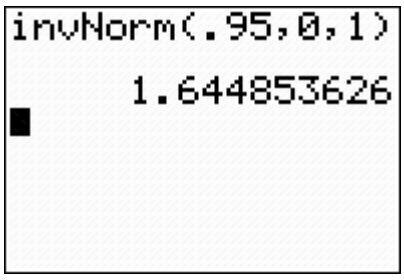
ASSIGNMENT: Do exercises 6.30-6.35 in your text.

Example 6.5: What is the z-score such that 5% of the area under the normal distribution is to its right?

Solution: Since we want .05 of the total area to the right of the z-score, we want .95 of the area to the left of it.

Step1: Press 2nd VARS (DIST), then press ⌄ to select **3: invNorm** and press ENTER

Step 2: Press . 9 5 , 0 , 1) ENTER. The calculator returns the following..

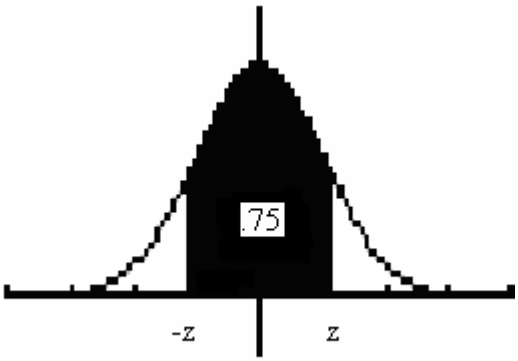


Thus, the z-score that gives 5% of the area to its right is approximately 1.645

ASSIGNMENT: Do exercises 6.30-6.35 in your text.

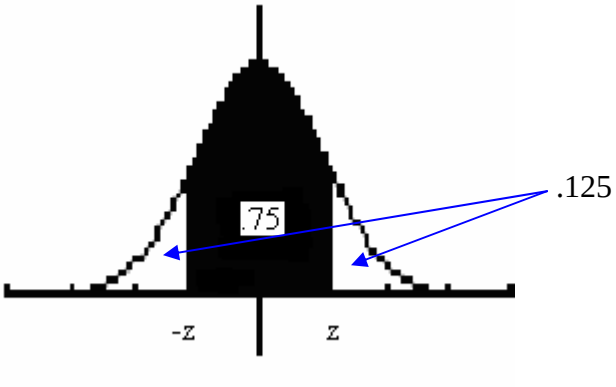
Example 6-6: What are the z-scores so that 75% of the middle of the normal distribution is bounded by them?

Solution: Graphically, we are looking for the following two z-scores.



Finding the left z-score is all that is required since the normal distribution is symmetric with respect to the origin ($\mu = 0$).

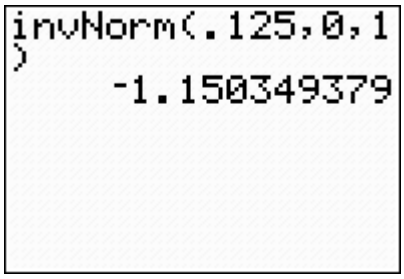
Since invNorm requires the area to the left of the z-score, we need to find the area. The total area under the curve is 1, so we subtract 1 - .75 = .25 Then we divide this into the two regions shown below. .25/2 = .125



Step 1: Press 2nd VARS 3 (invNorm)

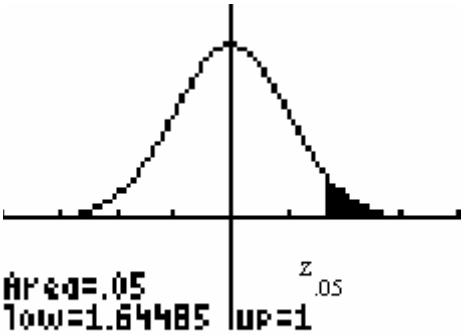
Step 2: Press . 1 2 5 , 0 , 1)

ENTER. The calculator returns the answer..

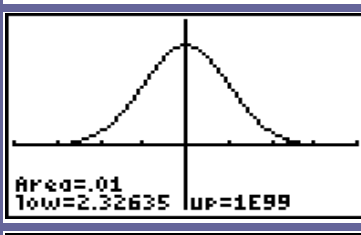
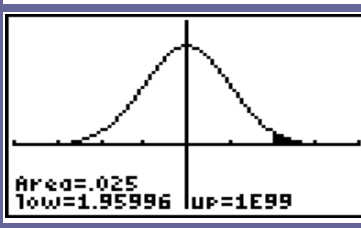
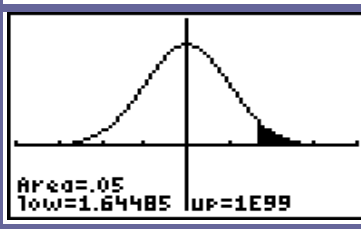
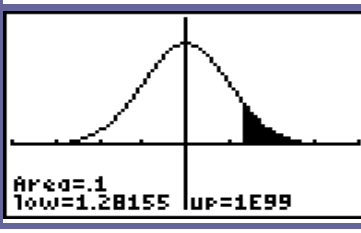


Thus, the two z-scores that bound the middle 75% of the area under the normal curve are
z = -1.15 to z = 1.15

The z-score that corresponds to the area contained in the right tail bounded by that z-score is denoted $z_{\alpha/2}$ For example, $z_{.05}$ is the z-score that yields 5% of the area in the right tail as shown in the figure below..



Example 6-7: Find the $z_{\alpha/2}$ values to complete the following table

	Right Tail Area	$z_{\alpha/2}$	Answer	invNorm	Graph
1	0.01	$Z_{.01}$		invNorm(.99,0,1)	
2	0.025	$Z_{.025}$		invNorm(.975,0,1)	
3	0.05	$Z_{.05}$		invNorm(.95,0,1)	
4	0.10	$Z_{.10}$		invNorm(.90,0,1)	

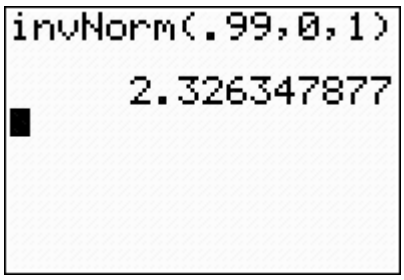
Solution:

Step 1: Press 

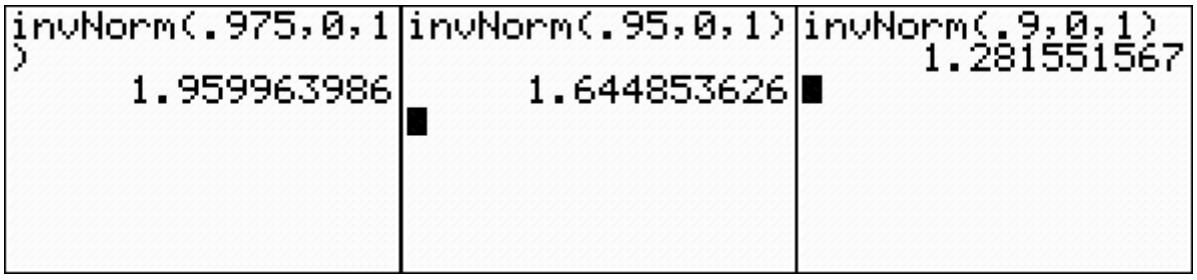
Step 2: Press 

.

The calculator displays the answer below..



Repeating the steps above yields the answers to the rest of the table



ASSIGNMENT: Do exercises 6.71-6.84 in your text.

Using the TI-84+ to generate random data from a normally distributed population

The randNorm function located in the 

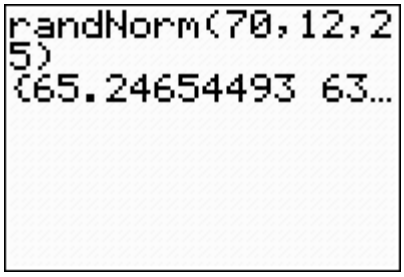
menu is used to generate random data. The syntax is randNorm(μ, σ, n) where μ and σ are the mean and standard deviation respectively, and n is the # of data values.

Example 6-8: Generate a random sample of 25 values from a normally distributed population with mean μ = 70 and σ = 12

Solution:

Step 1: Press MATH, then press ◀ to select **PRB**, then ▼ to select **6: randNorm** and press ENTER

Step 2: Press 7 0 , 1 2 , 2 5) ENTER. Your data will be different since it is randomly generated. However, the screen should look something like this..



We can view the values horizontally by pressing ▶ and scrolling through the different values. However, it is easier to store the data to a list so that we can work with it. To store the data, do step 3 below.

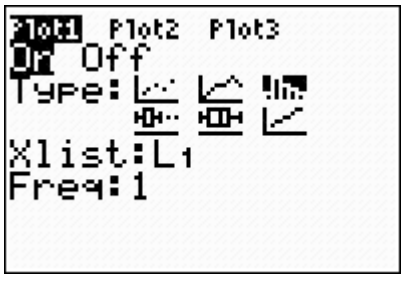
Step 3: Press STO▶ 2nd 1 to store the data in list L_1

To view the data in list L_1, press STAT ENTER

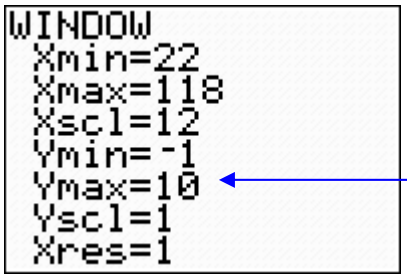
Note: To view the data graphically, we can graph the histogram of the random normal data in list L_1.

Step 1: Press 2nd Y= ENTER to enter into the Plot1 menu.

Step 2: Adjust the settings as shown in the next screen..



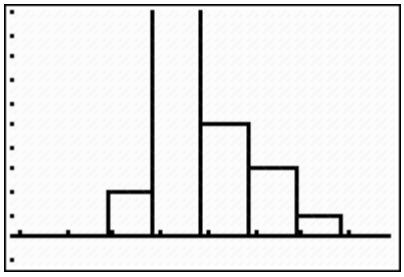
Step 3: Press WINDOW and adjust your settings to look like the next screen



The Ymax setting should be set no higher than the number of values in the data set. This setting may have to be adjusted as it is just a guess

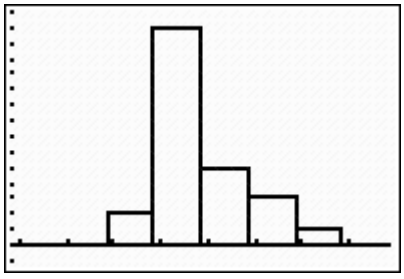
Note: Xmin is set for 4 standard deviations below the mean. i.e. Xmin = $\mu-4\sigma$ = 70-4(12)=22
Xmax is set for 4 standard deviation above the mean. i.e. Xmax = $\mu+4\sigma$ = 70+4(12)=118
Xscl is set for the standard deviation, i.e. Xscl = σ = 12

Step 4: Press GRAPH. The calculator returns a frequency histogram of the data.



Notice that the top of the graph is not displayed, this is due to an incorrect setting for Ymax.

Step 5: Press WINDOW and adjust the Ymax setting to 15, and then press GRAPH.

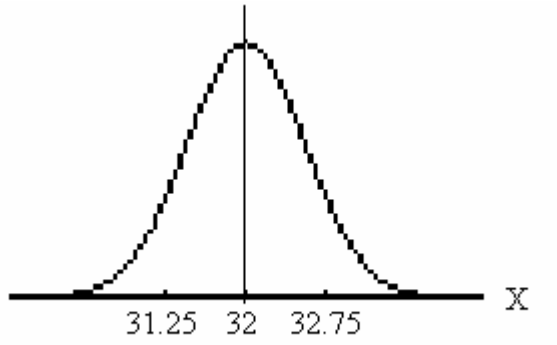


ASSIGNMENT: Do exercises 6.64-6.70 in your text.

Applications of the normal distribution and using normalcdf

Earlier, we used the normalcdf function to find standard normal probabilities/area. Recall that the standard normal distribution has mean $\mu=0$ and standard deviation $\sigma=1$. Now we wish to work with normal distributions that have a different mean and standard deviation

Example 6-9: Juan Garcia Coffee Importers imports coffee to the U.S. The mean weight of the cans is 32 oz. with a standard deviation of .75 oz. Assume the random variable X = fill weight of cans from population is normal.



Find the following probabilities:

(1) What is the probability that if a can is selected at random, it will contain between 30.5 and 32.8 oz.? i.e. find P(30.5<X<32.8)

(2) What is the probability that if a can is selected at random, it will contain at least 33 oz? i.e. find P(X≥33)

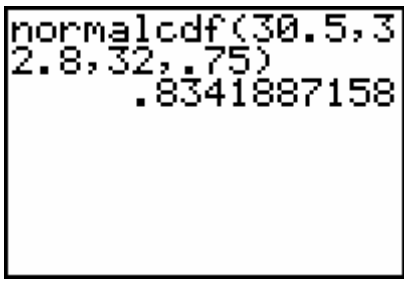
(3) What is the probability that if a can is selected at random, it will contain less than 32.66 oz?

Solution: Recall the syntax is normalcdf(Low, Up, μ, σ)

(1) What is the probability that if a can is selected at random, it will contain between 30.5 and 32.8 oz.? i.e. find P(30.5<X<32.8)

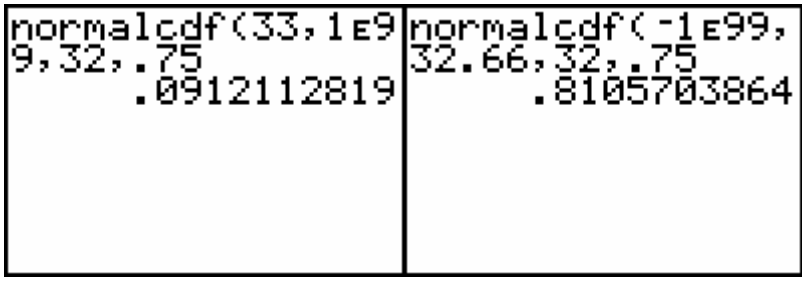
Step 1: Press 2nd VARS 2 (Normalcdf)

Step 2: Press 3 0 . 5 , 3 2 . 8 , 3 2 , . 7 5) ENTER. The calculator returns the following screen..



Thus, the probability is approx. 83.4% that a can selected at random will contain from 30.5 to 32.8 oz.

Repeating steps 1 and 2 above for the other two problems yields the following screens..



ASSIGNMENT: Do exercises 6.43-6.62 in your text.

Chapter 7

Sampling Variability and Sampling Distributions

Constructing a sampling distribution of means on the TI-84+

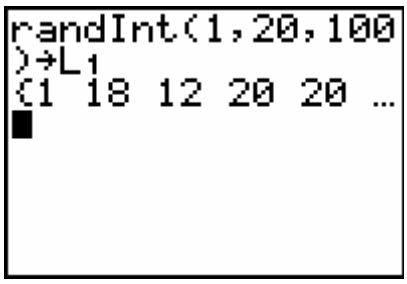
To generate a random sample of data of a given size, we can use the randInt function built into the TI-84+

Example 7-1: Generate 100 random samples each of size 5 from the numbers 1-20

Step 1: Press MATH (5 (randInt)

The syntax is randInt(Low, Up, Number)

Step 2: Press 1 , 2 0 , 1 0 0)
STO▸ 2nd 1 (L_1) ENTER. The calculator displays the following..

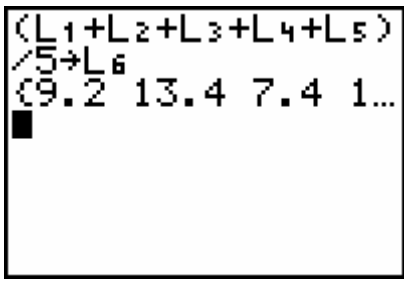


Step 3: Repeating the process, we can generate another 100 randomly selected numbers in list L_2

Press 1 , 2 0 , 1 0 0)
STO▸ 2nd 2 (L_2) ENTER.

Step 4: Continue to repeat the process until you have stored data into lists L_1 to L_5

Step 5: Press (2nd 1 + 2nd 2 + 2nd 3
+ 2nd 4 + 2nd 5) ÷ 5 STO▸
2nd 6 (L_6) ENTER to find the mean of each of the 100 samples of size 5 and store them to list L_6 . Your screen will look something like this..

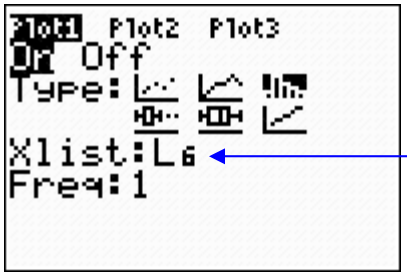


ASSIGNMENT: Do exercises 7.13-7.16 in your text.

Graphing the sampling distribution of sample means as a histogram

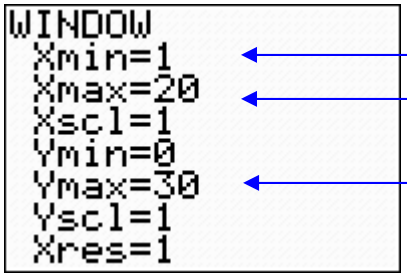
We can graph the sample means stored in list L_6 from our previous example.

Step 1: Press 2nd Y= ENTER to enter the Plot1 menu. Change your settings to look like those below..



Notice we are plotting the sample means found ln list L_6

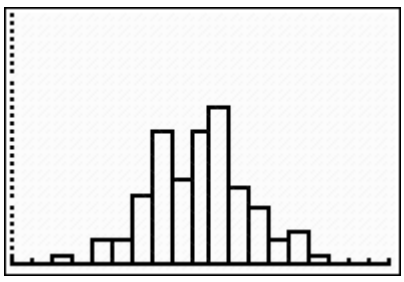
Step 2: Press WINDOW, and change your settings to look like the screen below..



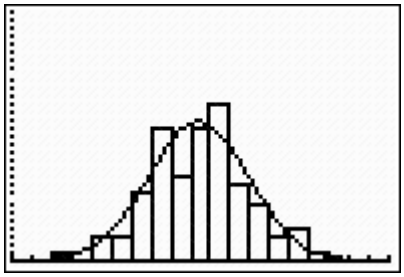
The range of the

Maximum Frequency - should be set less than 100

Step 3: Press GRAPH. The calculator returns the frequency histogram of the sample means



Step 6: Notice this data is somewhat bell shaped



Finding the mean $\mu_{\bar{X}}$ and the standard error $\sigma_{\bar{X}}$ of a sampling distribution

The TI-84+ can compute the mean and standard deviation of any discrete probability distribution. Let's consider the following example

Example 7-2: Consider the population of numbers {1,3,5,7,9,11}. Draw all samples of size n = 2 from this population with replacement.

(1) Construct the sampling distribution of sample means
(2) Graph the sampling distribution histogram
(3) Find the mean and standard error of the sampling distribution

Solution:

(1) To construct the sampling distribution, we need to identify all samples of size n=2 from the population {1,3,5,7,9,11}.

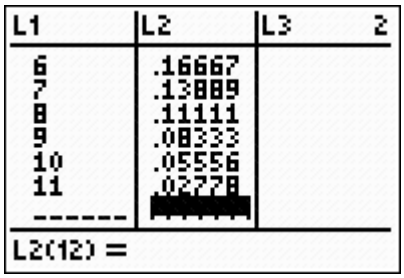
Sample	1,1	1,3	1,5	1,7	1,9	1,11	3,1	3,3	3,5	3,7	3,9	3,11	5,1	5,3	5,5	5,7	5,9	5,11
mean	1	2	3	4	5	6	2	3	4	5	6	7	3	4	5	6	7	8
Sample	7,1	7,3	7,5	7,7	7,9	7,11	9,1	9,3	9,5	9,7	9,9	9,11	11,1	11,3	11,5	11,7	11,9	11,11
mean	4	5	6	7	8	9	5	6	7	8	9	10	6	7	8	9	10	11

There are a total of 36 samples of size two, thus there are 36 sample means. To construct the sampling distribution, we need to fill out the table below..

