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Introduction To TI-83, TI-83 Plus, and TI-84 Plus

Getting Started with TI-83, TI-83 Plus, TI-84 Plus

This chapter covers the basic structure and commands of each graphing calculator. After reading this chapter you should be able to:

1. Identify function keys
2. Perform Basic Computations
3. Enter data
4. Open data

Calculators with built-in statistical support provide tremendous aid in performing the calculations required in statistical analysis. The Texas Instruments TI-83, TI-83 Plus and TI-84 Plus graphing calculators have many features that are particularly useful in an introductory statistics course. Among the features are:

(a) Data entry in a spreadsheet-like format

The TI-83 Plus and TI-84 Plus have six columns (called lists: L1, L2, L3, L4, L5, L6) in which data can be entered. There are also additional unnamed lists that allow the user to enter a list with the name of their choice.

Sample Data Screen from a TI-83 Plus or TI-84 Plus

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.5</td>
<td>8.6</td>
<td>1.1</td>
</tr>
<tr>
<td>3.8</td>
<td>6.7</td>
<td>1.0</td>
</tr>
<tr>
<td>4.5</td>
<td>9.8</td>
<td>2.0</td>
</tr>
<tr>
<td>1.0</td>
<td>1.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

(b) Single-variable statistics: mean, standard deviation, median, maximum, minimum, quartiles 1 and 3, sums

(c) Graphs for single-variable statistics: histograms, box-and-whisker plots

(d) Estimation: confidence intervals using the normal distribution, or Student’s t distribution, for a single mean and for a difference of means; intervals for a single proportion and for the difference of two proportions

(e) Hypothesis testing: single mean (z or t); difference of means (z or t); proportions, difference of proportions, chi-square test of independence; two variances; linear regression, one-way ANOVA

(f) Two-variable statistics: linear regression

(g) Graphs for two-variable statistics: scatter diagrams, graph of the least-squares line

USING THE TI-83, TI-83 PLUS, TI-84 PLUS

TI-83, TI-83 Plus and TI-84 Plus

The TI-83, TI-83 Plus and TI-84 Plus have several functions associated with each key, and both calculators use the same keystroke sequences to perform those functions. With the TI-83 Plus, all the yellow items on the keypad are accessed by first pressing the yellow 2nd key. On the TI-84 Plus these keys...
are blue in color. For both calculators, the items in green are accessed by first pressing the green ALPHA key. The four arrow keys \( \uparrow \downarrow \leftarrow \rightarrow \) enable you to move through a menu screen or along a graph. On the following page is the image of a TI-84 Plus calculator. The keypad of the TI-83 Plus is exactly the same as that of the TI-84 Plus.
The calculators each use screen menus to access additional operations. For instance, to access the statistics menu on the TI-83 Plus or TI-84 Plus, press STAT. Your screen should look like this:

![TI-83 Plus/84 Plus Statistics Menu]

Use the arrow keys to highlight your selection. Pressing ENTER selects the highlighted item. To leave a screen, press either 2nd [QUIT] or CLEAR, or select another menu from the keypad.

Now press MODE. When you use your TI-83 Plus or TI-84 Plus for statistics, the most convenient settings are as shown. (The TI-83 Plus does not have the SET CLOCK line; otherwise, it is identical to the TI-84 Plus).

![TI-83 Plus/84 Plus Mode Menu]

You can enter the settings by using the arrow keys to highlight selections and then pressing ENTER.

**COMPUTATIONS ON THE TI-83, TI-83 PLUS, and TI-84 PLUS**

**TI-83, TI-83 Plus and TI-84 Plus**

In statistics, you will be evaluating a variety of expressions. The following examples demonstrate some basic keystroke patterns for the TI-83, TI-83 Plus and TI-84 Plus.

**Example**

Evaluate $-2(3) + 7$.

Use the following keystrokes: $-2 \times 3 + 7 \text{ ENTER}$ The result is 1.