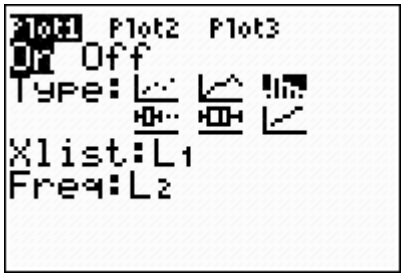
$\bar{X}$	1	2	3	4	5	6	7	8	9	10	11
$P(\bar{X})$	1/36	2/36	3/36	4/36	5/36	6/36	5/36	4/36	3/36	2/36	1/36

Step 1: Press STAT 4 ENTER to clear all the lists

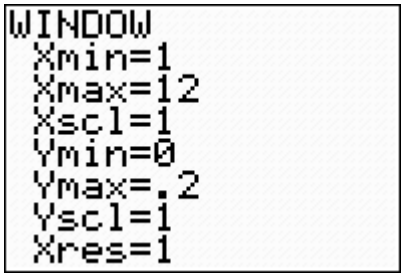
Step 2: Press STAT ENTER. Input the values of $\bar{X}$ in list L_1 and the values of $P(\bar{X})$ in list L_2



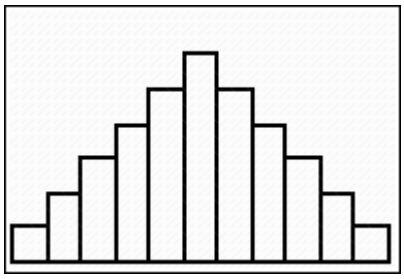
Step 3: Press 2nd Y= ENTER to enter the Plot1 menu. Change the settings to those below..



Step 4: Press WINDOW, adjust the settings to match those below.



Step 5: Press GRAPH, the calculator graphs the sampling distribution below..



Notice that this data is approximately normal. To graph a normal pdf on the screen we need the mean and standard error

Step 6: Press STAT) ENTER 2nd 1 , 2nd 2 ENTER.
The calculator returns the following screen.

```
1-Var Stats
 x̄=6
 Σx=6
 Σx²=41.8333333
 Sx=
 σx=2.415229458
↓n=1
```

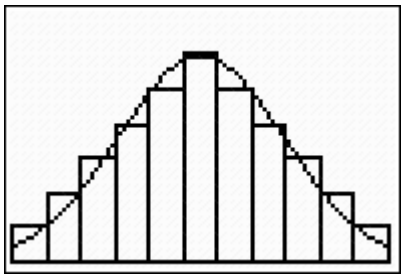
Thus the mean $\mu_{\bar{X}}$ = 6 and the standard error is $\sigma_{\bar{X}}$ = 2.415

Step 6: Press Y=, then press 2nd VARS ENTER (normalpdf)

Step 7: Press X,T,Θ,n , 6 . 5 , 2 . 4 1 5) GRAPH.

Note: The .5 shift of the mean centers the normalpdf the same as the histogram

The graph of the sampling distribution and corresponding normal curve are shown in the screen below.



Using the SAMPDIST Program to simulate a sampling distribution of means

The SAMPDIST program located in the PRGM menu is used to construct a sampling distribution at random.

Example 7-3: Randomly draw 30 samples of size 20 from the numbers 1-25 and display the sampling distribution of sample means of each of the samples in a histogram. Finally, fit a normalpdf to the histogram.

Step1: Press PRGM, then ▼ to select SAMPDIST, press ENTER, then ENTER again.

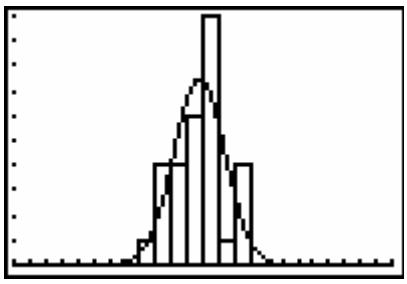
Step2: When prompted for "NUMBER OF SAMPLES" press 3 0 ENTER

Step3: When prompted for "SAMPLE SIZE" press 2 0 ENTER

Step4: When prompted for "LOW" press [1] [ENTER]

Step5: When prompted for "HIGH" press [2] [5] [ENTER]

Note: The calculator needs to do a great deal of computation at this point. It can take up to 3 minutes to finish the simulation. Your screen should look something like this..



ASSIGNMENT: Do exercises 7.27-7.28 in your text.

Example 7-4: Randomly draw 100 samples of size 30 from the numbers 1-25 and display the sampling distribution of sample means of each of the samples in a histogram. Finally, fit a normalpdf to the histogram.

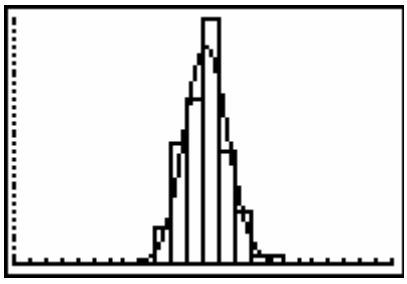
Step1: Press [PRGM], then [▼] to select SAMPDIST, press [ENTER], then [ENTER] again.

Step2: Press [1] [0] [0] [ENTER] to input the number of samples

Step 3: Press [3] [0] [ENTER] to input the sample size

Step4: Press [1] [ENTER] for the lower bound

Step5: Press [2] [5] [ENTER] for the upper bound. The histogram and normalpdf will look something like this..



Using the TI-84+ to compute normal probabilities for sampling distributions

Example 7-5: Kindergarten children have heights that are approximately normally distributed about a mean of 39 in. and a standard deviation of 2 in. Answer the following:

1) If a child is selected at random, find the probability that the child will be between 38.5 and 40.0 inches. i.e. Find P(38.5 < X < 40.0)

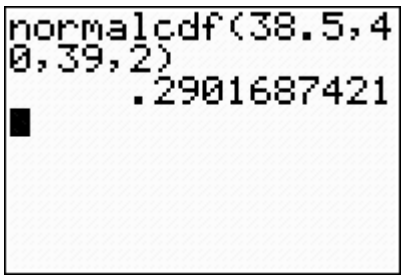
2) If a sample of size 25 children is randomly selected, find the probability that the mean of the sample will be between 38.5 and 40.0 inches. i.e. Find P(38.5 < $\overline{X}$ < 40.0)

Solution:

1) Since the population is approximately normal, we can answer this question easily using normalcdf.

Step 1: Press [2nd] [VARS] (DISTR) [2] (Normalcdf)

Step 2: The syntax is L, R, μ, σ. Press [3] [8] [.] [5] [,] [4] [0] [,] [3] [9] [,] [2] [)] [ENTER]. The calculator returns the following screen..



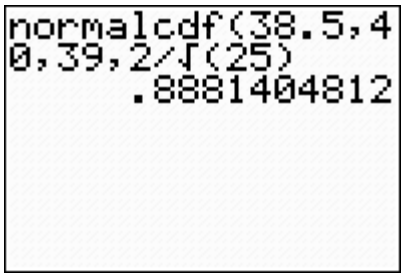
Thus, there is a 29% probability that a randomly selected child will be in the range (38.5,40)

2) Since the sampling distribution is normal, we can again use normalcdf to compute the probability. Recall, the mean of the sampling distribution is the same as the mean of the population. Thus $\mu_{\bar{x}} = \mu$. However, the standard error of the sampling distribution is given as $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$. In this case, this is $2/\sqrt{25}$

Step 1: Press [2nd] [VARS] (DISTR) [2] (Normalcdf)

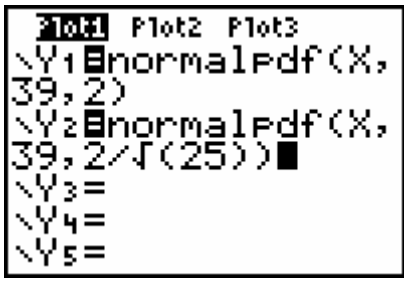
Step 2: Press 3 8 . 5 , 4 0 , 3 9 , 2 ÷ 2nd x^2 2 5) ENTER.

The calculator displays the answer..

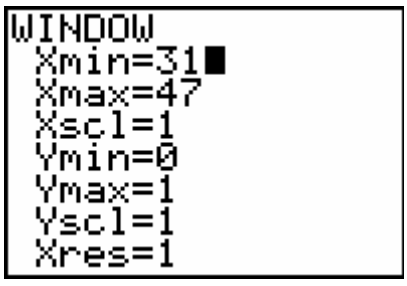


Note: The difference between 1) and 2) is that in 2) we are dealing with a different normal distribution that is centered at the same mean but has a different measure for the standard deviation. In this case, the standard error for the new sampling distribution is 1/5 the standard deviation of the original population. To compare the two graphs follow the steps below

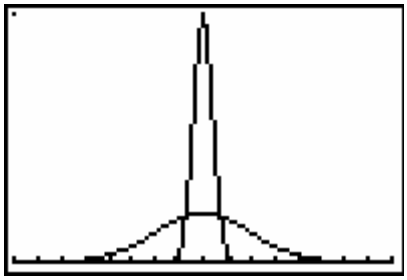
Step 3: Press Y= and input Y_1 and Y_2 as shown below..



Step 4: Press WINDOW and change the settings to match below..



Step 5: Press GRAPH to display the two distributions on the same screen..



ASSIGNMENT: Do exercises 7.33-7.37 in your text.

Chapter 8

Introduction to Statistical Inferences

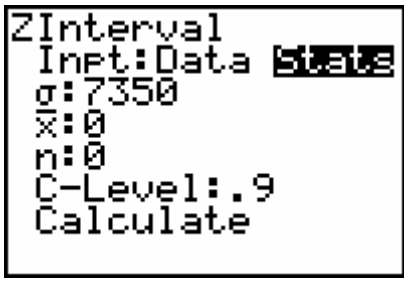
The TI-84+ has built in functions for confidence intervals and tests of hypotheses. They are located in the STAT TESTS menu.

Constructing a confidence interval for μ based on summary statistics

Example 8-1: The student activities office at a local state university would like to estimate the mean distance traveled to school by commuters. A random sample of 100 commuting students was selected and the one-way distance each commuted was obtained. The resulting sample mean distance was $\bar{x} = 10.22$ miles. If the population standard deviation is known to be σ = 6 miles, find a 95% confidence interval for the mean one-way distance traveled by commuter students at the school.

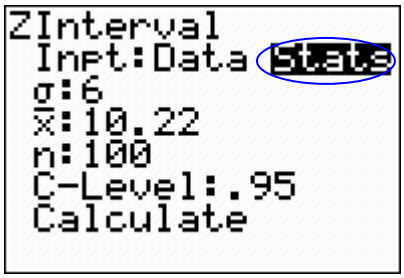
Solution:

Step 1: Press STAT, then press ▶ to select TESTS, then press 7 (7: ZInterval). Your screen should look like this..

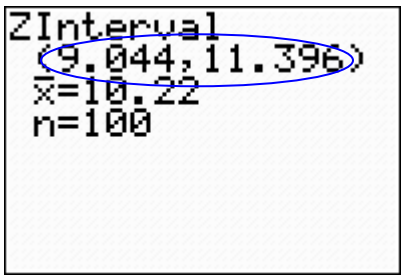


Since we know the summary statistics from the sample data, we want to select Stats as shown above. Press the arrow keys to highlight and press ENTER to select and set it to Stats mode.

Step 2: Adjust your screen to look like the following..



Step 3: Press  to highlight Calculate and press  . The calculator will return the following screen..



Thus, the 95% confidence interval for μ is (9.044, 11.396) minutes.

Note: This confidence interval is displayed in interval notation. Using error notation, we have 10.22 ±1.176

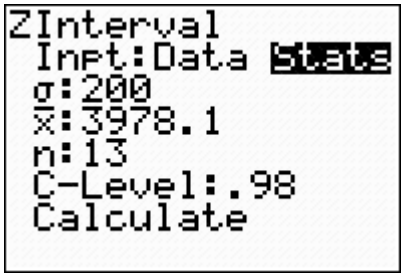
ASSIGNMENT: Do exercises 8.23-8.26, 8.34 in your text.

Example 8-2: "Particle size" is an important property of latex paint and is monitored during production as part of the quality control process. Thirteen particle size measurements were randomly taken using the Dwight P.Joyce Disc, and it was found that $\bar{x} = 3978.1$ angstroms. Assuming that particle size, X, is normally distributed with a population standard deviation of σ = 200 angstroms, find a 98% confidence interval for the true average particle size.

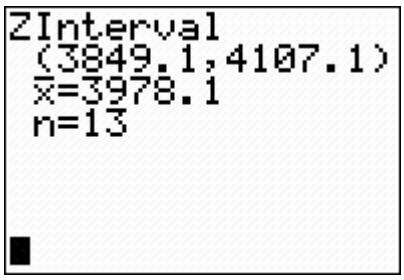
Solution:

Step 1: Press  (ZInterval)

Step 2: Adjust the screen to match the settings below..



Step 3: Press  to highlight Calculate and press  . The calculator will return the following screen..



Thus, the 98% confidence interval for μ is (3849.1, 4107.1) angstroms

ASSIGNMENT: Do exercises 8.35-8.38 in your text.

Constructing a confidence interval for μ based on raw data

Example 8-3: When snow melts, it becomes water, sometimes more water than at other times. A USA Today newspaper article compared the water contents of snow from two areas in the U.S. typically get about the same amount of snow annually. However, the water content differs significantly. A random sample of 40 measurements were taken, the data is displayed below. If the standard deviation of water content is known to be σ=2.87, what is the 90% confidence interval for the average water content based on this sample?

2	4	8	2	5	1	9	9
0	6	1	5	1	8	7	1
3	4	1	5	6	1	9	0
1	2	1	8	7	0	8	0
8	6	4	1	4	3	5	3

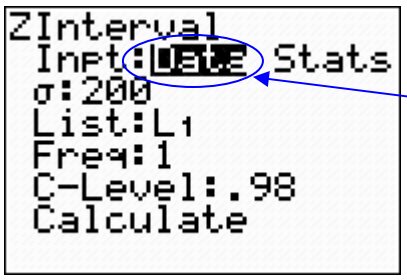
Solution:

Step 1: Press STAT 4 2nd 1 , 2nd 2 2nd 3 ENTER to clear lists L_1 through L_3

Step 2: Press STAT ENTER to access the STAT Editor. Enter the 40 values into list L_1

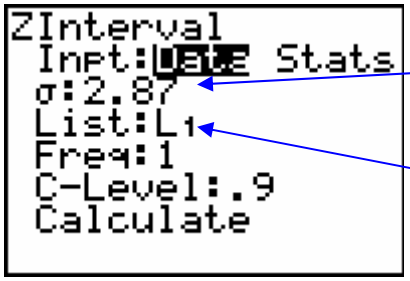
Step 3: Press STAT (7 (ZInterval)

Step 4: Select **Data** and press ENTER to set ZInterval to Data mode as shown below



Note: You must highlight and press ENTER to put in Data

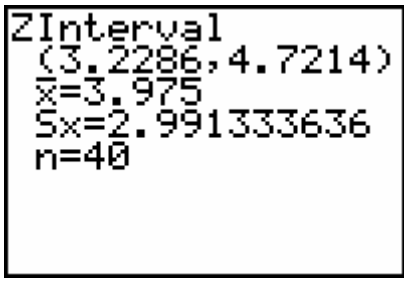
Step 5: Change the screen to match the settings below



To use the data feature of ZInterval, you must know the standard

Note: You are prompted for the list where the data is stored. In this case L_1

Step 6: Press ⌄ to highlight Calculate and press ENTER. The calculator will return the following screen..



Thus, the 90% confidence interval for μ is (3.23, 4.72) inches.

ASSIGNMENT: Do exercises 8.39-8.41 in your text.

Testing Hypotheses

Using ZTest to test for μ

Example 8-4: The admissions office at a local hospital claims the mean age of its patients is 42 years. In an attempt to check this claim, an insurance provider selects a random sample of 120 patients and records their ages. The sample mean is 44.2. Is there sufficient evidence to conclude the mean age of patients at the hospital is larger than 42? Use $\alpha = .05$ and $\sigma = 20$.

Solution:

The hypotheses for the test are:

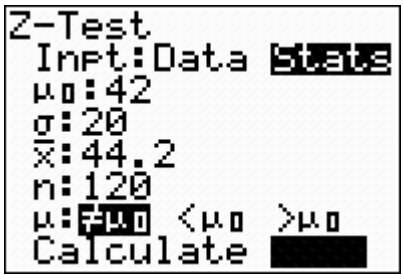
H_0: $\mu = 42$
H_A: $\mu \neq 42$ ← Two-Tailed Test

The sample data is given as:

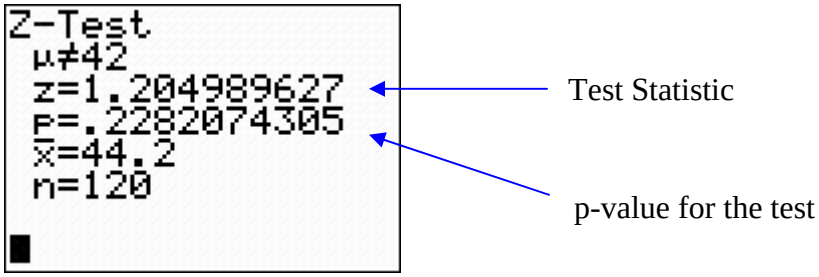
$n = 120$
$\bar{x} = 44.2$
$\sigma = 20$

Step 1: Press STAT ◄ ENTER (ZTest)

Step 2: Adjust the settings to match those below



Step 3: Press ▼ to highlight Calculate, and press ENTER. The calculator displays the following..



Test Statistic

p-value for the test

Since the p-value .2282 > .05 = α, we fail to reject the null hypothesis. Thus we can not reject the claim that the average age of patients is 42 years.

ASSIGNMENT: Do exercises 8.113-8.119, 8.145, 8.150 in your text.

Example 8-5: The manager at Air Express feels that the weights of packages shipped recently are less than in the past. Records show that in the past packages have had a mean weight of 36.7 pounds and a standard deviation of 14.2 pounds. A random sample of last month's shipping records yielded a mean weight of 32.1 pounds for 64 packages. Is this sufficient evidence to reject the null hypothesis in favor of the manager's claim? Use a = 0.01.

Solution:

The hypotheses for this test are:

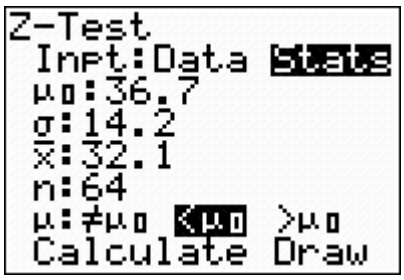
H_0: $\mu = 36.7$
H_A: $\mu < 36.7$ ← One Tailed

The sample data is:

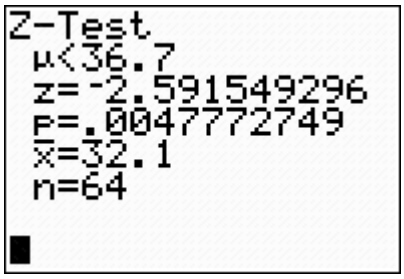
$n = 64$
$\bar{x} = 32.1$
$\sigma = 14.2$

Step 1: Press STAT ◄ ENTER (ZTest)

Step 2: Adjust the settings to match those below



Step 3: Press ▼ to highlight Calculate, and press ENTER. The calculator displays the following..



The p-value for the test is .0048 < .01 = α, so we reject the null hypothesis. The manager's claim is statistically proved.

ASSIGNMENT: Do exercises 8.141-8.142, 8.149, 8.155, 8.156 in your text.

Example 8-6: A manufacturer claims the weight of a full box of its cereal is normally distributed with a mean of 10 ounces and a standard deviation of 0.27 ounces. A random sample of 18 boxes is selected and

the weight of each box is given below. Using the data, determine is there any evidence to suggest the mean weight of the cereal boxes is more than 10 ounces? Use a 0.10 level of significance.

Weights

9.71	10.07	9.80	9.81	10.29	*10.01*
11.13	9.78	10.10	10.40	9.93	*10.18*
10.22	*9.88*	*10.00*	*9.95*	*9.91*	*9.73*

Solution:

The hypotheses for the test are:

H_0: $\mu = 10.00$
$H_{A:}$ $\mu > 10.00$

Step 1: Press 

to clear lists L_1 and L_2

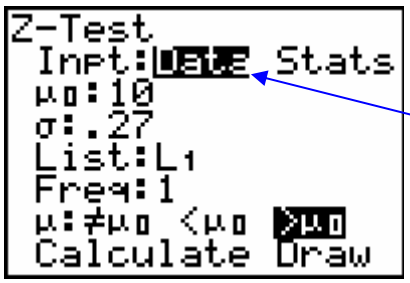
Step 2: Press 

and input the Weights data into list L_1

Step 3: Press 

(ZTest)

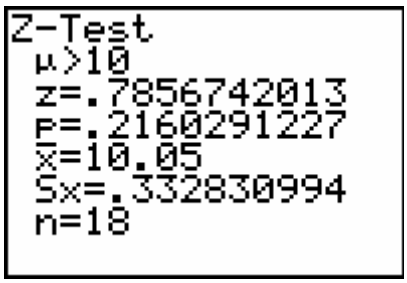
Step 4: Adjust the settings to match those below..



Note: Highlight Data and press 

Step 5: Press  to highlight Calculate, and press 

. The calculator displays the following..



Since the p-value for these test is .216 > .10 = α, we fail to reject the null hypothesis. The evidence does not establish that the mean fill weight is more than 10 oz.

ASSIGNMENT: Do exercises 8.120, 8.154, 8.153 in your text.

Example 8-7: A commercial aircraft manufacturer buys rivets to use in assembling airliners. Each rivet supplier that wants to sell rivets to the aircraft manufacturer must demonstrate that its rivets meet the required specifications. One of the specs is: "The mean shearing strength of all such rivets is at least 925 Lbs." A random sample of 50 rivets, had a sample mean shearing strength of $\bar{x}$ = 921.18 Lbs. with a sample standard deviation of s = 17.58 Lbs. Does this manufacturer's rivets fall short of the specification at α = .05?

Solution:

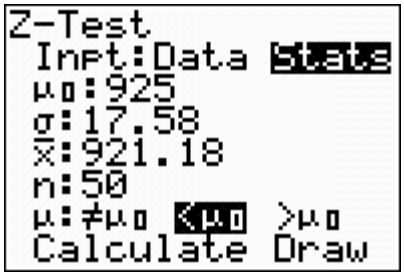
The hypotheses for the test are:

H_0: $\mu = 925$
$H_{A:}$ $\mu < 925$

Step 1: Press 

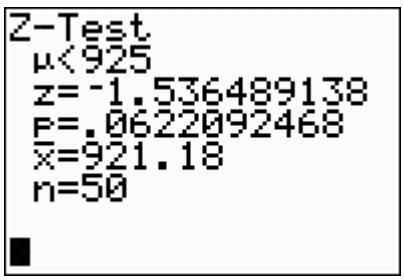
(ZTest)

Step 2: Adjust the settings to match those below



Step 3: Press  to highlight Calculate, and press 

. The calculator displays the following..



Since the p-value is .062 > .05 = α, we fail to reject the null hypothesis. The evidence does not show that the rivets fail to meet the specification.

Chapter 9

Inferences Involving One Population

Finding t-scores with the TI-84+

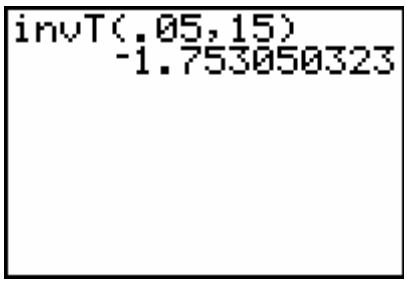
Although t-scores can be found from the accompanying tables, the TI-84+ has the invT function built in. The syntax for this function is given by invT(L, df) where ***L is the area to the left of the t-score that you want to find*** and df = n-1 is the degrees of freedom.

Example 9-1: Find the t-score that represents the 5th percentile under the t distribution with 15 degrees of freedom.

Solution:

Step 1: Press 2nd VARS (DIST) and press ▼ to select invT and then press ENTER

Step 2: Press . 0 5 , 1) ENTER. The calculator displays the result..



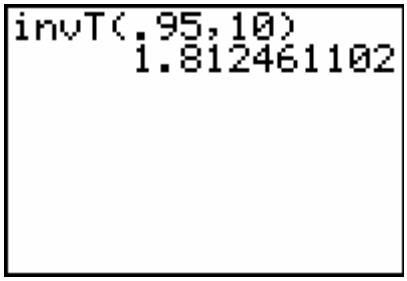
ASSIGNMENT: Do exercises 9.5-9.8 in your text.

Example 9-2: Find the t-score that represents the upper 5% of the t-distribution with 10 degrees of freedom. i.e. find the t-score that represents the 95th percentile under the t-distribution

Solution:

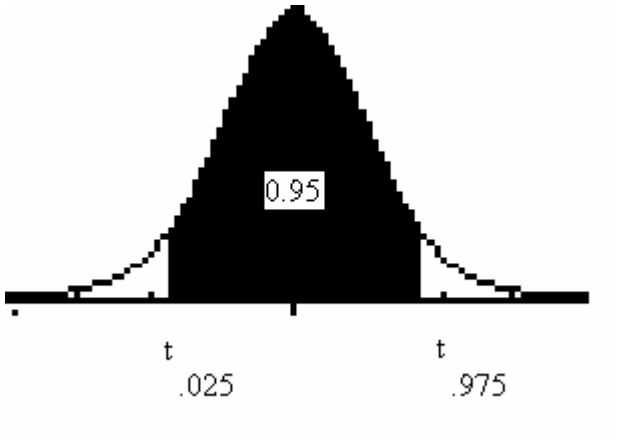
Step 1: Press 2nd VARS (DIST) and press ▼ to select invT and then press ENTER

Step 2: Since you want the area to the left of the t-score, subtract 1- .05 = .95. Press [.] [9] [5] [,] [1] [0] [)] [ENTER]. The calculator displays the t-score..



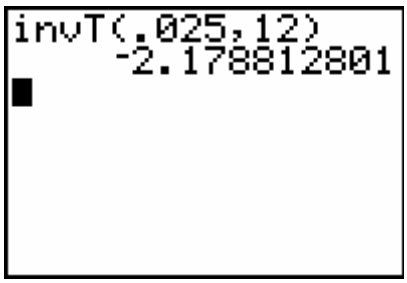
Example 9-3: Find the t-scores that bound the middle 95% of the area under the t-distribution for 12 degrees of freedom

Solution: Graphically, here is a picture of what is asked for..

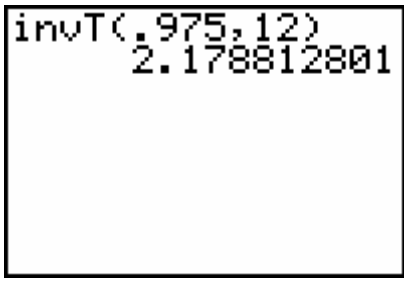


Step 1: Press [2nd] [VARS] (DIST) and press [▼] to select invT and then press [ENTER]

Step 2: To find the left t-score, press [.] [0] [2] [5] [,] [1] [2] [)] [ENTER]. The calculator displays the result..



Step 3: To find the right t-score, press . 9 7 5 , 1 2) ENTER. The calculator again displays the result..



Note: Since the t-score were symmetric about the mean, you don't have to compute the right t-score but simply take the left t-score and make it positive.

ASSIGNMENT: Do exercises 9.11-9.14 in your text.

Using the tcdf to find area/probability under the t-distribution

We use the tcdf to find area under the t-distribution. The syntax for the function is tcdf(L,R,df) where L is the left bound, R is the right bound and df is degrees of freedom.

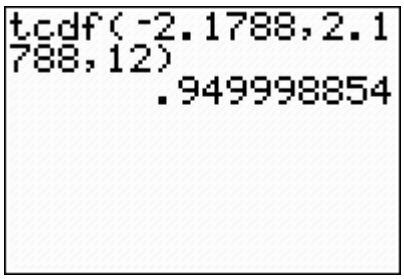
Example 9-4: Find the area under the t-distribution from t = -2.1788 to t = 2.1788 with 12 degrees of freedom

Solution:

Step 1: Press 2nd VARS (DIST), then press ▼ to select tcdf and press ENTER.

Step 2: Press (−) 2 . 1 7 8 8 , 2 . 1 7 8 8 , 1 2) ENTER.

The calculator displays the result.

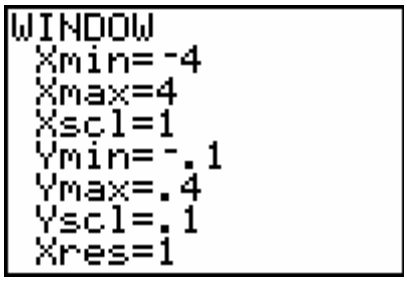


Using Shade_t to find area under the t-distribution

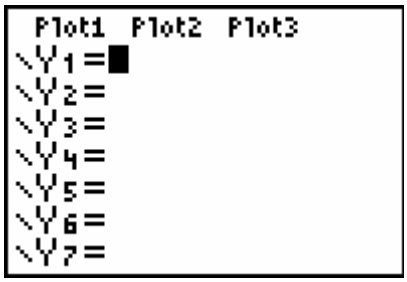
Example 9-5: Use Shade_t to find the area in the previous example

Step 1: Press 2nd VARS, then press ▶ to select DRAW and finally 2: Shade_t(and then ENTER.

Step 2: Press WINDOW and adjust the settings to match those in the next screen..



Step 3: Press Y= and make sure your screen is clear, as in the next screen

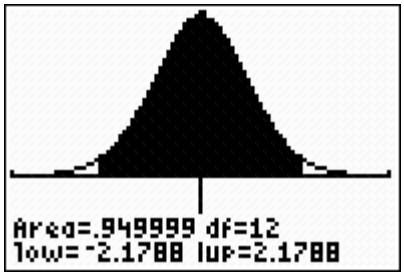


Step 4: Press 2nd PRGM ENTER ENTER to clear any previous drawings in memory

Step 5: Press 2nd Y= 4 ENTER to turn all Stat Plots Off

Step 6: Press (−) 2 . 1 7 8 8 , 2 . 1 7 8 8 , 1 2) ENTER.

The calculator will return the answer and the drawing as shown below..



ASSIGNMENT: Do exercises 9.17-9.18 in your text.

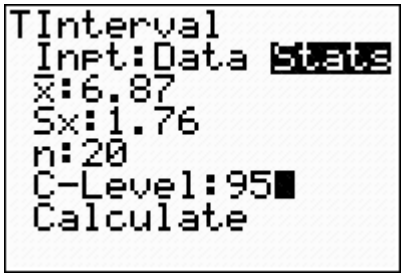
Using TInterval on the TI-84+

TInterval is located in the STAT TESTS menu and is used to find small sample confidence intervals for μ when the population is approximately normal and σ is unknown.

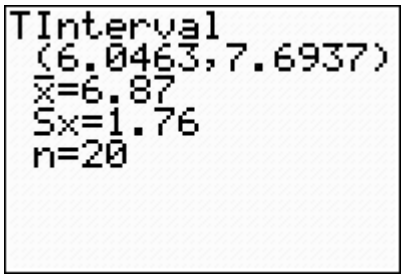
Example 9-6: A random sample of 20 weights is taken from babies born at Northside Hospital. A sample mean of 6.87 lb and a standard deviation of 1.76 lb were found for the sample. Estimate the true average weight of all babies born at Northside Hospital based on this sample at a 95% level of confidence

Step 1: Press STAT (8 (TInterval) ENTER.

Step 2: Change the settings to match those below..



Step 3: Press ⌄ to highlight Calculate and press ENTER. The calculator returns the following..



ASSIGNMENT: Do exercises 9.21-9.25 in your text.

Example 9-7: The following represent the daily revenues from 20 parking meters in a small municipality. Find a 95% confidence interval for the average daily revenue of all parking meters.

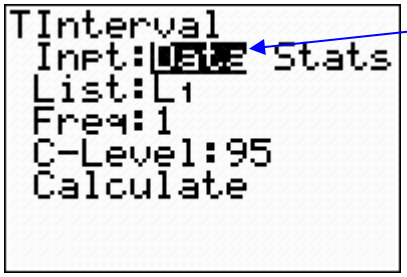
2.60	1.05	2.45	2.90	1.30
3.10	2.35	2.00	2.40	2.35
2.40	1.95	2.80	2.50	2.10
1.75	1.00	2.75	1.80	1.95

Step 1: Press STAT EDIT and input the 20 values into List L_1

Step 2: Press 2nd MODE (QUIT) CLEAR to exit the Stat Editor and go to a blank working screen.

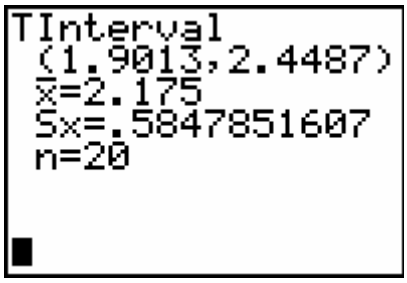
Step 3: Press STAT (8 (TInterval)

Step 4: Adjust the settings on screen to match those below..



Highlight Data and press ENTER

Step 5: Highlight Calculatre and press ENTER. The calculator returns the following..



ASSIGNMENT: Do exercises 9.26-9.29, 9.31-9.34 in your text.

Using T-Test on the TI-84+

The T-Test is used under the same conditions as TInterval and is located in the STAT TESTS menu.

Example 9-8: The EPA is citing the city of Rochester for noncompliance with carbon monoxide standards. Specifically, the EPA would like to show that the mean level of carbon monoxide (CO) in downtown Rochester is dangerously high, higher than 4.9 ppm. A random sample of 22 days provided the following: $\bar{x} = 5.1$, s = 1.17. At α=.05, does this data validate the EPA's citation?

Solution: The hypotheses for this test are:

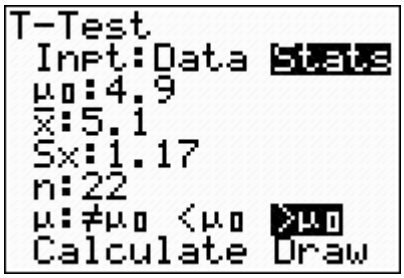
H_0: $\mu = 4.9$

H_A: $\mu > 4.9$

Step 1: Press 

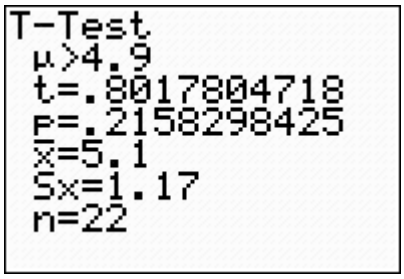
(TTest)

Step 2: Change the settings on screen to match those found below..



Step 3: Press  to highlight Calculate and press 

. The calculator returns the following..



Since the p-value for the test is .2158 > .05 = α, we fail to reject H_0 and the data does not validate the citation.

ASSIGNMENT: Do exercises 9.39-9.44 in your text.

Example 9-9: On a popular self-image test that results in normally distributed scores, the mean score for public assistance recipients is reported to be 65. A random sample of 28 public assistance recipients in Emerson County is given the test and yielded the following results: $\bar{x} = 62.1$, s = 5.83. At α = .02 does the data suggest that the mean score is actually different than reported?

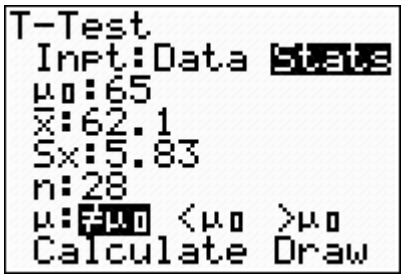
Solution: The hypotheses for the test are:

H_0: $\mu = 65$
H_A: $\mu \neq 65$

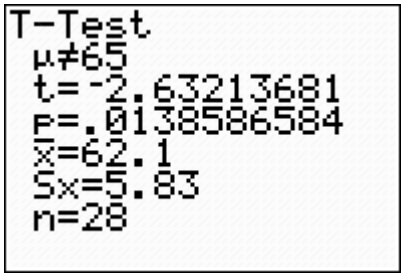
Step 1: Press 

(TTest)

Step 2: Change the settings on screen to match those found below..



Step 3: Press ▼ to highlight Calculate and press ENTER. The calculator returns the following..



The p-value for the test is .0138 < .02 = α, thus we reject H_0 and the data does suggest that the mean score is different from 65 as reported.

ASSIGNMENT: Do exercises 9.47-9.50 in your text.

Example 9-10: For the parking meter data above, suppose that it is claimed that the average parking meter revenue is at least $2.38 per day. The sample data of 20 randomly selected parking meters is given below. Is there evidence to refute the claim at $\alpha = .01$?

2.60	1.05	2.45	2.90	1.30
3.10	2.35	2.00	2.40	2.35
2.40	1.95	2.80	2.50	2.10
1.75	1.00	2.75	1.80	1.95

Solution: The hypotheses for the test are:

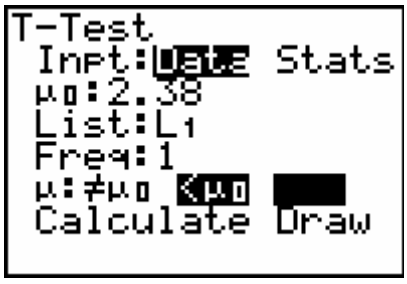
H_0: $\mu \geq 2.38$
H_A: $\mu < 2.38$

Step 1: Press STAT ENTER and input the data into list L_1

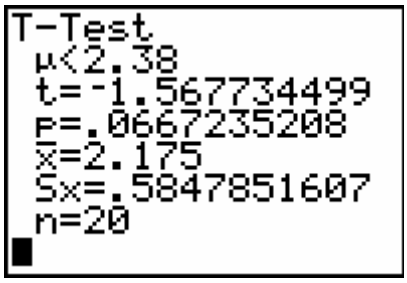
Step 2: Press 2nd MODE (QUIT) CLEAR to exit the Stat Editor and go to a blank working screen.

Step 3: Press STAT ◀ 2 (TTest)

Step 4: Change the settings on screen to match those found below..



Step 5: Press ⌄ to highlight Calculate and press ENTER. The calculator returns the following..



Since the p-value for the test is .0667 > .01 = α, we fail to reject H_0 and therefore there is not sufficient evidence to reject the accountant's claim.

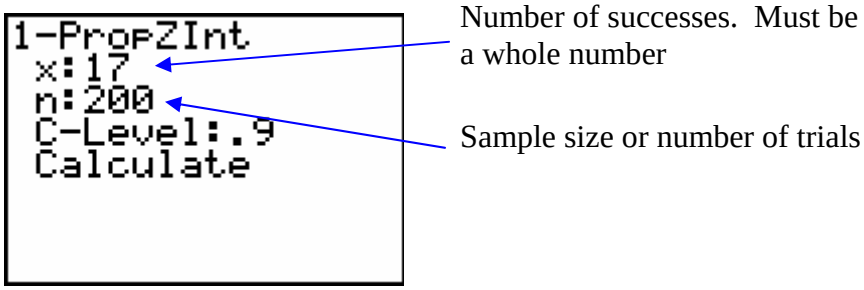
ASSIGNMENT: Do exercises 9.51-9.58, 9.60-9.61 in your text.

Confidence Interval for Proportion. Using 1PropZInterval on the TI-84+

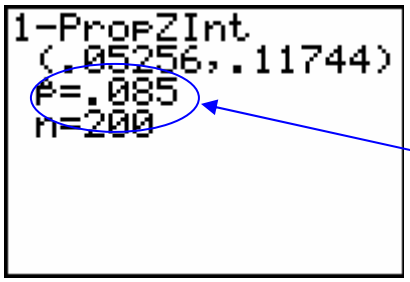
Example 9-11: Dana would like to estimate the overall proportion of convertibles that students drive. She randomly sampled 200 cars and found 17 of those were convertibles. Find a 90% confidence interval for the overall proportion of convertibles that students drive.

Step 1: Press STAT ⟨ (TESTS) and then press ⌄ to select 1-PropZInt and press ENTER.

Step 2: Adjust the screen to match the settings found below..



Step 3: Highlight Calculate and press ENTER. The calculator returns the following screen..



$\hat{p} = \frac{17}{200}$

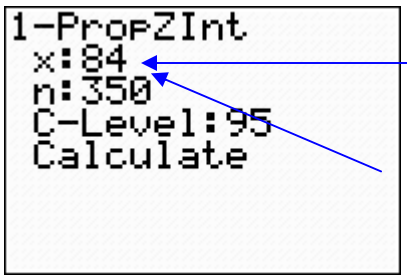
Thus, the 90% confidence interval is (.05256, .11744) in interval notation.

ASSIGNMENT: Do exercises 9.69-9.81 in your text.

Example 9-12: A random sample of 350 Cal Trans workers included 24% females. Find a 95% confidence interval for the proportion of female Cal Trans workers.

Step 1: Press STAT ((TESTS) and then press ▼ to select 1-PropZInt and press ENTER.

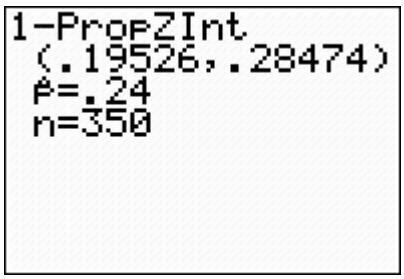
Step 2: Adjust the settings to match those below..



.24 x 350 = 84

Note: It may be necessary to round x to the nearest whole number

Step 3: Highlight Calculate and press ENTER. The calculator returns the following screen..



Thus, the true proportion of female Cal Trans workers is (.19526, .28474) or 0.24± .04474

Test of Hypothesis for p. Using 1-PropZTest on the TI-84+

The large sample test for proportion is the 1-PropZTest located in the STAT TESTS menu.