To enter a negative number, be sure to use the key (-) rather than the subtract key. Notice that the expression $-2 \times 3 + 7$ appears on the screen. When you press ENTER, the result 1 is shown on the far right side of the screen.

![TI-83 Plus/84 Plus Keystroke Example]
Example

(a) Evaluate \( \frac{10-7}{3.1} \) and round the answer to three places after the decimal.

A reliable approach to evaluating fractions is to enclose the numerator in parentheses, and if the denominator contains more than a single number, enclose it in parentheses as well.

\[
\frac{10-7}{3.1} = (10-7) \div 3.1
\]

Use the keystrokes \([10-7] \div [3.1] \text{ ENTER}\)

The result is 0.9677419355, which rounds to 0.968.

(b) Evaluate \( \frac{10-7}{2} \) and round the answer to three places after the decimal.

Place both numerator and denominator in parentheses: \((10 - 7) \div (3.1 \div 2)\)

Use the keystrokes \([10-7] \div [3.1 \div 2] \text{ ENTER}\)

The result is 1.935483871, or 1.935 rounded to three places after the decimal.

Example

Several formulas in statistics require that we take the square root of a value. Note that a left parenthesis, (, is automatically placed next to the square root symbol when 2nd 
\([\sqrt{\text{ ]}}\) is pressed. Be sure to close the parentheses after typing in the radicand.

(a) Evaluate \( \sqrt{10} \) and round the result to three places after the decimal.

\(\sqrt{10} \text{ ENTER}\)

The result is 3.16227766, which rounds to 3.162.

(b) Evaluate \( \frac{\sqrt{10}}{3} \) and round the result to three places after the decimal.

\(\sqrt{10 \div 3} \text{ ENTER}\)

The result rounds to 1.054.

Be careful to close the parentheses. If you do not close the parentheses, you will get the result of \( \frac{\sqrt{10}}{3} \approx 1.826 \)

Example

Some expressions require us to use powers.

(a) Evaluate \( 3.2^2 \).

In this case, we can use the \( x^2 \) key.

\(3 \cdot 2 \text{ x}\text{\(^2\)} \text{ ENTER}\)

The result is 10.24.

(b) Evaluate \( 0.4^3 \).

In this case, we use the \(^\text{\(^3\)} \) key.

\(0.4 \text{ \(^3\)} \text{ ENTER}\)

The result is 0.064.

ENTERING DATA

TI-83, TI-83 Plus and TI-84 Plus

To use the statistical processes built into the TI-83, TI-83 Plus and TI-84 Plus, we first enter data into lists. Press the STAT key. Next we will clear any existing data lists. With EDIT highlighted, select 4:ClrList using the arrow keys and press ENTER.
Then type in the six lists separated by commas as shown. (The lists are found using the ` key, followed by 1, 2, 3, 4, 5, and 6.) Press ENTER.

Next press STAT again and select item 1:Edit. You will see the data screen and are now ready to enter data.

Let’s enter the numbers.

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 5 7 9 11</td>
<td>3 6 9 11 1</td>
<td></td>
</tr>
</tbody>
</table>

Press ENTER after each number, and use the arrow keys to move between L1 and L2.

To correct a data entry error, highlight the entry that is wrong and enter the correct data value.

We can also create new lists by doing arithmetic on existing lists. For instance, let’s create L3 by using the formula L3 = 2L1+L2.

Highlight L3. Then type in 2L1+L2 and press ENTER.
To leave the data screen, press 2nd [QUIT] or press another menu key, such as STAT.

**COMMENTS ON ENTERING AND CORRECTING DATA**

**TI-83, TI-83 Plus and TI-84 Plus**

(a) To create a new list from old lists, the lists must all have the same number of entries.

(b) To delete a data entry, highlight the data value you wish to correct and press the DEL key.