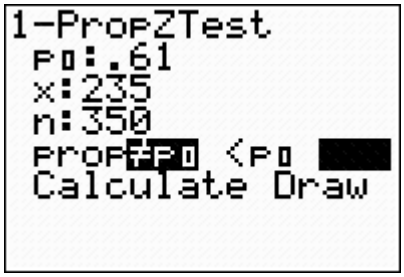
Example 9-13: Many people sleep in on the weekends to up for short nights during the week. The Better Sleep Council reports that 61% of us get more than seven hours of sleep per night on the weekend. A random sample of 350 adults found that 235 had more than seven hours of sleep each night last weekend. At $\alpha = .05$, does the evidence show that more than 61% of people get more than 7 hours sleep on the weekends?

The hypotheses for the test are:

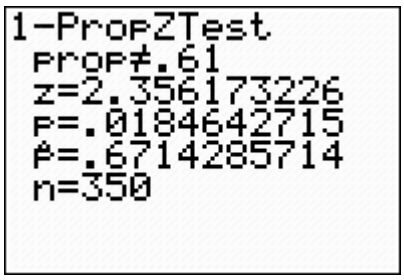
H_0: p=.61
H_A: p>.61

Step 1: Press STAT ◄ 5 (1-PropZTest)

Step 2: Adjust the settings to match those below..



Step 3: Press ▼ to highlight Calculate and press ENTER. The calculator returns the following screen..



Since the p-value for the test is .01846 < .05 = α, we reject H_0 and thus the data does show that more than 61% of people get more than 7 hours sleep on the weekends.

ASSIGNMENT: Do exercises 9.94-9.99 in your text.

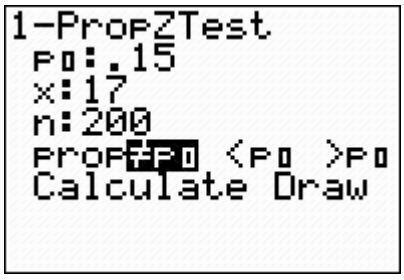
Example 9-14: Tom claims that 15% of students drive convertibles. Jody finds this hard to believe and decides to put this claim to the test. Using Dana's sample in the earlier example, can Jody refute Tom's claim? Use $\alpha = .10$

Jody's hypotheses are:

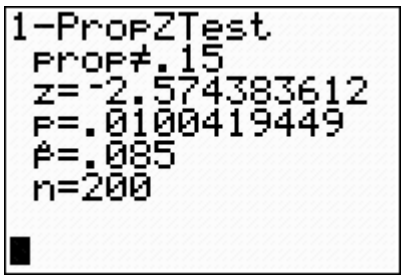
H_0: p = .15
H_A:p ≠ .15

Step 1: Step 1: Press STAT (5 (1-PropZTest)

Step 2: Adjust the settings to match those below..



Step 3: Press ⌄ to highlight Calculate and press ENTER. The calculator returns the following screen..



The p-value for the test is .0100 < .10 = α. Thus we reject H_0. The data refutes Tom's claim.

ASSIGNMENT: Do exercises 9.103-9.109 in your text.

Finding area under the χ^2 distribution using χ^2cdf

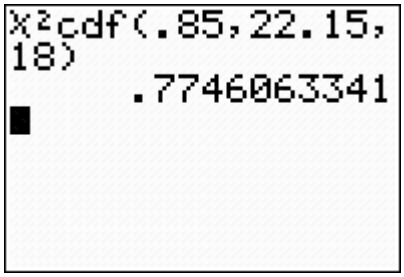
The TI-84+ can easily find area/probability under the chi-square distribution family. The syntax for using χ^2cdf is χ^2cdf(L,R,df) where L is the left bound, R the right bound and df = n-1 is the degrees of freedom

Example 9-15: Find the area under the chi-square distribution from X=.85 to X = 22.15 with 18 degrees of freedom.

Solution:

Step 1: Press 2nd VARS (DISTR), then press ⌄ to select χ^2cdf(and press ENTER

Step 2: Press . 8 5 , 2 2 . 1 5 , 1 8) ENTER. The calculator returns the following screen



ASSIGNMENT: Do exercises 9.117-9.118, 9.121-9.124 in your text.

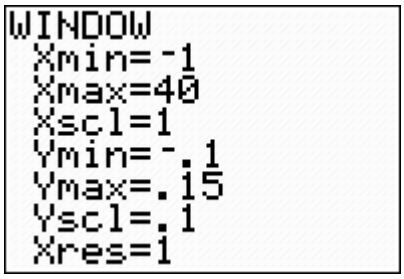
Using Shade_χ^2 on the TI-84+

It is possible to draw the χ^2pdf and to find the area at the same time using Shade_χ^2(

Example 9-16: Repeating the above example, use Shade_χ^2(to draw the function, shade the corresponding area and compute the probability.

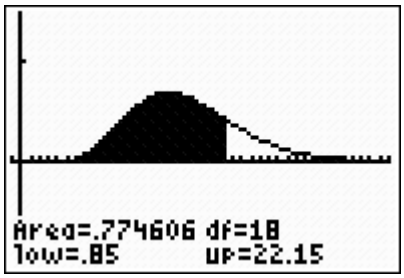
Step 1: Press 2nd PRGM ENTER ENTER to clear all drawings that may be in memory

Step 2: Press WINDOW, adjust the settings to match the next screen



Step 3: Press 2nd VARS) 3 Shade_χ^2(

Step 4: Press . 8 5 , 2 2 . 1 5 , 1 8) ENTER. The calculator displays the χ^2pdf and the solution below..



ASSIGNMENT: Do exercises 9.125-9.126 in your text.

Constructing confidence intervals for σ and σ^2 using the TI-84+

The Program CHISQRINT constructs confidence intervals for both standard deviation and variance simultaneously.

Example 9-17: A soft drink bottling company wishes to estimate the variance of fill weights. A random sample of 28 bottles from an approximately normal population yielded $s^2 = .0007$. Find the 95% confidence interval.

Step 1: Press PRGM and then ▼ to select CHISQRINT and press ENTER

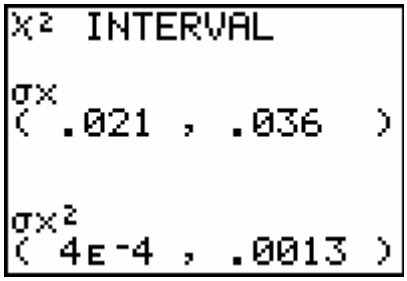
Step 2: When prompted for 1: DATA or 2: STATS, press 2 ENTER

Step 3: When prompted for S=, press 2nd x^2 ($\sqrt{}$) . 0 0 0 7 ENTER.

Note: The variance is given as .0007, but the program requires the standard deviation which is the square root of the variance.

Step 4: When prompted for N=, press 2 8 ENTER.

Step 5: When prompted for C-LEVEL, press . 9 5 ENTER. The calculator displays the confidence interval for σ and σ^2 respectively in the following screen..



Thus, the 95% confidence interval for σ^2 is (.0004, .0013)

Test of hypothesis for σ and σ^2 using the TI-84+

The program CHISQRTST is used to test hypotheses involving σ and σ^2

Example 9-18: Returning to the previous example, suppose that the bottling company would like to be reasonably certain that the variance does not exceed .0004 oz. The random sample of size 28 yields a sample variance $s^2 = .0007$. Does this data suggest that the variance is higher? Assume $\alpha = .05$

Solution: The hypotheses for this test are:

H_0: $\sigma^2 \leq .0004$
H_A: $\sigma^2 > .0004$

Step 1: Press PRGM, then ▼ to select CHISQRTST and press ENTER.

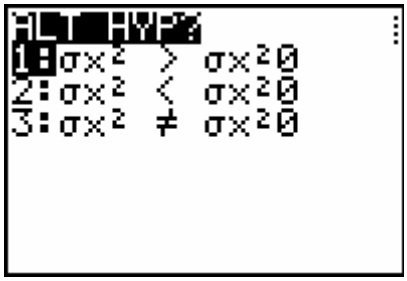
Step 2: When prompted for 1: DATA or 2: STATS, press 2 ENTER.

Step 3: When prompted for S=, press 2nd x^2 (√) . 0 0 0 7 ENTER.

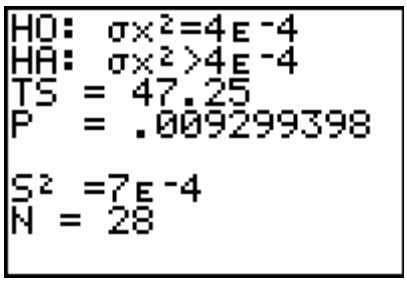
Step 4: When prompted for N=, press 2 8 ENTER

Step 5: When prompted for σ_0^2, press . 0 0 0 4 ENTER

Step 6: Your next screen will look like this..



Press 1 ENTER to indicate that this is a right tail test. The calculator returns the following..



Since the p-value for the test is .0093 < .05 = α, we reject H_0. The data suggests that the variance is significantly higher than .0004 and thus the bottling process is not properly controlled.

ASSIGNMENT: Do exercises 9.129-9.139 in your text.

Example 9-19: The manufacturer claims that a photographic chemical has a shelf life that is normally distributed about a mean of 180 days with a standard deviation of 10 days. As a user of this chemical, Fast photo is concerned that the standard deviation is different than stated. A random sample of size 12 was selected and the standard deviation was found to be 14 days. Does this sample present sufficient evidence to show that the standard deviation of the population is different from 10 days as stated by the manufacturer? Assume $\alpha = .05$

The hypotheses for the test are:

H_0: $\sigma = 10$
H_A: $\sigma \neq 10$

Step 1: Press PRGM, then ▼ to select CHISQRTST and press ENTER.

Step 2: When prompted for 1: DATA or 2: STATS, press 2 ENTER.

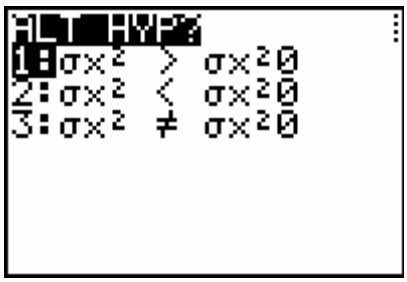
Step 3: When prompted for S=, press 1 4 ENTER

Step 4: When prompted for N=, press 1 2 ENTER

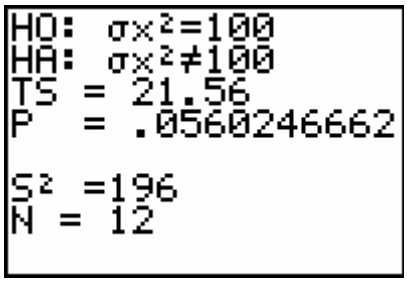
Step 5: When prompted for σ_0^2, press 1 0 x^2 ENTER

Note: Since 10 is the hypothesized value of the standard deviation, the calculator prompts the user for the variance. Thus you have to enter 10^2

Step 6: For the next prompt, consider the following screen..



Press 3. The calculator displays the result..



Although the p-value is close, it is .056 > .05 = α. Thus we fail to reject H_0 and the sample does not provide sufficient evidence to show that the standard deviation is significantly different from 10 days as stated by the manufacturer.

ASSIGNMENT: Do exercises 9.140-9.143 in your text.

Chapter 10

Inferences Involving Two Populations

Using the TI-84+ to conduct the Dependent Samples T-Test

The TI-84+ does not have a built in function for the difference in means test we refer to as the dependent samples t-test. However, we can use the T-Test with differences. Consider this example.

Example 10-1: A test was conducted to compare the wearing quality of the tires produced by two tire companies. One tire of each brand was placed on each of six test cars. The data in the below table lists the amount of wear that resulted from the test. Is there a significant difference in wear quality between the two brands of tires? Use $\alpha = .05$

	Amount of Tire Wear					
Car	**1**	**2**	**3**	**4**	**5**	**6**
Brand A	125	64	94	38	90	106
Brand B	133	65	103	37	102	115

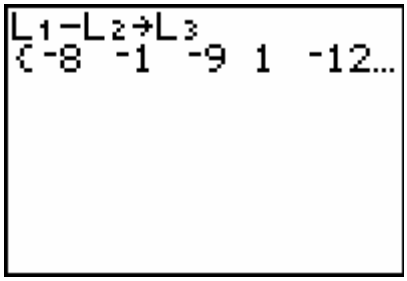
Solution: The hypotheses for the test are:

H_0: $\mu_D = 0$
H_A: $\mu_D \neq 0$

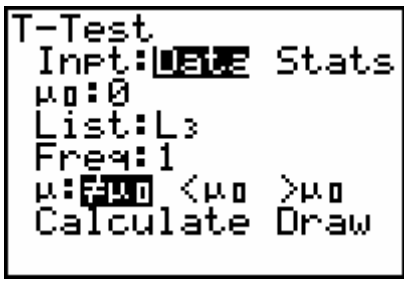
Step 1: Press STAT ENTER and input the Brand A data into list L_1, the Brand B data in list L_2.

Step 2: Press 2nd MODE (QUIT) CLEAR to exit the stat editor and to return to a blank working screen.

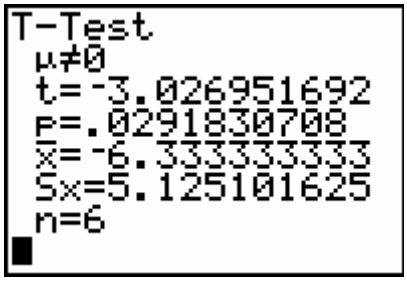
Step 3: Press 2nd 1 (L_1) − 2nd 2 (L_2) STO▶ 2nd 3 (L_3) ENTER. This stores the differences, taken in order, to list L_3 as shown in the next screen.



Step 4: Press STAT ◄ (TESTS) 2 (TTest). Adjust the settings to match those below..



Step 5: Press ▼ to highlight Calculate, then press ENTER. The calculator returns the following..



Since the p-value for the test is p = .02918 < .05 = α, we reject H_0 in favor of H_A. Thus, there is a significant difference in wear quality between the two brands.

ASSIGNMENT: Do exercises 10.26-10.33 in your text.

Example 10-2: In a study of high blood pressure and the drugs used to control it, the effect of calcium channel blockers on pulse rate was a concern. Twenty-six patients were randomly selected from a large pool of potential subjects, and their pulse rates were recorded. The patients were then given the channel blockers, and after a waiting period their pulse rates taken again. The summary statistics are listed below.

$\hat{d} = 1.07$, $s_D = 1.74$, $n = 26$

At $\alpha = .05$, does the sample data show that the calcium channel blockers lowered pulse rate?

Solution: The hypotheses for the test are:

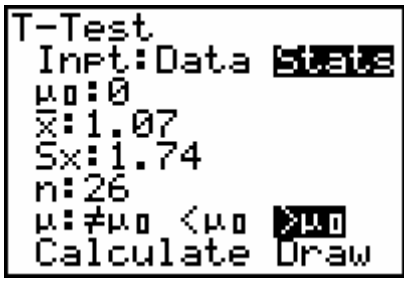
H_0: $\mu_D = 0$
H_A: $\mu_D > 0$ (Since a positive difference means that the pulse rate was higher before and lower after)

Step 1: Press STAT ENTER and input the Brand A data into list L_1, the Brand B data in list L_2.

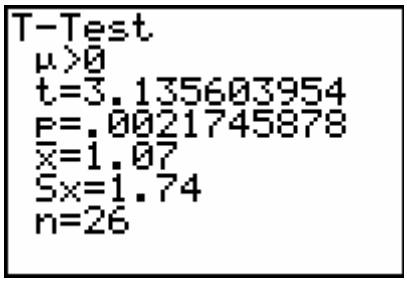
Step 2: Press [2nd] [MODE] (QUIT) [CLEAR] to exit the stat editor and to return to a blank working screen.

Step 3: Press [2nd] [1] (L_1) [−] [2nd] [2] (L_2) [STO▶] [2nd] [3] (L_3) [ENTER].

Step 4: Press [STAT] [◀] [2], adjust the settings to match those below..



Step 5: Press [▼] to highlight Calculate, then press [ENTER]. The calculator returns the following..



Since the p-value is $p = .00217 < .05 = \alpha$, we reject H_0 and thus the data shows that calcium channel blockers have lowered pulse rate significantly.

ASSIGNMENT: Do exercises 10.34-10.36, 10.38 in your text.

Using the TI-84+ to construct a Dependent Samples Confidence Interval

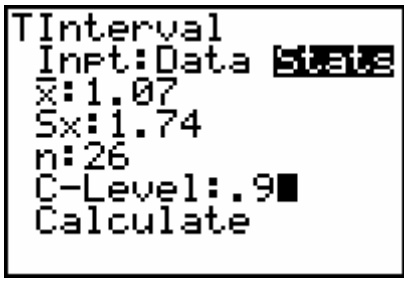
TInterval from Statistics

Example 10-3: In the previous example concerning calcium channel blockers and lowered pulse rate we had the following sample data.

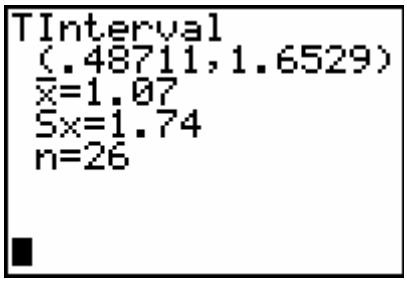
$\hat{d} = 1.07$, $s_D = 1.74$, $n = 26$

Construct a 90% confidence interval for the true difference of means.

Step 1: Press STAT ◀ 8 (TInterval). Adjust the settings to match those below..



Step 2: Press ▼ to highlight Calculate, then press ENTER. The calculator returns the following..



Thus, the 90% confidence interval is (.4871, 1.6529).

ASSIGNMENT: Do exercise 10.15 in your text.

TInterval from Data

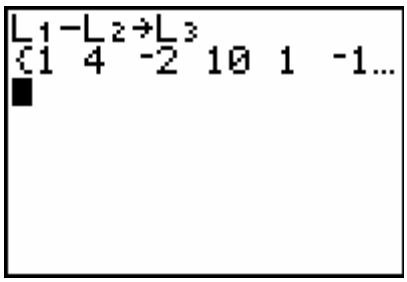
Example 10-4: Salt-free diets are often prescribed for people with high blood pressure. The data in the table below was obtained from an experiment designed to estimate the reduction in diastolic blood pressure as a result of following a salt-free diet for two weeks. Assuming diastolic readings are normally distributed, find a 98% confidence interval for the mean reduction in diastolic blood pressure.

Before	93	106	87	92	102	95	88	110
After	92	102	89	82	101	96	88	105

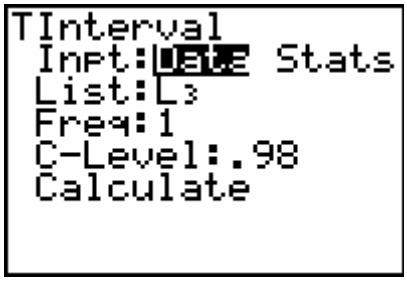
Step 1: Press STAT ENTER and input the Before data into list L_1, the After Data in list L_2.

Step 2: Press 2nd MODE (QUIT) CLEAR to exit the stat editor and to return to a blank working screen.

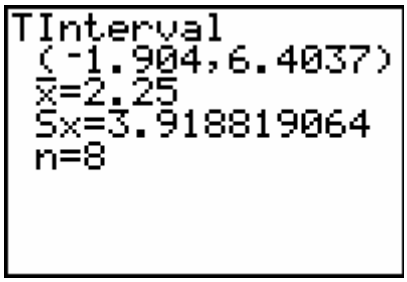
Step 3: Press 2nd 1 (L_1) − 2nd 2 (L_2) STO▶ 2nd 3 (L_3) ENTER. This stores the differences, taken in order, to list L_3 as shown in the next screen.



Step 4: Press STAT (8 to select TInterval. Adjust your settings to look like the next screen..



Step 5: Press ⌄ to highlight Calculate and press ENTER. The calculator returns the following screen..



ASSIGNMENT: Do exercises 10.16-10.22, 10.38 in your text.

Using 2SampTInterval on the TI-84+

The TI-84+ has the 2SampTInterval as one of the confidence intervals built into the STAT TESTS menu. The 2SampTInterval is called the independent samples t-test for difference of means.

Example 10-5: The heights of 20 randomly selected women and 30 randomly selected mean were independently obtained from the student body of a large college in order to estimate the difference in their mean heights. The sample data is listed below.

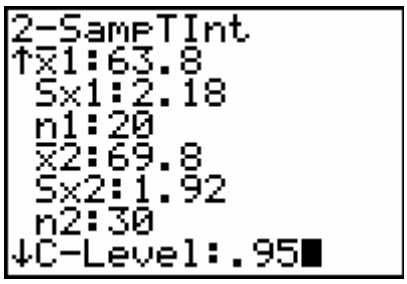
Student Heights Data

Gender	Number	Mean	Standard Deviation
Female	20	63.8	2.18
Male	30	69.8	1.92

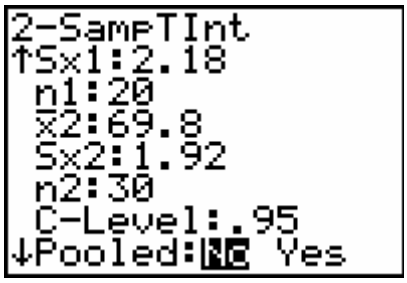
Construct a 95% confidence interval for the true difference in means.

Solution:

Step 1: Press STAT (, then press ▼ to select 0: 2-SampTInt.. and press ENTER. Adjust your settings to match those in the next screen..



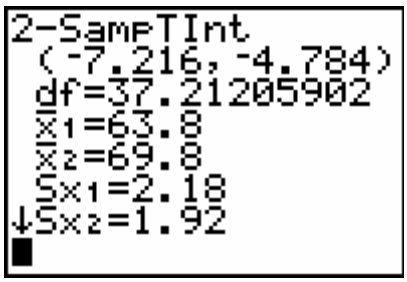
Step 2: Press ▼. This brings you to the next screen..



Step 3: Select No and press ENTER

Note: We typically use the non-pooled measure when no assumptions are made about equality of the population variances.

Step 4: Press ▼ to highlight Calculate and press ENTER. The calculator returns the following screen..



Thus, the 95% confidence interval for the difference in heights is (-7.216, -4.784). The negative indicates that the average for females is lower than for males.

ASSIGNMENT: Do exercises 10.43-10.49 in your text.

Using the TI-84+ to conduct the 2SampTTest

Example 10-6: Two independent samples of college students were randomly selected to determine if Fraternity members had a significantly lower GPA then Nonmembers. The data is summarized below.

Grade Point Average Data

Sample	Number	Mean	Standard Deviation
Fraternity Members (f)	40	2.03	0.68
Nonmembers (N)	40	2.21	0.59

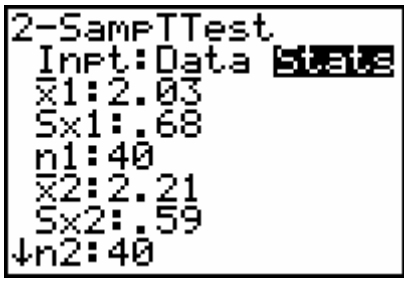
Does the sample data show that Fraternity members have a significantly lower average cumulative GPA then Nonmembers? Use $\alpha = .05$

Solution: The hypotheses for the test are:

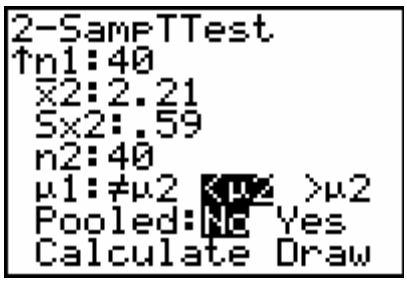
H_0: $\mu_f = \mu_N$
H_A: $\mu_f < \mu_N$

Step 1: 

(2-SampTTest). Adjust the settings to match those below..

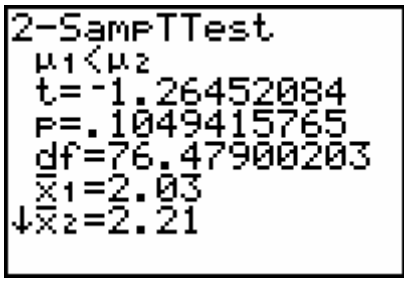


Step 2: Press  twice. This brings you to the next screen..



Adjust the statement for H_A, to "<" and make sure that the test is Non-Pooled as shown above.

Step 3: Press ⌄ to highlight Calculate and press ENTER. The calculator returns the following screen..



Since the p-value is p = .1049 > α = .05, the decision is Fail to Reject H_0. We can not conclude that Fraternity Members have a significantly lower cumulative GPA then Nonmembers.

ASSIGNMENT: Do exercises 10.60-10.69 in your text.

Example 10-7: Many students have complained that the soft-drink vending machine A dispenses a different amount than machine B. To test this belief, a student randomly selected several servings from each machine. The sample data is listed below.

Vending Machine Data

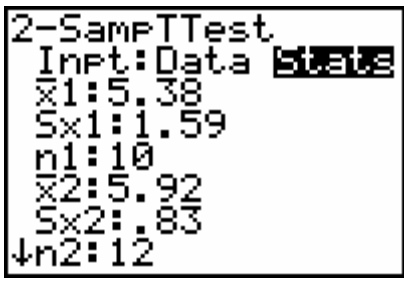
Machine	Number	Mean	Standard Deviation
A	10	5.38	1.59
B	12	5.92	0.83

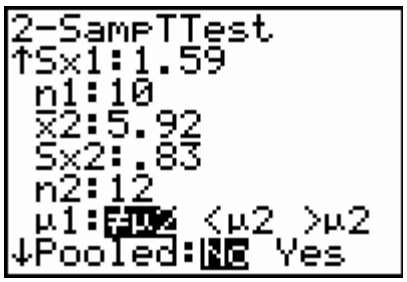
Does this data support the students contention that there is a significant difference in average fill weights between the two machines? Let α = .90

Solution: The hypotheses for this test are:

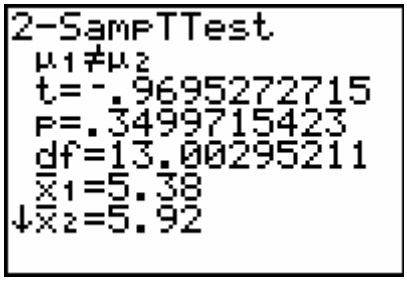
H_0: $\mu_A = \mu_B$
H_A: $\mu_A \neq \mu_B$

Step 1: STAT (4 (2-SampTTest). Adjust the settings to match those below..





Step 2: Press  to highlight Calculate and press  . The calculator returns the following screen..



The p-value is p = .3499 > .10 = α. Thus we fail to reject H_0 and the students contention is not supported by the data.

ASSIGNMENT: Do exercises 10.70-10.74 in your text.

Using the TI-84+ to construct confidence intervals for difference in proportion, 2-PropZInterval

The TI-84+ includes the 2-PropZInterval as one of the built in confidence interval functions located in the STAT TESTS menu.

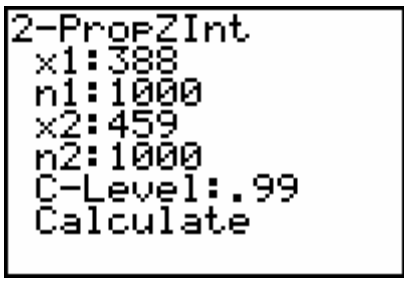
Example 10-8: In studying his campaign plans, Mr. Morris wishes to estimate the difference between men's and women's views regarding his appeal as a candidate. He asks his campaign manager to take two random independent samples. The sample data is summarized below.

Campaign Appeal Data

Gender	Number	Support
Male	1000	388
Female	1000	459

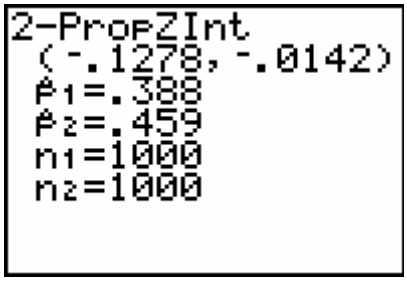
Construct a 99% confidence interval for the true difference in proportions between Male and Female voters

Step 1: Press   , then press  to select B:2-PropZInt…Adjust the settings to match those below..



Step 2: Press  to highlight Calculate and press 

. The calculator returns the following screen..



Thus, the 99% confidence interval for the true difference in proportion between male and female voters is (-.1278, -.0142). Again, the negative indicates that the percentage for males was less than that for females.

ASSIGNMENT: Do exercises 10.83-10.88 in your text.

2-PropZTest on the TI-84+

The difference in proportions test is referred to as the 2-PropZTest and is located in the STAT TESTS menu.

Example 10-9: A salesman for a new manufacturer of cell phones claims not only that they cost the retailer less but also that the percentage of defective cellular phones found among his products will be no higher than the percentage of defectives found in a competitor's line. To test this claim, the retailer took random samples of each manufacturer's product. The data is summarized below.

Cellular Phone Data

Product	Defectives	Number
Salesman's	15	150
Competitor	6	150

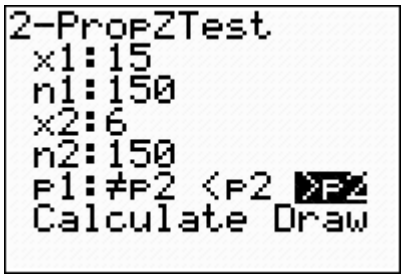
Can we reject the salesman's claim at the $\alpha = .05$ level of significance?

Solution: The hypotheses for the test are:

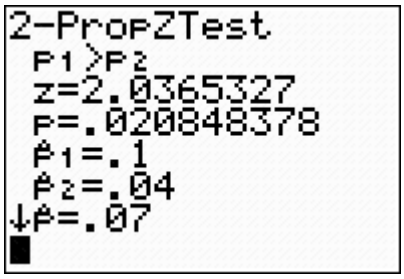
H_0: $p_s \leq p_c$

H_A: $p_s > p_c$

Step 1: Press STAT ◀ 6. Adjust the settings to match the next screen..



Step 2: Press ▼ to highlight Calculate and press ENTER. The calculator returns the following screen..



Since the p-value p=.0208 < .05 = α, we reject H_0 in favor of the alternate hypothesis. Thus, there is enough evidence to reject the salesman's claim.

ASSIGNMENT: Do exercises 10.94-10.102 in your text.

Using the TI-84+ to compute area/probability under the F-Distribution

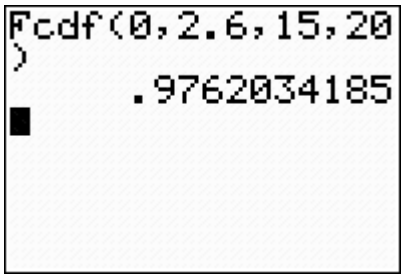
The Fcdf, located in the DISTR menu is used to compute the area/probability under the F-Distribution(s). The syntax for Fcdf is Fcdf(Left, Right, df_N, df_D) where df_N and df_D denote the degrees of freedom of the numerator and denominator respectively.

Example 10-10: Find the area under the F-Distribution from X=0 to X = 12.6 where df_N = 15 and df_D = 20

Solution:

Step 1: Press 2nd VARS 9 (Fcdf)

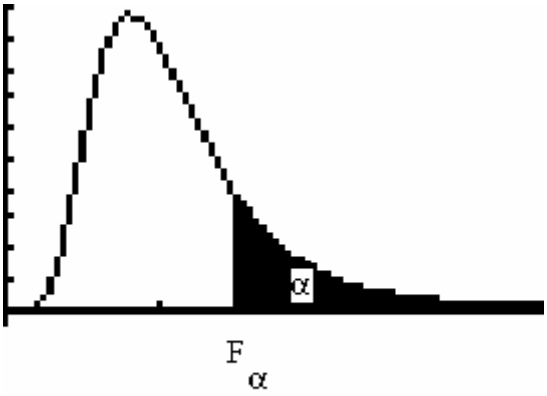
Step 2: Press 0 , 1 2 . 6 , 1 5 , 2 0 ENTER. The calculator returns the answer..



ASSIGNMENT: Do exercises 10.110, 10.111 in your text.

Using the program FSCORE to find F critical values on the TI-84+

The program FSCORE is used to find F_α critical values where α is the area in the right tail as shown in the picture below. The program prompts the user for the value of α (right tail area), the degrees of freedom for the numerator (d.f.N) and the degrees of freedom for the denominator (d.f.D)



Example 10-11: Find the $F_{.05}$ where d.f.N = 24 and d.f.D = 17

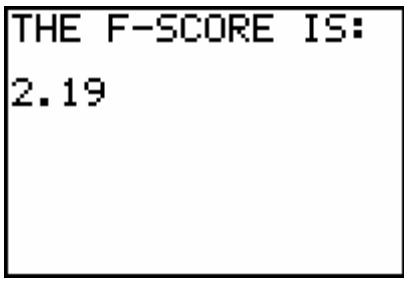
Solution:

Step 1: Press PRGM, then press ▼ to select FSCORE and press ENTER.

Step 2: When prompted for α, press . 0 5 ENTER.

Step 3: When prompted for the DF NUMERATOR? Press 2 4 ENTER.

Step 4: When prompted for the DF DENOMINATOR? Press 1 7 ENTER. The calculator returns the following screen..



ASSIGNMENT: Do exercises 10.110-10.111 in your text.

The 2-SampFTest on the TI-84+

The 2-SampFTest is the hypothesis test for difference in two variances or standard deviations. It is located in the STAT TESTS menu.

Example 10-12: A medical researcher would like to determine whether the variance of heart rates of smokers is significantly different from the variance of non-smokers. Two samples are selected and the data is summarized below. At $\alpha = .05$, can we conclude that there is a significant difference?

	Smokers	Non-Smokers
n	26	18
s^2	36	10

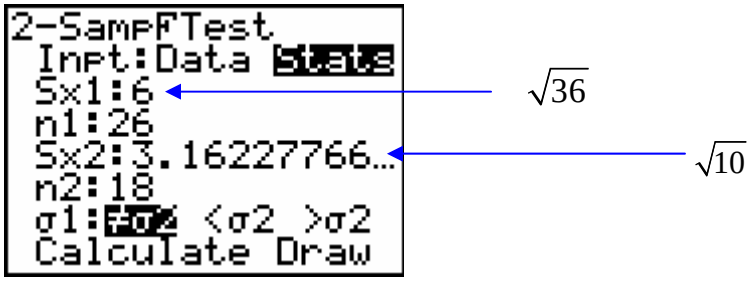
Solution: The hypotheses for the test are:

$H_0: \sigma_1^2 = \sigma_2^2$
$H_A: \sigma_1^2 \neq \sigma_2^2$

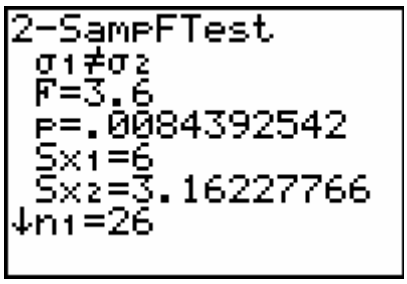
To conduct the test on the calculator we will use the following steps.

Step 1: Press CLEAR STAT (, then press ^ to select D: 2-SampFTest and press ENTER.

Step 2: Adjust the settings on screen to match those below..



Step 3: Press  to highlight Calculate and press  . The calculator returns the following screen..



Since the p-value for the test is p = .0084 < .05 = α, we reject H_0 and thus we can conclude that there is a significant difference in variances.

ASSIGNMENT: Do exercises 10.112-10.114 in your text.

Example 10-13: The soft-drink bottling company is interested in a new high speed machine. The manufacturer's claim is that the new machine fills bottles with no greater variance than the older machine that the company has. Samples are taken and the data summarized below.Assume that the fill weights are normally distributed for both machines. Can we reject the manufacturer's claim at the α = .01 level of significance?

Variances of Fill Weights

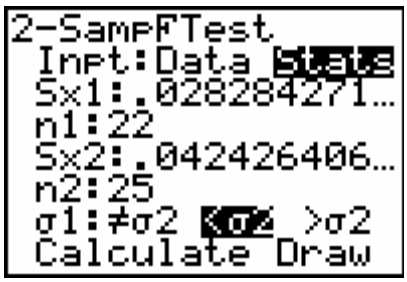
Sample	n	s^2
Older Machine	22	0.0008
New High-Speed Machine	25	0.0018

Solution: The hypotheses for the test are:

H_0: $\sigma^2_{old} \geq \sigma^2_{new}$ (Variance of new machine is less than or equal to the old)
H_A: $\sigma^2_{old} < \sigma^2_{new}$

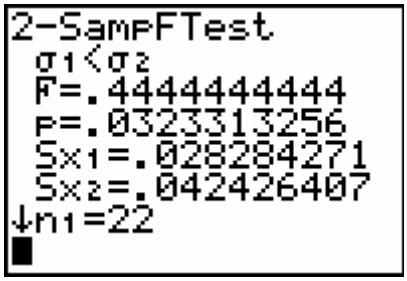
Step 1: Press    , then press  to select D: 2-SampFTest and press  .

Step 2: Adjust the settings on screen to match those below..



Step 3: Press  to highlight Calculate and press 

. The calculator returns the following screen..



Since the p-value for the test p= .03233 > .01 = α, we fail to reject H_0. From this data we can not reject the manufacturer's claim.

ASSIGNMENT: Do exercises 10.119-10.122, 10.125-10.129 in your text.

Chapter 11

Applications of the Chi-Square Distribution

The Chi-Square Goodness of Fit Test on the TI-84+

The TI-84+ has the Chi-Square Goodness of Fit (χ^2-GOF) Test built in and is found in the 

TESTS menu. Essentially, the Chi-Square Distribution is used to test for differences in 3 or more proportions.

(Note: The program GOODNESS is basically the same program and can be used in place of χ^2-GOF)

Multinomial Hypothesis Tests with Equal Expected Frequencies

Example 11-1: 100 consumers were randomly selected and asked "What flavor of soft-drink do you prefer?". The responses are listed below. Does this data suggest that consumers have a preference? Test at the $\alpha = .05$

Frequency	Cherry	Strawberry	Orange	Lime	Grape
Observed	32	28	16	14	10

Solution: Since there are 5 categories, if there was no preference for flavor of soda we would expect 100/5 = 20 people to fit in each category, as shown below

Frequency	Cherry	Strawberry	Orange	Lime	Grape
Observed	32	28	16	14	10
Expected	20	20	20	20	20

The Hypotheses for the test are:

H_0: Consumers show no preference
H_A: Consumers show a preference

Step 1: Press 

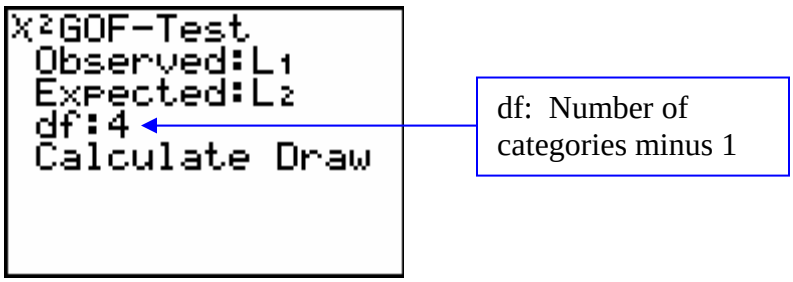
and input the observed frequencies in list L_1 and the expected frequencies in list L_2

Step 2: Press 

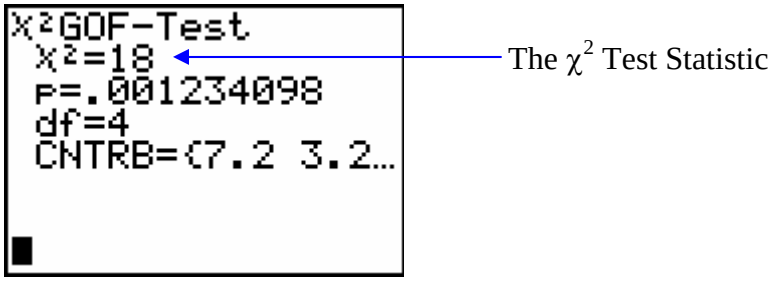
Step 3: Press 

, then press  to select D: χ^2-GOF and press 

. Adjust your settings to match those below..



Step 4: Press  to highlight Calculate and press  . The calculator returns the following screen..



Since the p-value for the test is p = .00123 < .05 = α, we reject H_0 and thus we can conclude that consumers show a preference.

ASSIGNMENT: Do exercises 11.14-11.19 in your text.

Example 11-2: Suppose we would like to test whether a die is "unfair". We roll the die 60 times and the observed frequencies are listed below. Can we conclude that the die is "unfair".

60 Rolls of a Die

#	1	2	3	4	5	6
Observed	7	12	10	12	8	11

Solution: First we need to compute the Expected values. Since we "expect" 1/6 x 60 = 10 in each category we obtain the following..