(c) To insert a new entry into a list, highlight the position directly below the place you wish to insert the new value. Press 2nd [INS] and then enter the data value.
Chapter 1
The Role of Statistics and the Data Analysis
Problem

One of the most useful ways to begin an initial exploration of data is to use techniques that result in a graphical representation of the data. These can quickly reveal characteristics of the variable being examined. There are a variety of graphical techniques used for variables.

Unfortunately, bar charts are not able to be produced on the TI-83/84.

Example 1.8 – Bar Chart

TI-83, TI-83 Plus and TI-84 Plus do not offer this capability.
Chapter 2
Collecting Data Sensibly

Section 2.2 of the text discusses random sampling. We can use the TI-83, TI-83 Plus and TI-84 Plus graphing calculators have a random number generator which can be used in place of a random number table. We use the MATH button to access the

\texttt{rand}

command to generate random numbers.

Example 2.3 – Selecting a Random Sample

Breaking strength is an important characteristic of glass soda bottles. Suppose that we want to measure the breaking strength of each bottle in a random sample of size \( n = 3 \) selected from four crates containing a total of 100 bottles (the population).

To randomly select 3 bottles from bottles numbered from 1 to 100, we press the MATH button. Use the arrow keys to highlight PRB. Again, use the arrow keys to highlight \texttt{5:randInt} and press ENTER. Type 1,100 and press ENTER. A random number will appear on the screen. Do this two more times to find three random numbers.

\begin{verbatim}
MATH NUM CPX PRB
1:rand
2:nPr
3:nCr
4:!
5:randInt(
6:randNorm(
7:randBin(
\end{verbatim}

The results will be displayed as below. Note: Your results will be different from those below.

\begin{verbatim}
randInt(1,100) 15
randInt(1,100) 52
randInt(1,100) 41
\end{verbatim}
Chapter 3
Graphical Methods for Describing Data

Chapter 3 describes a number of graphical displays for both categorical and quantitative data. The TI-83, TI-83 Plus and TI-84 have limited graphing capabilities. We will use data in a list along with the command **STAT PLOT** to create histograms.

TI-83, TI-83 Plus and TI-84 Plus does not have the capability to produce bar charts, pie charts or stem-and-leaf displays.

**Example 3.1 – Comparative Bar Charts**

The TI-83, TI-83 Plus and TI-84 Plus do not provide this capability.

**Example 3.3 – Pie Charts**

The TI-83, TI-83 Plus and TI-84 Plus do not provide this capability.

**Example 3.8 – Stem-and-Leaf Displays**

The TI-83, TI-83 Plus and TI-84 Plus do not provide this capability.

**Example 3.15 – Histogram**

States differ widely in the percentage of college students who attend college in their home state. The percentages of freshmen who attend college in their home state for each of the 50 states are shown in the text (*The Chronicle of Higher Education*, August 23, 2013).

Begin by entering the data into L1.

```
<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>83</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>92</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>91</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>94</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>90</td>
<td>-----</td>
<td>-----</td>
<td>----</td>
</tr>
<tr>
<td>90</td>
<td>-----</td>
<td>-----</td>
<td></td>
</tr>
</tbody>
</table>
```

L1 = {93, 92, 91, 91...}

Next, we set the graphing window. Press the **WINDOW** key. Set **Xmin** to 30, **Xmax** to 110, **Xsc1** to 10 (this will control our bin width). Set **Ymin** to 0, **Ymax** to 30.
Next, press **STAT PLOT**. Select 1:Plot1 and press **ENTER**. Highlight **ON** and press **ENTER**. Select the graphic for histogram. Input L1 for Xlist and 1 for Freq.

To display the plot, press **GRAPH**. The results follow.

**Example 3.21 – Scatterplots**

The report title “2007 College Bound Seniors” (College Board, 2007) included data showing the average score on the writing and math sections of the SAT for groups of high school seniors completing different numbers of years of study in six core academic subjects (arts and music, English, foreign languages, mathematics, natural sciences, and social sciences and history).