60 Rolls of a Die

#	1	2	3	4	5	6
Observed	7	12	10	12	8	11
Expected	10	10	10	10	10	10

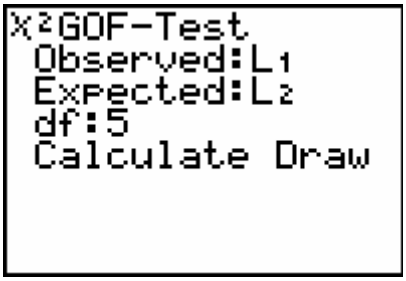
The Hypotheses for the test are:

H_0: The die is "fair" i.e. the frequencies are all equal
H_A: The die is "unfair" i.e. at least one pair of frequencies is significantly different

Step 1: Press STAT ENTER and input the observed frequencies in list L_1 and the expected frequencies in list L_2

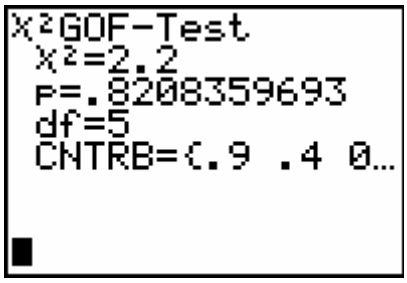
Step 2: Press 2nd MODE CLEAR

Step 3: Press STAT ◄, then press ▲ to select D: χ^2-GOF and press ENTER. Adjust your settings to match those below..



Note: There are 6 categories, thus df=5.

Step 4: Press ▼ to highlight Calculate and press ENTER. The calculator returns the following screen..



Since the p-value is $p = .8208 > .05 = \alpha$, we fail to reject H_0. We can not conclude that the die is "unfair"

Example 11-3: College students have regularly insisted on freedom of choice when they register for courses. This semester there were 7 sections in a particular math course meeting at different times of the day. 119 students self-registered for the sections as shown in the table below.

Section Enrollment Data

Section	1	2	3	4	5	6	7	Total
Number of Students	18	12	25	23	8	19	14	119

Do the data indicate that students show a preference? Test at $\alpha = .05$

Solution: Compute the expect values. Since there were 7 sections, we would expect 119/7 = 17 students in each section if they did not show a preference. As shown in the table below

Section Enrollment Data

Section	1	2	3	4	5	6	7	Total
Number of Students (Observed)	18	12	25	23	8	19	14	119
Expected	17	17	17	17	17	17	17	119

The Hypotheses for the test are:

H_0: Students show no preference. i.e. frequencies are all equal
H_A: Students who a preference. There is at least one pair significantly different

Step 1: Press 

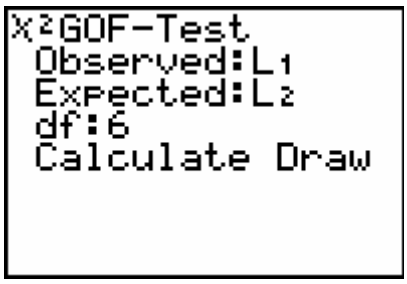
and input the observed frequencies in list L_1 and the expected frequencies in list L_2

Step 2: Press 

Step 3: Press 

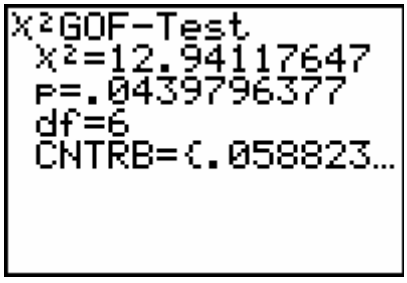
, then press 
to select D: χ^2-GOF and press 

. Adjust your settings to match those below..



Step 4: Press 
to highlight Calculate and press 

. The calculator returns the following screen..



Since the p-value for the test is $p = .044 < .05 = \alpha$, we reject H_0 and conclude that students do show a preference.

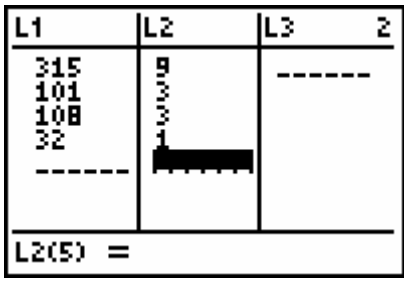
Multinomial Hypothesis Tests with Un-Equal Expected Frequencies

The program EXPECTED will calculate the expected frequencies list.

Example 11-4: The Mendelian theory of inheritance claims that the frequencies of round and yellow, wrinkled and yellow, round and green, and wrinkled and green peas will occur in the ratio 9:3:3:1 when two specific varieties of peas are crossed. In testing this theory, Mendel obtained frequencies of 315, 101, 108 and 32 respectively. Do these data provide sufficient evidence to reject the theory at $\alpha = .05$?

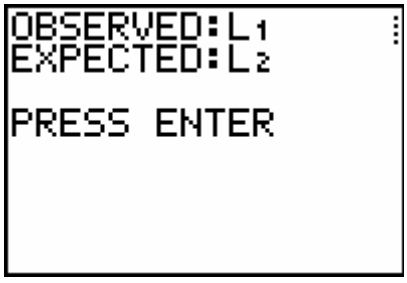
First, we have to compute the expected values using the program EXPECTED

Step 1: Press STAT ENTER, input the observed data into list L_1 and the frequencies 9,3,3,1 into list L_2



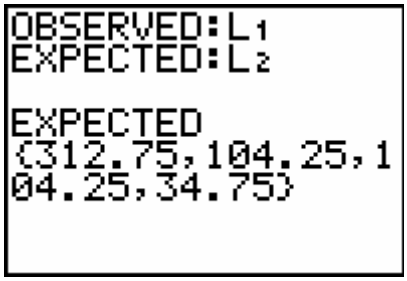
Step 2: Press 2nd MODE CLEAR to exit the Stat Editor

Step 3: Press PRGM, then press ▼ to select EXPECTED and press ENTER twice. This will bring you to the next screen..



Step 4: Press ENTER as instructed and the next screen appears..

Step 5: Since we entered the frequencies rather than percentages in list L_2, press ▼ to highlight **FREQ** and press ENTER. The calculator returns the following screen..



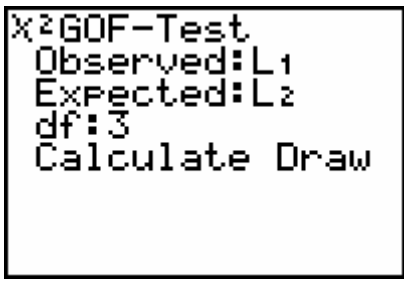
Note: The EXPECTED Values are stored in list L_3

Now we are ready to conduct the test of hypothesis regarding Mendel's theory.

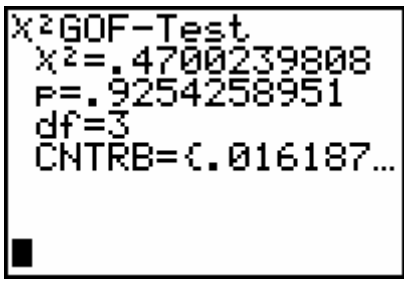
The Hypotheses for the test are:

H_0: The observed frequencies fit the Expected ratio
H_A: The Observed Frequencies don't fit the Expected ratio

Step 1: Press STAT ◄, then press ▲ to select D: χ^2-GOF and press ENTER. Adjust your settings to match those below..



Step 2: Press ▼ to highlight Calculate and press ENTER. The calculator will display the result..



Since the p-value for the test is $p = .9254 > .05 = \alpha$, we fail to reject H_0 and thus Mendel's theory is not refuted.

ASSIGNMENT: Do exercises 11.20-11.24 in your text.

Example 11-5: It is typical when hiring for a position to look at the pool of applicants and decide on those who would be best to interview based on predefined criteria. Due to Affirmative Action quotas in the 1980's to 1990's some of these criteria included gender, age, and ethnicity to name a few. Suppose that a position is to be filled in a certain geographical location. Suppose further that it is known that we have the following breakdown based on ethnicity in this location.

White (Non-Hispanic)	54%
Hispanic	31%
African-American	13%
Asian	2%

The board would like to have a pool of applicants that reflects this population or "fits" this data well. Suppose that in 60 applicants we arrive at the following data. Should this pool be rejected as a poor fit at $\alpha = .01$? In that case applicant screening would be repeated.

White (Non-Hispanic)	Hispanic	African-American	Asian
26	18	10	6

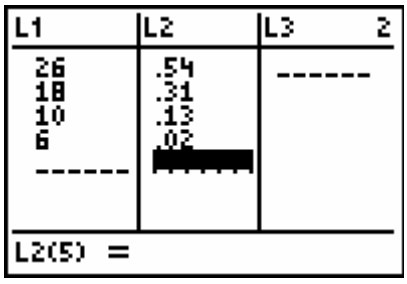
Our hypotheses for this test would be..

H_0: The pool fits the population. i.e. Observed = Expected

H_A: The pool does not fit the population. i.e. Observed ≠ Expected

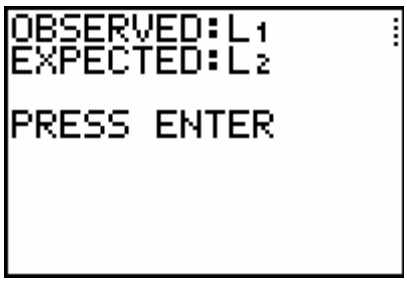
First, we have to compute the expected values using the program EXPECTED

Step 1: Press STAT ENTER, input the observed data into list L_1 and the percentages into list L_2 as shown in the next screen..



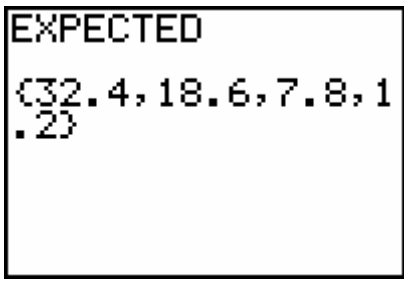
Step 2: Press 2nd MODE CLEAR to exit the Stat Editor

Step 3: Press PRGM, then press ▼ to select EXPECTED and press ENTER twice. This will bring you to the next screen..



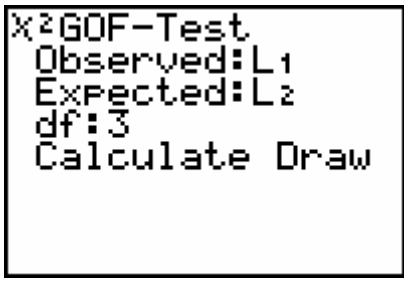
Step 4: Press ENTER as instructed and the next screen appears..

Step 5: Since we entered the expected values as percentages, press ENTER. The calculator returns the following screen..

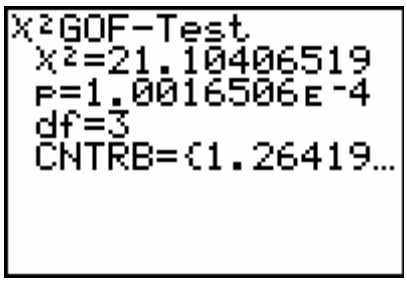


Note: The EXPECTED data is stored in list L_2 where it is ready for use in the χ^2-GOF Test.

Step 1: Press STAT, then press ◄ ▲ to select D: χ^2-GOF and press ENTER. Adjust your settings to match those below..



Step 2: Press ▼ to highlight Calculate and press ENTER. The calculator will display the result..



Since the p-value for this test is $p = 1.00 \times 10^{-4} < .05 = \alpha$, we reject H_0 and conclude that the pool doesn't fit the percentages in the population.

Using the TI-84+ with contingency tables - test for independence

Another application of the Chi-Square distribution is to test variables for independence.

Example 11-6: Each person in a group of 300 students was identified as male or female and then asked whether he or she preferred taking liberal arts courses in the area of math/science, social science, or the humanities. The following 2 x 3 contingency table yields the results..

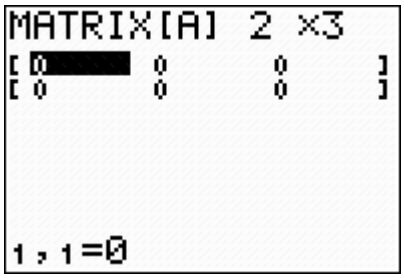
Gender and Subject Preference

	Subject			
Gender	Math/Science	Social Science	Humanities	Total
Male	37	41	44	122
Female	35	72	71	178
Total	72	113	115	300

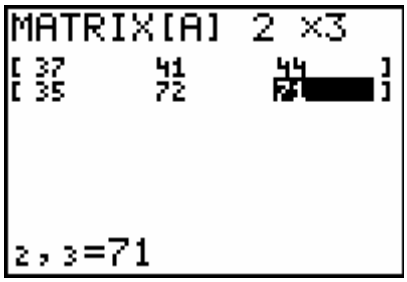
Does this data suggest that gender and subject are dependent? Test at $\alpha = .05$ level of significance

Step 1: The TI-84+ will compute the expected values automatically. It is only necessary to input the observed data into Matrix [A]. Press  (MATRIX)  .

Step 2: The calculator first prompts the user for the dimensions of the matrix in Edit mode. Since this is a 2 x 3 contingency table (# rows x # columns) where the total column and row don't get counted, we press  . This brings us to the next screen..

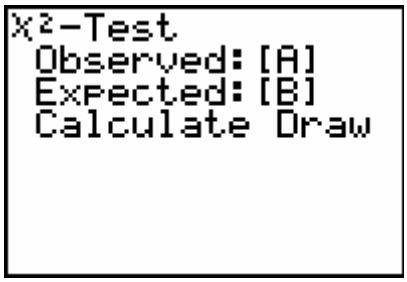


Step 3: Input the data into Matrix [A] as shown..



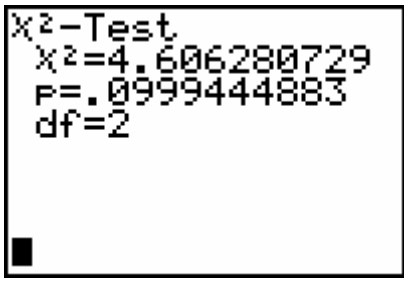
Step 4: Press 2nd MODE CLEAR to exit the MATRIX Editor

Step 5: Press STAT ◄, then press ▲ to select C: χ^2-Test and press ENTER. This brings you to the next screen..



Note: Although we haven't entered anything into Matrix[B], the calculator will compute this for us

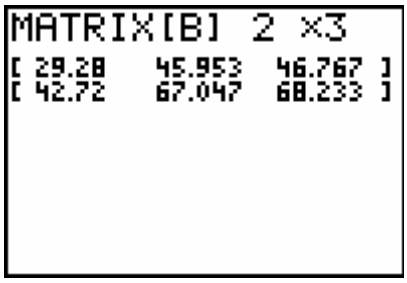
Step 6: Press ▼ to highlight Calculate and press ENTER. The calculator returns the following..



Since the p-value for the test is $p = .0999 > .05 = \alpha$, we fail to reject H_0. Thus we have failed to prove that the variables are significantly dependent.

ASSIGNMENT: Do exercises 11.32-11.37 in your text.

Note: We can obtain the Expected Matrix[B] by pressing   , the Matrix Editor displays [B] below for this example..



Using the TI-84+ to conduct the Homogeneity of Proportions Test

Another type of test is called the Homogeneity of Proportions test. We use contingency tables as in the previous examples but now the row totals are fixed. Otherwise, this test is very similar to the test for independence discussed earlier.

Example 11-7: A poll of registered voters was taken with 200 urban, 200 suburban and 100 rural residents randomly selected. They were asked if they favored or opposed the governor's proposed legislation. The 3 x 2 contingency table is summarized below..

	Governor's Proposal		
Residence	Favor	Oppose	Total
Urban	143	57	200
Suburban	98	102	200
Rural	13	87	100

Does the data show that residents have a significant difference of opinion based on their residence? Use $\alpha = .05$

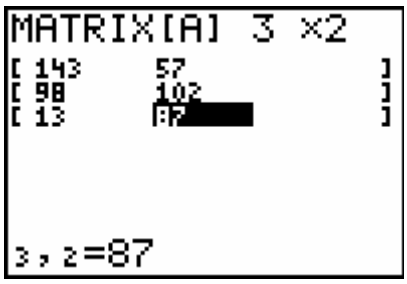
The hypotheses for the test are:

H_0: proportions are all equal
H_A: proportions are not all equal

Step 1: We need to put the 3 x 2 contigency table into Matrix[A]. Press  (MATRIX)  .

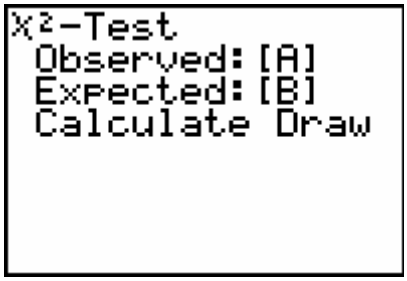
Step 2: Press  to set the dimensions of [A] to 3 x 2

Step 3: Input the row and column data as shown in the next screen..

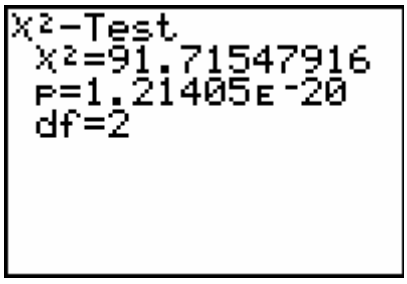


Step 4: Press 2nd MODE CLEAR to exit the MATRIX Editor

Step 5: Press STAT (, then press ^ to select C: χ^2-Test and press ENTER. This brings you to the next screen..



Step 6: Press v to highlight Calculate and press ENTER. The calculator will display the result..



Since the p-value is $p = 1.21 \times 10^{-20} < .05 = \alpha$, we reject H_0 and conclude that there is a significant difference in proportions of residents who favor the governor's proposal.

ASSIGNMENT: Do exercises 11.38-11.42 in your text.

Chapter 12

Analysis of Variance

Many experiments are conducted to determine the effect of different levels of a test factor on a response variable. Analysis-of-variance (ANOVA) is a statistical technique used to test equality of population means. The TI-84+ built-in function ANOVA may be used to compare the means in up to 20 populations, or factor levels. The assumptions for ANOVA are:

- Each population is normally distributed.
- Each population has the same variance
- The samples are selected independently from each population.

The hypothesis test for a one-way ANOVA is based on an F distribution that compares the variation between the samples to the variance within the samples.

Example 12-1: A recent study compared the number of calories in certain kinds of diet snack foods. The researcher randomly selected 50 snacks and divided them into four categories: crunchy choices, salty sensations, creamy concoctions, and sinless sweets. The calorie content for each snack was measured and the results are given in the table below. Is there any evidence to suggest a difference in the mean calorie content for the four different snack food categories? Use $\alpha = .01$.

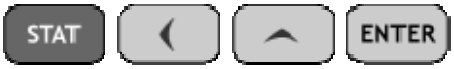
Snack Food Category							
Crunchy Choices		Salty Sensations		Creamy Concoctions		Sinless Sweets	
89	99	100	14	99	100	90	96
91	76	32	52	97	50	99	50
90	90	60	59	65	94	94	70
97	52	65	70	79	100	91	90
93	80	100	5	99	70	100	75
82	90			90	90	54	100
						87	70
						88	88

The hypotheses for the test are:

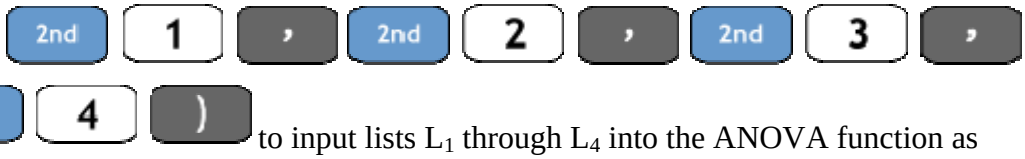
H_0: $\mu_1=\mu_2=\mu_3=\mu_4$
H_A: Not all the means are equal

Step 1: Press STAT ENTER and input the data for the four snack food categories into lists L_1 through list L_4

Step 2: Press 2nd MODE CLEAR.

Step 3: Press 

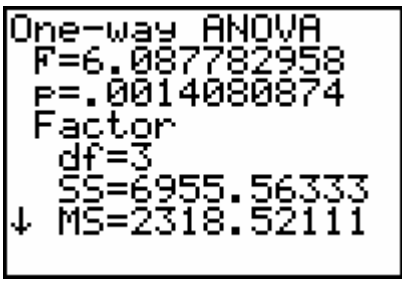
(ANOVA)

Step 4: Press 

to input lists L_1 through L_4 into the ANOVA function as shown in the next screen..

Step 5: Press 

. The calculator returns the following screen..



Since the p-value for the test is $p = .0014 < .01 = \alpha$, we reject H_0 and conclude that the average calories are not the same across the four snack food groups.

ASSIGNMENT: Do exercises 12.25-12.36 in your text.

Example 12-2: The temperature at which a manufacturing plant is maintained is believed to affect the rate of production in the plant. The data in the following table are the production totals at three different temperature levels obtained randomly.

Temperature and Production Data

Temperature Levels		
68°	72°	76°
10	7	3
12	6	3
10	7	5
9	8	4

Does the data suggest that temperature has a significant effect on the production level? Test at $\alpha = .05$

The hypotheses for the test are:

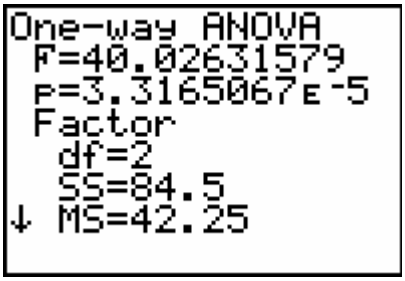
H_0: $\mu_1=\mu_2=\mu_3$
H_A: Not all the means are equal

Step 1: Press STAT ENTER and input the data for the three temperature columns into lists L_1 through L_3

Step 2: Press 2nd MODE CLEAR.

Step 3: Press STAT ◀ ▲ ENTER (ANOVA)

Step 4: Press 2nd 1 , 2nd 2 , 2nd 3 to input lists L_1 through L_3 into the ANOVA function, then press ENTER. The calculator returns the following..



Since the p-value is $p = 3.32 \times 10^{-5} < .05 = \alpha$, we reject H_0 and conclude that temperature does affect production

Example 12-3: A rifle club performed an experiment on a randomly selected group of first-time shooters. The purpose of the experiment was to determine whether shooting accuracy is affected by the method of sighting used: only right eye open, only left eye open, both eyes open. Fifteen first-time shooters were selected and divided into three groups. Each group experienced the same training and practicing procedures with one exception: the method of sighting that they used. After completing training, each student was given the same number of rounds and asked to shoot at a target. Their scores are listed in the table below.

Target Shooting Data

Method of Sighting		
Right Eye	Left Eye	Both Eyes
12	10	16
10	17	14
18	16	16
12	13	11
14		20
		21

At $\alpha = .05$, is there sufficient evidence to reject the claim that the three methods of sighting are equally effective?
The hypotheses for the test are:

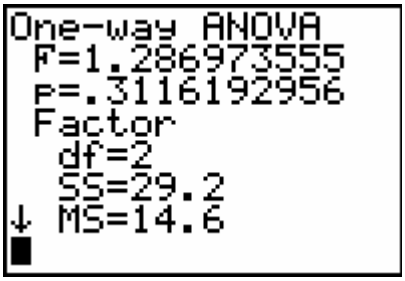
H_0: $\mu_1=\mu_2=\mu_3$
H_A: Not all the means are equal

Step 1: Press STAT ENTER and input the data for the three method of sighting columns into lists L_1 through L_3

Step 2: Press 2nd MODE CLEAR.

Step 3: Press STAT (^ ENTER (ANOVA)

Step 4: Press 2nd 1 , 2nd 2 , 2nd 3 to input lists L_1 through L_3 into the ANOVA function, then press ENTER. The calculator returns the following..



Since the p-value for the test is $p = .3116 > .05 = \alpha$, we fail to reject H_0 and thus we can not reject the claim that the three sighting methods are equally effective.

Chapter 13

Linear Correlation and Regression Analysis

Using the TI-84+ to find covariance

The Program COVAR is used to find the covariance of a set of ordered pair data. Consider the following example:

Example 13-1: Professional golfers are commonly rated on the basis of how much money they earn while playing on the tour. They are also given a world point raking that considers their performances for the past two years, with an emphasis on the last year. Money winnings in 1998 through August of that year and the world point rankings for 16 players are shown in the table below. Calculate the covariance and the linear correlation coefficient between money earnings and the world point earnings and points rankings, then graph the scatterplot of the data.

Player	Money Earnings ($)	Points
David Duval	1,668,678	9.42
Mark O'Meara	1,523,295	9.51
Fred Couples	1,495,698	7.50
Tiger Woods	1,388,542	11.82
Jim Furyk	1,292,346	6.59
Justin Leonard	1,253,129	7.14
Lee Janzen	1,052,622	5.45
Mark Calcavecchia	910,254	5.51
Scott Hoch	878,623	5.76
Phil Mickelson	873,477	7.61
Jesper Parnevik	857,956	5.73
Tom Watson	822,385	5.47
Davis Love III	815,766	10.59
Tom Lehman	812,114	5.91
Vijay Singh	745,661	6.25
Nick Price	484,737	7.94

Step 1: Press 

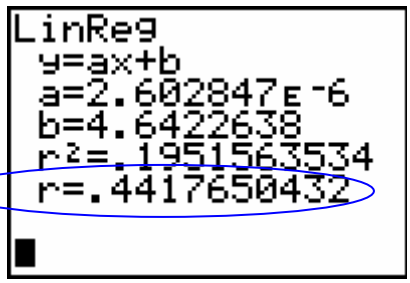
, input the Earnings data into list L_1 and the Points data into list L_2

Step 2: Press PRGM, then press ▼ to select COVAR and press ENTER.

Step 3: Follow the directions in the program, the calculator will return the answer as shown below..

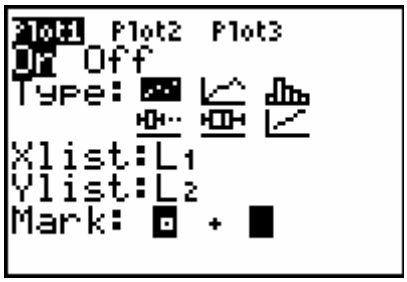
Step 4: To compute the correlation coefficient, press STAT ▶ 4 4: LinReg(ax+b)

Step 5: Press 2nd 1 (L_1) , 2nd 2 (L_2) ENTER. The calculator displays the line of best fit and the correlation coefficient (r) as shown in the next screen..

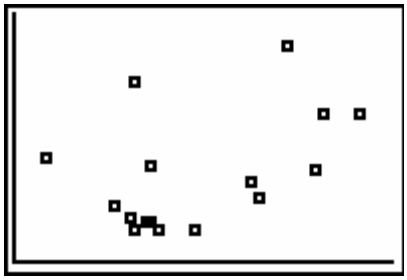


The coefficient of linear correlation indicates only a weak positive linear relationship between money earnings and world point rankings.

Step 6: To graph the scatterplot, press 2nd Y= ENTER to enter the Plot1 menu. Adjust the settings to match those below..



Step 7: Press ZOOM 9 (9:ZoomStat). The graph of the scatterplot is shown below..



Thus, both the scatterplot and the correlation coefficient show that there is a weak (at best) positive linear relationship between the variables Earnings and Points.

ASSIGNMENT: Do exercises 13.7-13.8, 13.13 in your text.

Inference about the linear correlation coefficient ρ using the TI-84+

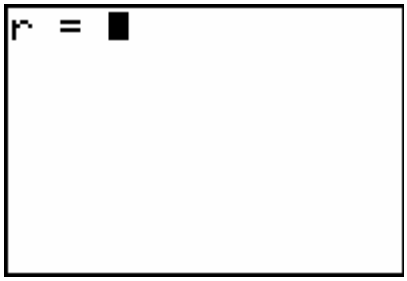
The calculator program CORRTEST will compute a confidence interval for r, conduct a hypothesis test based on a *t* distribution, or conduct a more general hypothesis test based on a standard normal distribution.

Constructing a confidence interval for ρ using the TI-84+

Example 13-2: A random sample of 15 ordered pairs of data has a calculated value of r = 0.35. Find a 95% confidence interval for ρ

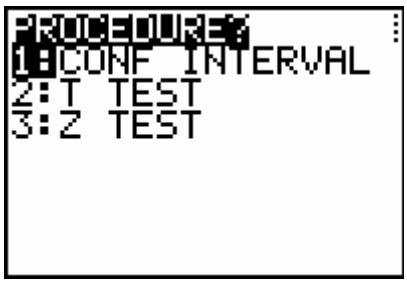
Step 1: Press PRGM, then press ▼ to select CORRTEST and press ENTER, then press ENTER again. This brings you to the following screen..

Step 2: Press 2. This brings you to the next screen..



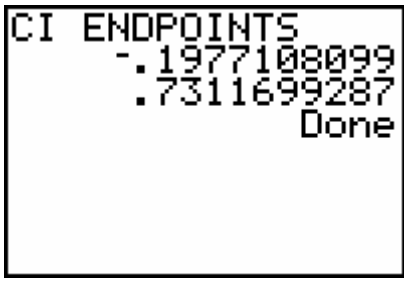
Step 3: When prompted for r, press [.] [3] [5] [ENTER]

Step 4: When prompted for n, press [1] [5] [ENTER]. This brings you to the next screen..



Step 5: Press [1] [ENTER] to select the Confidence Interval Option.

Step 6: When prompted for C-Level: press [.] [9] [5] [ENTER]. The confidence interval for ρ is displayed..



ASSIGNMENT: Do exercises 13.16, 13.18-13.24 in your text.

Conducting a test of hypothesis about the linear correlation coefficient using the TI-84+

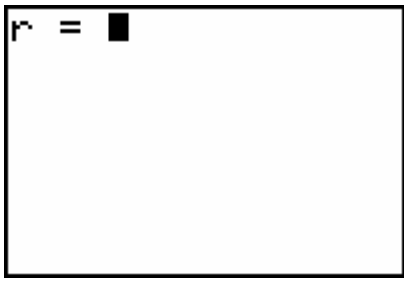
Example 13-3: In a study of 15 randomly selected ordered pairs, r = 0.548 Is this linear correlation coefficient significantly different from zero at the $\alpha = .02$ level of significance?

Solution: The hypotheses for the test are:

H_0: $\rho = 0$
H_A: $\rho \neq 0$

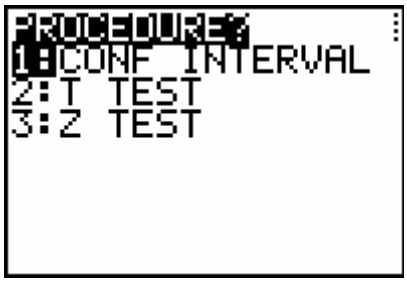
Step 1: Press [PRGM], then press [▼] to select CORRTEST and press [ENTER], then press [ENTER] again. This brings you to the following screen..

Step 2: Press 2. This brings you to the next screen..

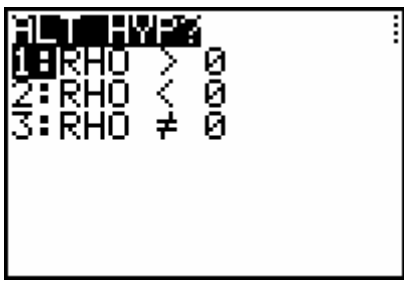


Step 3: When prompted for r, press . 5 4 8 ENTER

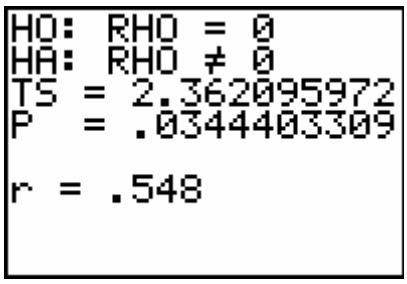
Step 4: When prompted for n, press 1 5 ENTER. This brings you to the next screen..



Step 5: Press 2 ENTER since the data set is small and nothing about the population being bivariate normal is specified. This brings you to the next screen..



Step 6: Press 3 ENTER to select the alternate hypothesis as ≠. The calculator returns the following..



Since the p-value for this test is p = .0344 > .02 = α, we fail to reject H_0 and we conclude that ρ is not significantly different from zero.

ASSIGNMENT: Do exercises 13.32-13.40 in your text.

Example 13-4: The Test-Retest Method is one way of establishing the reliability of a test. The test is administered and then, at a later date, the same test is readministered to the same individuals. The correlation coefficient is computed between the two sets of scores. The following test scores were obtained in a Test-Retest.

First Score	75	87	60	75	98	80	68	84	47	72
Second Score	72	90	52	75	94	78	72	80	53	70

Is the linear correlation coefficient significantly greater than zero at α= .05?

Solution: The hypotheses for the test are:

H_0: ρ = 0
H_A: ρ > 0

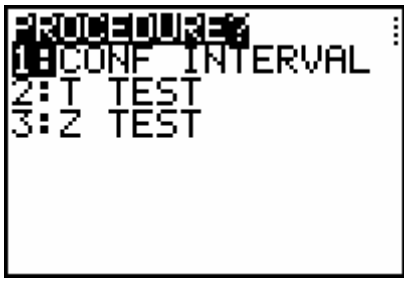
Step 1: Press STAT ENTER, input the First Score data into list L_1 and the Second Score data into list L_2

Step 2: Press PRGM, then press ▼ to select CORRTEST and press ENTER, then press ENTER again. This brings you to the following screen..

Step 3: Press ENTER to select the DATA option

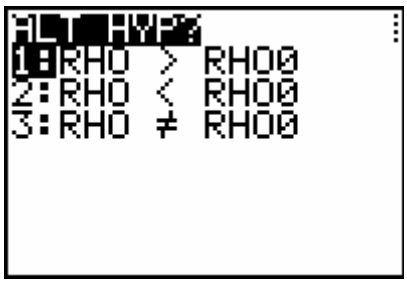
Step 4: When prompted for XLIST: Press 2nd 1 ENTER

Step 5: When prompted for YLIST: Press 2nd 2 ENTER. This brings you to the next screen..

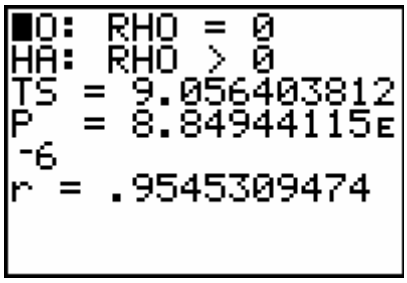


Step 6: Press 2 ENTER to select T test.

Step 7: When prompted for ρ_0 (Rho0), press 0 ENTER. This brings you to the next screen..



Step 8: Press ENTER to select > for the alternate hypothesis. The calculator returns the solution..



Since the p-value for the test is $p = 8.85 \times 10^{-6}$, we reject H_0. Thus, the linear correlation coefficient is significantly greater than zero.

Inference about the slope of the regression line using the TI-84+

Using the LinRegTInterval on the TI-84+

Example 13-5: Suppose you move to a new city and take a job. You would like to know how long it will take you to drive to work each morning. Your employer provides you with a random sample of data to help you answer the question as shown in the table below.

Co-Worker	Miles(x)	Minutes(y)
1	3	7
2	5	20
3	7	20
4	8	15
5	10	25
6	11	17
7	12	20
8	12	35
9	13	26
10	15	25
11	15	35
12	16	32
13	18	44
14	19	37
15	20	45

Find the line of best fit and the variance y about the line of best fit. Then construct the 95% confidence interval for the slope β of the line of best fit for the population and interpret its meaning.

Solution:

Step 1: Press 

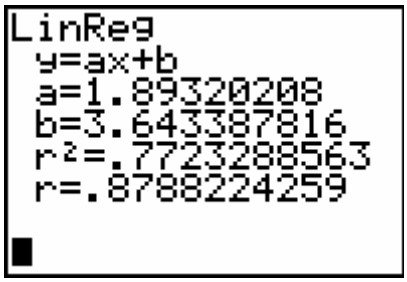
, input the Miles data into list L_1 and the Minutes data into list L_2

Step 2: Press 

to exit the Stat Editor and return to a blank screen

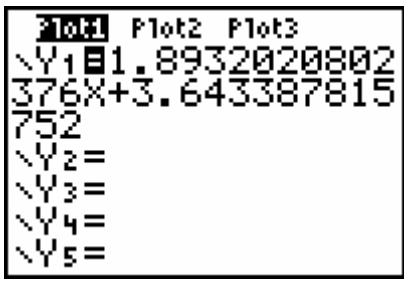
Step 3: Press 

to compute the line of best fit. This brings you to the next screen..

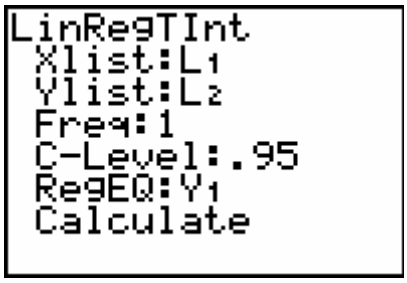


Step 4: Press 

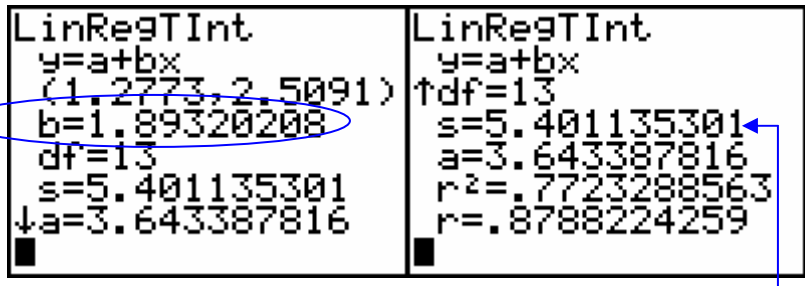
. This pastes the regression equation above into Y_1 as shown below..



Step 5: Press STAT (, then press ⌄ to select LinRegTInt… and press ENTER. Adjust your settings to match the screen below..



Step 6: Press ⌄ to select Calculate and press ENTER. The calculator returns the following..



Notice that the line is given as y = a + bx rather than y = ax + b as we computed above. This switch is done by the program so it is important that you realize which letter represents the slope of the regression line. In algebra, the coefficient of the linear term is the slope, which is now b. Also note that the confidence interval is clearly constructed around the value 1.89 and not 3.64

To compute the variance about the line of best fit we find $s^2 = 5.4011^2 = 29.17$

Step 7: Note the 95% confidence interval is given as (1.2773, 2.5091). Thus, we are 95% sure that this interval contains the slope of the true regression line through all data from the population from which this sample of size 15 was drawn is 1.89 ± .62 minutes per mile.

ASSIGNMENT: Do exercises 13.63-13.67 in your text.

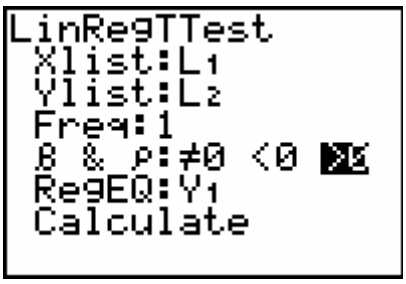
The LinRegTTest on the TI-84+

Example 13-6: In the previous example about commute times, is the slope of the line of best fit significantly greater than zero and therefore useful in predicting y (minutes). Use $\alpha = .05$

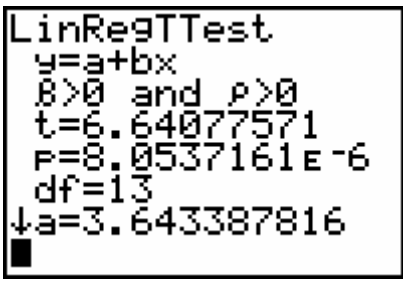
Solution: The hypotheses for the test are:

H_0: $\beta = 0$
H_A: $\beta > 0$ (Since we expect the minutes to increase as the miles increase)

Step 1: Press STAT ◄ ▲ and select F: LinRegTTest and then press ENTER. Adjust the settings to match the screen below..



Step 2: Press ▼ to highlight Calculate and press ENTER. The calculator returns the following screen..



Since the p-value for the test is 8.05×10^{-6}, we reject H_0 and conclude that the slope is sufficiently large to be a useful predictor of the y variable.

ASSIGNMENT: Do exercises 13.67-13.70 in your text.

Example 13-7: As part of a study for the graduate school at a large university, a researcher investigated the effect of undergraduate grade point average (GPA) on the graduate record exam (GRE). Fifteen random students were selected and their GPA and GRE scores were recorded. The data is given in the table below.

GPA (x)	2.3	3.65	3.00	2.75	3.1	2.55	2.5	2.3	2.9	3.15	3.25	2.00	2.75	2.65	3.13
GRE (y)	925	1300	1150	1400	900	825	950	1050	1200	1200	1100	700	850	990	1000

1) Find the regression coefficients and construct a graph of the regression line and the scatter diagram.
(2) Is the regression line significant? (Is there any evidence to suggest $\beta_1 \neq 0$.) Use $\alpha = .05$.

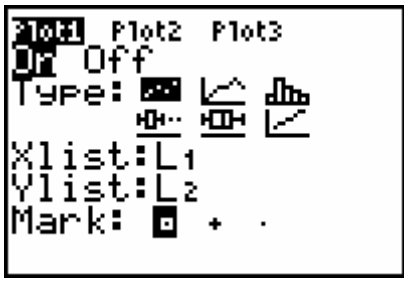
(3) If a student has an undergraduate GPA of 3.25, what is the 95% confidence interval for the GRE score?

1) Find the regression coefficients and construct a graph of the regression line and the scatter diagram.