Begin by loading or entering the dataset into the calculator as below into L1, L2 and L3.
We will create a scatterplot for L2 and L3 using STAT PLOT. First, we set the plot window. Press WINDOW. Set Xmin and Ymin to 430, Xmax and Ymax to 560.

![WINDOW
Xmin=430
Xmax=550
Xscl=1
Ymin=430
Ymax=560
Yscl=1
Xres=1]

Press STAT PLOT and select 1:Plot1. Highlight On and press ENTER. Select the first type of graph and press ENTER. For Xlist input L2 and for Ylist input L3.

![Plot1 Plot2 Plot3
On Off
Type: □ □ □
Xlist: L2
Ylist: L3
Mark: □ + .]

Press Graph. The results follow.
Chapter 4
Numerical Methods for Describing Data

In previous chapters, we examined graphical methods for displaying data. These provide a visual picture of the data, but do not provide any numerical summaries. In this chapter, we compute numerical summaries for quantitative data. We use the

STAT

button.

Example 4.3 – Calculating the Mean

Forty students were enrolled in a section of a general education course in statistical reasoning during one fall quarter at Cal Poly, San Luis Obispo. The instructor made course materials, grades and lecture notes available to students on a class web site, and course management software kept track of how often each student accessed any of the web pages on the class site. One month after the course began, the instructor requested a report that indicated how many times each student had accessed a web page on the class site. The 40 observations are listed in the text.

We begin by entering or loading the data into the calculator into L1.

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

L1 = (20, 37, 4, 20, ...)

Press STAT. Use the arrow keys to navigate to CALC. Select 1:1-Var Stats and press ENTER. You should see 1-Var Stats appears on the screen. Type L1 and press ENTER.
The results are shown below. The mean is the first statistic output.

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.02</td>
<td>-----</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>4.67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.28</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.88</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

L1 = {3.02, 4.67, 3...}

Example 4.8 – Calculating the Standard Deviation

McDonald’s fast-food restaurants are now found in many countries around the world. But the cost of a Big Mac varies from country to country. Table 4.3 in the text shows data on the cost of a Big Mac taken from the article “The Big Mac Index” (*The Economist*, July 11, 2013).

We begin by entering this data or loading this data in L1.

To calculate the standard deviation, press STAT. Use the arrow keys to navigate to CALC and select 1:1-Var Stats then press ENTER. You should see 1-Var Stats appear on the screen. Type L1 and press ENTER.

The results follow. The standard deviation appears as sx.
Example 4.11 – Quartiles and IQR

The accompanying data from Example 4.11 of the text came from an anthropological study of rectangular shapes (*Lowie’s Selected Papers in Anthropology*, Cora Dubios, ed. [Berkeley, CA: University of California Press, 1960]: 137-142). Observations were made on the variable $x = \text{width/length}$ for a sample of $n = 20$ beaded rectangles used in Shoshani Indian leather handicrafts.

Begin by opening or loading the data.

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>.553</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.57</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.576</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.601</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.608</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.606</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.609</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1 = {.553, .57, .5...</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To find the quartiles, press **STAT**. Use the arrow keys to select **CALC** then **1:1-Var Stats** and press **ENTER**. You should see 1-Var Stats appear on the screen. Type L1 and press **ENTER**.

Scroll through the results to find the quartiles.

1-Var Stats L1

To find the IQR, simply subtract Q3 and Q1. This gives 0.681-0.606=0.075.
<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>minX</td>
<td>.553</td>
</tr>
<tr>
<td>Q1</td>
<td>.606</td>
</tr>
<tr>
<td>Med</td>
<td>.641</td>
</tr>
<tr>
<td>Q3</td>
<td>.681</td>
</tr>
<tr>
<td>maxX</td>
<td>.933</td>
</tr>
<tr>
<td>.681-.606</td>
<td>.075</td>
</tr>
</tbody>
</table>
Chapter 5
Summarizing Bivariate Data

This chapter introduces methods for describing relationships among variables. The goal of this type of analysis is often to predict a characteristic of the response or dependent variable. The characteristics used to predict the response variable are called the independent or predictor variables.

In this chapter, we will learn how to compute the correlation and least squares regression fit to bivariate data for the graphing calculator. We will use the STAT button again.

**Important Note:** Before beginning this chapter, press 2nd [CATALOG] (above 0 ) and scroll down to the entry DiagnosticOn. Press ENTER twice. After doing this, the regression correlation coefficient \( r \) will appear as output with the linear regression line.

**Example 5.2 – Correlation**

Are more expensive bike helmets safer than less expensive ones? The data from Example 5.2 of the text shows data on \( x = \) price and \( y = \) quality rating for 12 different brands of bike helmets appeared on the *Consumer Reports* web site.

Begin by loading or entering the data into L1 and L2.

```
<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>65</td>
</tr>
<tr>
<td>20</td>
<td>61</td>
</tr>
<tr>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td>23</td>
<td>47</td>
</tr>
<tr>
<td>30</td>
<td>44</td>
</tr>
</tbody>
</table>
```

To calculate the correlation, Press STAT. Using the arrows, navigate to CALC, then to 8:LinReg(a+bx). Press ENTER. Type L1,L2 and press ENTER.
The results are displayed below.

```
LinReg
y=a+bx
a=39.57470349
b=.3122661785
r2=.920583316
r=.3034111593
```

Example 5.2 – Regression Equation

For the example above, we now want to fit the regression equation. Note that this has already been output by using the steps above. In this output, b is the slope and a is the intercept.
Chapter 6
Probability

There are no examples or material from Chapter 6.
Chapter 7
Random Variables and Probability Distributions

Chapter 7 explores further the concepts of probability, expanding to commonly used probability distributions. These distributions will be closely linked to the processes that we use for inference.

In this chapter, we learn how to use the graphing calculator to compute probabilities from the Normal distribution. We will use the DISTR button (above VARS) to compute probabilities.

Example 7.27 – Calculating Normal Probabilities

Data from the paper “Fetal Growth Parameters and Birth Weight: Their Relationship to Neonatal Body Composition” (Ultrasound in Obstetrics and Gynecology [2009]: 441-446) suggest that a normal distribution with mean $\mu = 3500$ grams and standard deviation $\sigma = 600$ grams is a reasonable model for the probability distribution of the continuous numerical variable $x =$ birth weight of a randomly selected full-term baby. What proportion of birth weights are between 2900 and 4700 grams?

To begin, press DISTR and scroll to 2: normalcdf( and press ENTER. Type 2900, 4700, 3500, 600) and press ENTER.

The results follow.

```
normalcdf(2900, 4700, 3500, 600)
.8185946784
```
Chapter 8
Sampling Variability and Sampling Distributions

There are no examples or material from Chapter 8.
Chapter 9
Estimation using a Single Sample

The objective of inferential statistics is to use sample data to decrease our uncertainty about the corresponding population. We can use confidence intervals to provide estimation for population parameters.

In this chapter, we will use the graphing calculator to create confidence intervals for the population mean. We will use the STAT button with the 8:TInterval under the TESTS tab to find a confidence interval for the population mean.

Example 9.10 – Confidence Interval for the Mean

The article “Chimps Aren’t Charitable” (Newsday, November 2, 2005) summarizes the results of a research study published in the journal Nature. In this study, chimpanzees learned to use an apparatus that dispensed food when either of the two ropes was pulled. When one of the ropes was pulled, only the chimp controlling the apparatus received food. When the other rope was pulled, food was dispensed both to the chimp controlling the apparatus and also to a chimp in the adjoining cage. The data (listed in the text) represents the number of times out of 36 trials that each of the seven chimps chose the option that would provide food to both chimps (the “charitable” response).

To begin, we load or enter the dataset into L1.