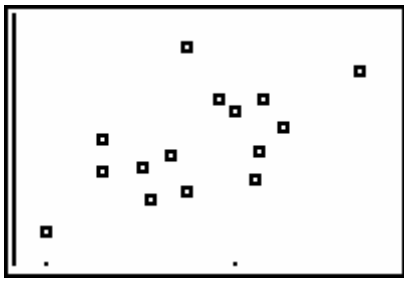
Step 1: Press STAT ENTER, input the GPA data into list L_1 and the GRE data into list L_2

Step 2: Press Y= CLEAR to clear any functions

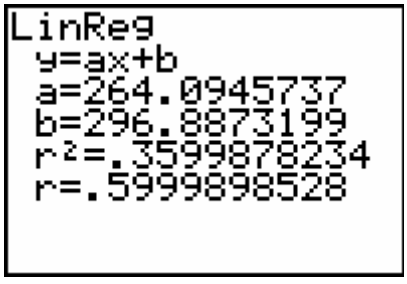
Step 3: Press 2nd Y= ENTER to enter the Plot1 menu. Adjust the settings as in the following screen..



Step 4: Press ZOOM 9 (ZoomStat) to obtain the scatterplot

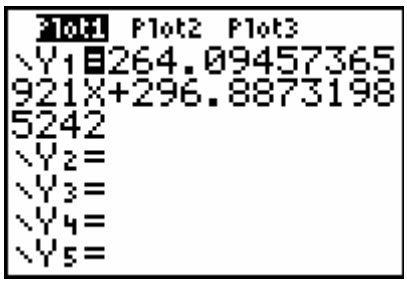


Step 5: Press STAT ▶ 4 ENTER, to compute the regression line as shown below..

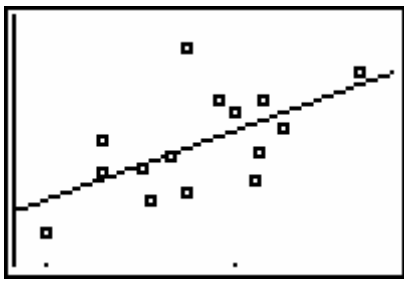


So, the regression coefficients are slope a = 264.09 and the y-intercept is b = 296.89

Step 6: Press Y= VARS 5 ▸ ▸ ENTER to paste the regression equation into Y_1 as shown..

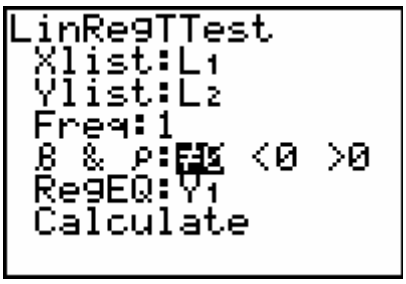


Step 7: Press GRAPH. The calculator will graph the regression line and the scatterplot simultaneously..

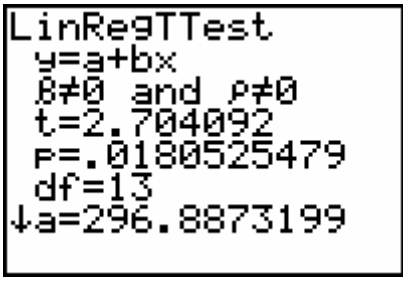


(2) Is the regression line significant? (Is there evidence to suggest $\beta_1 \neq 0$.) Use $\alpha = .05$.

Step 1: Press STAT ◂ ▴ to select LinRegTTest and press ENTER. Adjust the settings in the menu to match those below..



Step 2: Press ▾ to highlight Calculate and press ENTER. The calculator will return the following screen..



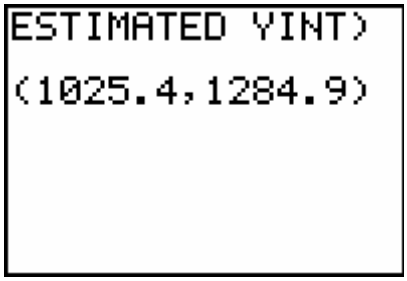
Since the p-value for the test is $p = .018 < .05 = \alpha$, we reject H_0 and there is significant evidence to show that $\beta \neq 0$.

(3) If a student has an undergraduate GPA of 3.25, what is the 95% confidence interval for the GRE score?

Step 1: Press PRGM ▼ to select ESTYINT and then press ENTER, then press ENTER again.

Step 2: When prompted for C-Level press . 9 5 ENTER

Step 3: When prompted for X-Value press 3 . 2 5 ENTER. The calculator returns the following..



Thus, the 95% confidence interval for the GRE score of a student with 3.25 GPA is (1025.4, 1284.9)

ASSIGNMENT: Do exercises 13.70-13.73 in your text.

Chapter 14

Elements of Nonparametric Statistics

Using the program SIGNTEST on the TI-84+

1) Finding a confidence interval for the population median

Example 14-1: A sample of thirteen cups of Starbucks coffee was sampled and the caffeine levels (in milligrams) displayed below.

250	300	259	400	303	402	564	500	498	402	600	602	502

Find a 95% confidence interval for the median amount of caffeine found in a cup of Starbucks coffee.

Solution:

Step 1: Press 

and input the Caffeine data into list L_1

Step 2: Press 

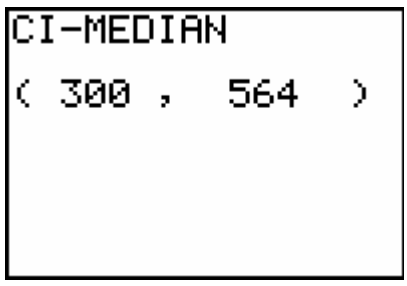
to select SIGNTEST and press 

twice.

Step 3: Press 
to select 2: CI-DATA and press 

Step 4: When prompted for C-LEVEL: press 

. The calculator displays the following answer..



Thus the 95% confidence interval for the population median caffeine level is (300, 564)

ASSIGNMENT: Do exercises 104.3-14.8 in your text.

2) Test of Hypotheses for Population Median

Example 14-2: A random sample of 75 students was selected, and each student was asked to carefully measure the amount of time it takes to commute from his or her front door to the college parking lot. The median time of commute for the sample was 15 minutes. The sample data is summarized below..

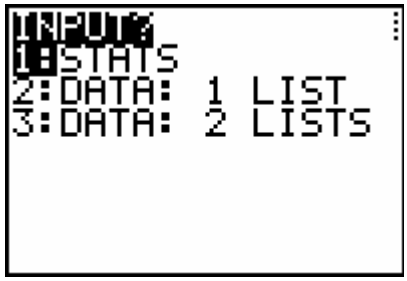
Under 15: 18
15: 12
Over 15: 45

Test the hypothesis that the median is 15 minutes against the alternate hypothesis that the median is different or not equal to 15 minutes using the Wilcoxon Sign Test

Solution:

Step 1: Press PRGM ▲ to select SIGNTEST and press ENTER twice.

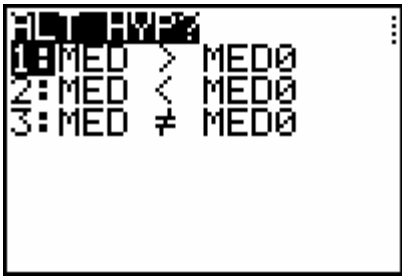
Step 2: Press ▼ to select 3: HYP TEST and press ENTER. This brings you to the following screen..



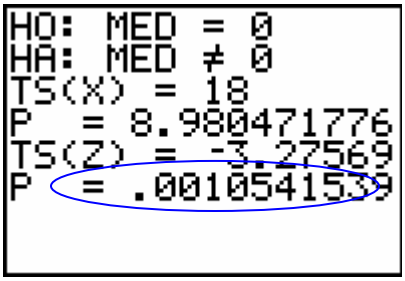
Step 3: Since we are given summary statistics rather than data, press ENTER to select STATS

Step 4: When prompted for X, input the number of the less frequent sign. In this case, 18 < 45 so X = 18. Press 1 8 ENTER.

Step 5: When prompted for N, we want the number of signs different from 15. In this case N = 75 - 12 = 63. Press 6 3 ENTER. This brings us to the next screen..



Step 6: Press 3 to select the sign for the alternate hypothesis (≠). The calculator displays the following..



Notice the p-value for the test is p = .00105 < .05 = α. So we reject H_0 in favor of the alternate. The median value is not equal to 15.

ASSIGNMENT: Do exercises 14.11-14.12 in your text.

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3) Hypothesis test for the median of paired differences.

Example 14-3: A new, no exercise, no starve weight reducing plan has been developed and advertised. A statistician obtained the before and after weights of 18 randomly selected adults who had used the plan. The data is summarized in the table below..

Weight Reducing Plan

	Weight	
Person	Before	After
Mrs. Smith	146	142
Mr. Brown	175	178
Mrs. White	150	147
Mr. Collins	190	187
Mr. Gray	220	212
Ms. Collins	157	160
Mrs. Allen	136	135
Mrs. Noss	146	138
Ms. Wagner	128	132
Mr. Carroll	187	187
Mrs. Black	172	171
Mrs. McDonald	138	135
Ms. Henry	150	151
Ms. Greene	124	126
Mr. Tyler	210	208
Mrs. Williams	148	148
Mrs. Moore	141	138
Mrs. Sweeney	164	159

Have people lost weight as claimed? Test at $\alpha = .05$

Solution: The hypotheses for the test are:

H_0: $Med_{Before} = Med_{After}$ (No weight loss)
H_A: $Med_{Before} > Med_{After}$ (Significant weight loss)

Step 1: Press STAT ENTER. Input the Before Weights in list L_1 and the After Weights in list L_2

Step 2: Press 2nd MODE CLEAR

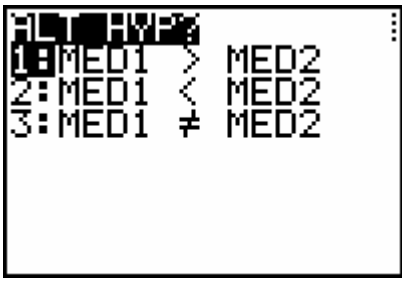
Step 3: Press PRGM ^ to select SIGNTEST and press ENTER twice

Step 4: Press 3 to select 3: HYP TEST

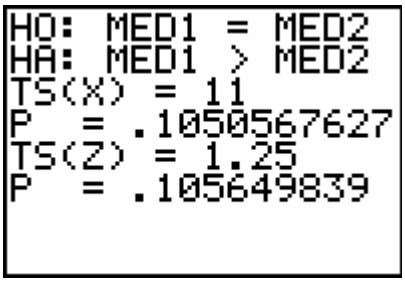
Step 5: Press 3 to select 3: DATA: 2 LISTS

Step 6: When prompted for XLIST: press 2nd 1 ENTER

Step 7: When prompted for the YLIST: press 2nd 2 ENTER. This brings us to the next screen:



Step 8: Press ENTER to select 1: MED1 > MED2. The answer is displayed below..



Since the p-value for the test is p = .1056 > .05 = α, we fail to reject H_0 and thus the Weight reduction claim is not supported by the data.

ASSIGNMENT: Do exercises 14.13-14.21 in your text.

The Mann-Whitney U Test on the TI-84+

Example 14-4: In a large lecture class, an instructor gives two exams. It is reasonable to ask, are these two different exams equivalent? Students in even numbered seats are given test A and those in odd numbered seats are given test B. The data is summarized in the table below..

Exam Scores

Test A	52	78	56	90	65	86	64	90	49	78
Test B	72	62	91	88	90	74	98	80	81	71

Can we conclude that the tests are not equivalent? Test at α = .05

Solution: The hypotheses for the test are:

H_0: Tests A & B have identical distributions
H_A: The two distributions are not the same

Step 1: Press STAT ENTER, input the Test A scores into list L_1 and Test B scores in L_2

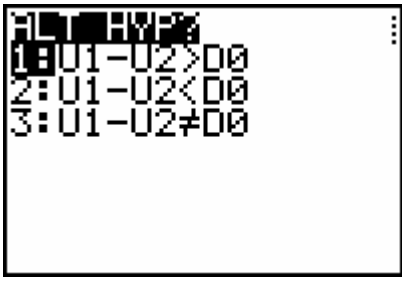
Step 2: Press 2nd MODE CLEAR

Step 3: Press PRGM ▼ to select MANNWHIT and press ENTER twice.

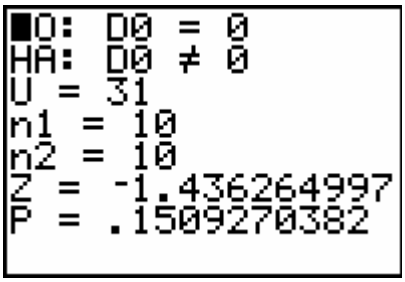
Step 4: When prompted for XLIST: press 2nd 1 ENTER

Step 5: When prompted for YLIST: press 2nd 2 ENTER

Step 6: When prompted for the NULL HYPOTHESIS D0= press 0 ENTER. This brings you to the next screen..



Step 7: Press [3]. The calculator returns the following screen..



Since the p-value for the test is p = .1509 > .05 = α, we fail to reject H_0 and conclude that there isn't a significant difference in the distributions.

ASSIGNMENT: Do exercises 14.30-14.36 in your text.

Example 14-5: A dog obedience trainer is training 27 dogs to obey a certain command. The trainer is using two different training techniques. (1) The reward and encouragement method and (2) the no-reward method. The table below shows the the numbers of obedience sessions that were necessary before the dogs would obey the command.

Dog Training

Method 1	29	27	32	25	27	28	23	31	37	28	22	24	28	31	34
Method 2	40	44	33	26	31	29	34	31	38	33	42	35			

Doe the trainer have sufficient evidence to claim that the reward method (1) will, on average, require less training time? (α = .05)

Solution: The hypotheses for the test are:

H_0: The distributions of training times are the same for both methods
H_A: The reward method, on average, requires less time

Step 1: Press [STAT] [ENTER], input the Method 1 times into list L_1 and Method 2 times in L_2

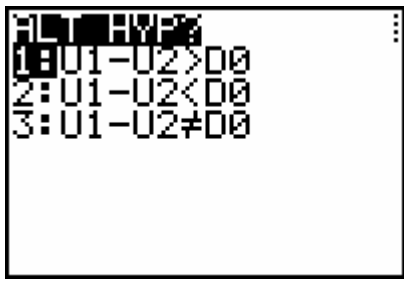
Step 2: Press [2nd] [MODE] [CLEAR]

Step 3: Press [PRGM] [▼] to select MANNWHIT and press [ENTER] twice.

Step 4: When prompted for XLIST: press [2nd] [1] [ENTER]

Step 5: When prompted for YLIST: press [2nd] [2] [ENTER]

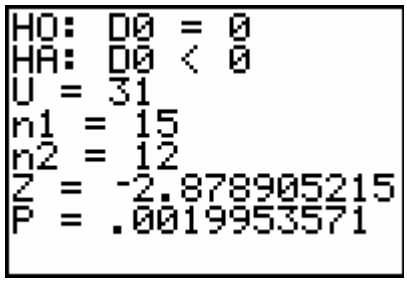
Step 6: When prompted for the NULL HYPOTHESIS D0= press 0 ENTER. This brings you to the next screen..



Step 7: Press 2 to select 2: U1-U2 < 0

Note: If Method1 is less than Method2, subtracting in that order will produce a negative value or U1-U2 < 0

The calculator returns the following screen..



Since the p-value for the test is p = .00199 < .05 = α, we reject H_0 and conclude that Method 1 results in significantly lower average training times.

The Runs Test on the TI-84+

The runs test is used, most frequently, to test the randomness of data or lack thereof

Example 14-6: Consider the following sample and determine whether the data points form a random sequence with regard to being above or below the median value. Use $\alpha = .05$

2 5 3 8 4 2 9 3 2 3 7 1 7 3 3
6 3 4 1 9 5 2 5 5 2 4 3 4 0 4

Solution: The hypotheses for the test are:

H_0: The numbers in the sample form a random sequence wrt the properties "above" and "below" the median value
H_A: The sequence is not random

Step 1: Press STAT ENTER and input the data, in order, into list L_1

Step 2: Press 2nd MODE CLEAR

Step 3: Press 2nd 1 — 2nd STAT (4 2nd 1) STO▸ 2nd 2 ENTER (L_1 - median(L_1)→ L_2), to subtract the median from each value in the data set and store the results in list L_2.

Step 4: Delete the zeros from list L_2. Press STAT ENTER ▸, then press ▾ to select each zero, then press DEL to omit them from the list.

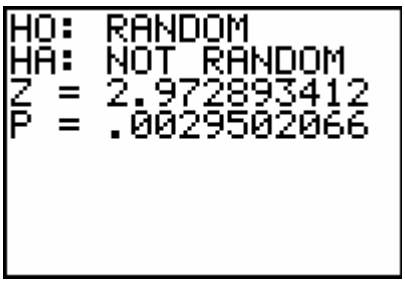
Step 5: Count the number of negatives, number of positives and number of runs in list L_2. You should get 15, 15 and 24 respectively

Step 6: Press PRGM ▾ to select RUNSTEST and press ENTER twice.

Step 7: When prompted for N1, press 1 5 ENTER

Step 8: When prompted for N2, press 1 5 ENTER

Step 9: When prompted for RUNS: press 2 4 ENTER. The calculator returns the following screen..



Since the p-value is p = .003 < .05 = α, we reject H_0 and conclude that the data is not random.

ASSIGNMENT: Do exercises 14.38-14.50 in your text.

Example 14-7: Test the null hypothesis that the following sequence of sample data is a random sequence with regard to each data being odd or even. Use α=.10

1	2	3	0	2	4	3	4	8	1
2	1	2	4	3	9	6	2	4	1
5	6	3	3	2	2	1	2	4	2
3	6	3	5	1	7	3	3	0	1
4	4	1	2	7	2	1	7	5	3

Solution: The hypotheses for the test are:

H_0: The sequence of odd and even numbers is random
H_A: The sequence of odd and even numbers is not random

Step 1: Press STAT ENTER and input the data, in order, into list L_1

Step 2: Press 2nd MODE CLEAR

Step 3: Press ((−) 1) ^ 2nd 1 STO▶ 2nd 2 ENTER. To raise (-1) to the power of each value in list L_1 and store to L_2

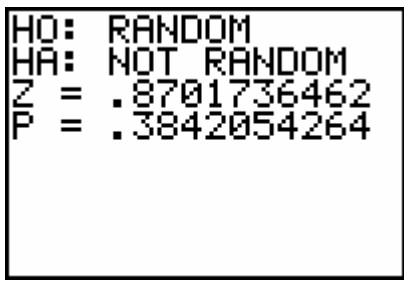
Step 4: Count the number of positives as evens, the number of negatives as odds. You should get 24 evens, 26 odds and 29 runs.

Step 5: Press PRGM ▼ to select RUNSTEST and press ENTER twice.

Step 6: When prompted for N1, press 2 4 ENTER

Step 7: When prompted for N2, press 2 6 ENTER

Step 8: When prompted for RUNS: press 2 9 ENTER. The calculator returns the following..



Since the p-value = .384 > .10 = α, we fail to reject H_0 and thus we can conclude that the data forms a random sequence.

ASSIGNMENT: Do exercises 14.38-14.50 in your text.

Spearman Rank Correlation on the TI-84+

Example 14-8: Students who finish exams more quickly than the rest of the class are often thought to be smarter. The table below presents the scores and order of finish for 12 students on a recent one-hour exam. At the $\alpha = .01$ level, do these data support the claim that the first students to complete the exam have the higher scores?

Exam Scores

Order of Finish	1	2	3	4	5	6	7	8	9	10	11	12
Exam Score	90	78	76	60	92	86	74	60	78	70	68	64

Solution: The hypotheses for the test are:

H_0: Order of finish has no relationship to exam score
H_A: The first to finish tend to have higher grades

Step 1: Press 

and input the order data into list L_1 and the exam score data in list L_2

Step 2: Press 

Step 3: Press 

to select the program SPEARMAN and press 

twice.

Step 4: When prompted for XLIST: press 

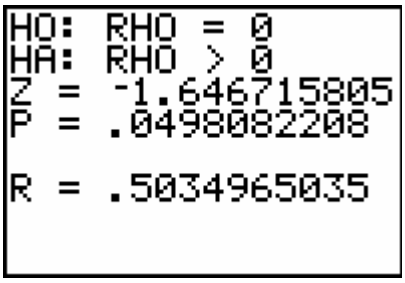
Step 5: When prompted for YLIST: press 

. This brings you to the next screen..

Step 6: Press 

to select 1: UNRANKED? This brings us to the next screen..

Step 7: Press ENTER to select 1: RHO > 0. The calculator returns the following screen..



Since the p-value for the test is p = .0498, we fail to reject H_0 and thus there is not enough evidence to support the claim that the earliest finishers have the highest scores.

ASSIGNMENT: Do exercises 14.54-14.65 in your text.