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ L1 = \{23, 22, 21, 20, \ldots\} \]

To compute the confidence interval for the mean, we press STAT. Use the arrow keys to navigate to TESTS then down to 8:TInterval and press ENTER. Select Data for Inpt. Input L1 for List. Input .95 for C-Level. Highlight Calculate and press Enter.
The results follow.

\[
\text{TInterval} \\
(18.764, 23.807) \\
x=21.28571429 \\
Sx=1.799470822 \\
n=7
\]
Chapter 10
Hypothesis Testing using a Single Sample

In the previous chapter, we considered one form of inference in the form of confidence intervals. In this chapter, we consider the second form of inference: inference testing. Now we use sample data to create a test for a set of hypotheses about a population parameter.

We will use the STAT button and options under the TESTS tab to complete these tests.

Example 10.11 – Testing for a Single Proportion

The article “7 Million U.S. Teens Would Flunk Treadmill Tests” (Associated Press, December 11, 2005) summarized the results of a study in which 2205 adolescents age 12 to 19 took a cardiovascular treadmill test. The researchers conducting the study indicated that the sample was selected in such a way that it could be regarded as representatives of adolescents nationwide. Of the 2205 adolescents tested, 750 showed a poor level of cardiovascular fitness. Does this sample provide support for the claim that more than 30% of adolescents have a low level of cardiovascular fitness? We carry out a hypothesis test to determine this.

To calculate the p-value matching the hypotheses from the text, we press STAT and use the arrow keys to navigate to 5:1-PropZTest and press ENTER. Input .30 for p0. Input 750 for x and 2205 for n. Highlight >p0 for prop. Highlight Calculate and press ENTER.

The results are shown below.
Example 10.14 – Testing for a Single Mean

A growing concern of employers is time spent in activities like surfing the Internet and e-mailing friends during work hours. The *San Luis Obispo Tribune* summarized the findings from a survey of a large sample of workers in an article that ran under the headline “Who Goofs Off 2 Hours a Day? Most Workers, Survey Says” (August 3, 2006). Suppose that the CEO of a large company wants to determine whether the average amount of wasted time during an 8-hour work day for employees of her company is less than the reported 120 minutes. Each person in a random sample of 10 employees was contacted and asked about daily wasted time at work. (Participants would probably have to be guaranteed anonymity to obtain truthful responses!). The resulting data are the following:

108  112  117  130  111  131  113  113  105  128

We begin by loading or entering the data into L1.

To perform the test, press STAT then navigate to TESTS and 2:T-Test and press ENTER. Select Data for Inpt. Input 120 for μ0. Input L1 for List. Highlight <μ0. Highlight Calculate and press ENTER.

The results are shown below.
T-Test
μ<120
t=-1.070905796
p=.1560443206
x=116.8
Sx=9.449279808
n=10
Chapter 11  
Comparing Two Populations or Treatments

In many situations, we would like to compare two groups to determine if they behave in the same way. We may want to compare two groups to determine if they have the same mean value for a particular characteristic or to determine if they have the same success proportion for a particular characteristic.

We continue to use the inference procedures of interval estimation and inference testing for these situations. In this chapter, we perform both types of inference for comparing two groups’ population means and proportions. Again, we use the STAT button and the TESTS menu to perform this analysis.

Example 11.1 – Confidence Interval and Inference Test for Two Population Means

In a study of the ways in which college students who use Facebook differ from college students who do not use Facebook, each person in a sample of 141 college students who use Facebook was asked to report his or her college grade point average (GPA). College GPA was also reported by each person in a sample of 68 students who do not use Facebook ("Facebook and Academic Performance," *Computers in Human Behavior* [2010]: 1237-1245). One question that the researchers were hoping to answer is whether the mean college GPA for students who use Facebook is lower than the mean college GPA of students who do not use Facebook. Summarized data is listed in the text. We will produce a confidence interval and inference test for the difference of the means.

To perform the test, press STAT and scroll to TESTS then to 4:2-SampTTest and press ENTER. Highlight Stats and press ENTER. Input 3.06, then 0.95, then 141 for sample 1. For sample 2, input 3.82, then .41, then 68. Highlight ≠ for µ2. Highlight No for Pooled and press ENTER. Highlight Calculate and press ENTER.

The results follow.
To compute the confidence interval, press STAT and scrolls to TESTS. Then select 0:2-SampTIntB and press ENTER. Highlight Stats and press ENTER. Input 3.06, then 0.95, then 141 for sample 1. For sample 2, input 3.82, then .41, then 68. Enter .95 for C-Level. Highlight No for Pooled and press ENTER. Highlight Calculate and press ENTER.

The results follow.

Example 11.8 – Confidence Interval and Inference Test for Paired Means

Ultrasound is often used in the treatment of soft tissue injuries. In an experiment to investigate the effect of an ultrasound and stretch therapy on knee extension, range of motion was measured both before and after treatment for a sample of physical therapy patients. A subset of the data appearing in the paper “Location of Ultrasound Does Not Enhance Range of Motion Benefits of Ultrasound and Stretch Treatment” (University of Virginia Thesis, Trae Tashiro, 2003) is given in the text.

Begin by loading or entering the data into L1 and L2.
We now create the differences of these two columns by highlighting the header for column L3. Enter L2-L1 and press ENTER.

Press STAT and scroll to TESTS. Scroll to 2:T-Test and press ENTER. Highlight DATA and press ENTER. Input 0 for μ0. Input L3 for List. Highlight ≠μ0. Highlight Calculate and press ENTER.

The results are shown below.

Example 11.10 – Confidence Interval and Inference Tests for Difference of Two Proportions

Do people who work long hours have more trouble sleeping? This question was examined in the paper “Long Working Hours and Sleep Disturbances: The Whitehall II
Prospective Cohort Study” (Sleep [2009]: 737-745). The data in text are from two independently selected samples of British civil service workers, all of whom were employed full-time and worked at least 35 hours per week. The authors of the paper believed that these samples were representative of full-time British civil service workers who work 3 to 40 hours per week and of British civil service workers who work more than 40 hours per week. We will produce an inference test and confidence interval for this data.

To produce the test, press STAT and navigate to TESTS. Navigate to 6:2-PropZTest and press ENTER. Input 750 for x1, 1501 for n1, 407 for x2 and 958 for n2. Highlight ≠p2. Highlight Calculate and press ENTER.

The results follow.

To find a confidence interval, press STAT and navigate to TESTS. Navigate to B:2-PropZInt and press ENTER. Input 750 for x1, 1501 for n1, 407 for x2 and 958 for n2. Input .95 for C-Level. Highlight Calculate and press ENTER.

The results follow.
Chapter 12
The Analysis of Categorical Data and Goodness-of-Fit Tests

The information in this chapter is specifically designed to explore the relationship between two categorical variables. Excel does not easily compute goodness-of-fit tests, so these are not addressed in this manual.

To complete an independence test, we use the STAT key and TESTS menu.

**Example 12.7 – Chi-squared Test for Independence**

The paper “Facial Expression of Pain in Elderly Adults with Dementia” (Journal of Undergraduate Research [2006]) examined the relationship between a nurse’s assessment of a patient’s facial expression and his or her self-reported level of pain. Data for 89 patients are summarized in the text. We use this data to test for independence.

Begin by entering the data as a matrix. Press 2nd [MATRX]. Highlight EDIT and select 1:[A] and press ENTER. Input 2 x 2.

```
17 40
12 28
```

When the table is entered completely, press 2nd [MATRX] again. This time, select 2:[B]. Set the dimensions to be the same as for matrix [A].

Next, press STAT then highlight TESTS. Select the option C: χ²-Test. This tells you that the observed values of the table are in matrix [A]. The expected values will be placed in matrix [B]. Highlight Calculate and press ENTER.

The results follow.
$X^2$-Test

$X^2 = 4.919304999$

$p = .0265581987$

$df = 1$
Chapter 13
Simple Linear Regression and Correlation: Inferential Methods

Regression and correlation were introduced in Chapter 5 as techniques for describing and summarizing bivariate data. We continue this discussion in this chapter, moving into prediction and inferential methods for bivariate data.

We will use the commands **STAT** and the **TESTS** menu in this chapter.

**Example 13.2 – Prediction (Regression)**

Medical researchers have noted that adolescent females are much more likely to deliver low-birth-weight babies than are adult females. Because low-birth-weight babies have higher mortality rates, a number of studies have examined the relationship between birth weight and mother’s age for babies born to young mothers.

One such study is described in the article “Body Size and Intelligence in 6-Year-Olds: Are Offspring of Teenage Mothers at Risk?” (Maternal and Child Health Journal [2009]: 847-856). The data in the text on $x =$ maternal age (in years) and $y =$ birth weight of baby (in grams) are consistent with the summary values given in the referenced article and also with data published by the National Center for Health Statistics.

To predict baby weight for an 18-year-old mother, begin by opening or entering the dataset as below.

<table>
<thead>
<tr>
<th>x</th>
<th>y</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>2657</td>
</tr>
<tr>
<td>17</td>
<td>2297</td>
</tr>
<tr>
<td>16</td>
<td>2870</td>
</tr>
<tr>
<td>18</td>
<td>3138</td>
</tr>
<tr>
<td>19</td>
<td>3278</td>
</tr>
</tbody>
</table>

Press **STAT** and navigate to **CALC**. Navigate to **4:LineReg(ax+b)** and press **ENTER**. Type L1,L2 and press **ENTER**.
To find the prediction for $x=18$, input this value into the predicted line from the output:

$$-1163.45 + 245.15 \times 18 = 3249.25.$$
Chapter 14
Multiple Regression Analysis

In this chapter, we consider multiple predictors in regression analysis. There are many similarities between multiple regression analysis and simple regression analysis. There is also a great deal more to consider when multiple predictors are involved.

The graphing calculator does not have the capability to complete multiple regression analysis.
Chapter 15
Analysis of Variance

In previous chapters, we have discussed comparison of means for two groups. We now consider comparison of means for more than two groups. Analysis of variance provides a method to compare means amongst multiple groups.

In this chapter, we use the graphing calculator to produce ANOVA results using STAT and the TESTS menu.

Example 15.4 – ANOVA

The article “Growth Hormone and Sex Steroid Administration in Healthy Aged Women and Men” (Journal of the American Medical Association [2002]: 2282-2292) described an experiment to investigate the effect of four treatments on various body characteristics. In this double-blind experiment, each of 57 female subjects age 65 or older was assigned at random to one of the following four treatments:

1. Placebo “growth hormone” and placebo “steroid” (denoted by P + P);
2. Placebo “growth hormone” and the steroid estradiol (denoted by P + S);
3. Growth hormone and placebo “steroid” (denoted G + P); and
4. Growth hormone and the steroid estradiol (denoted by G + S).

We perform an ANOVA to determine if the mean change in body fat mass differs for the four treatments.

Begin by loading or inputting the data as below.

Press STAT then navigate to TESTS. Navigate to F:ANOVA( and input L1,L2,L3,L4) and press ENTER.

<table>
<thead>
<tr>
<th>L2</th>
<th>L3</th>
<th>L4</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>-3.4</td>
<td>-3.1</td>
<td></td>
</tr>
<tr>
<td>9.2</td>
<td>-3.6</td>
<td>-3.8</td>
<td></td>
</tr>
<tr>
<td>-4.1</td>
<td>-3.4</td>
<td>-3.3</td>
<td></td>
</tr>
<tr>
<td>-1.1</td>
<td>-2.8</td>
<td>-3.2</td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>-2.2</td>
<td>-4.5</td>
<td></td>
</tr>
</tbody>
</table>

L4 = (-3.1, -3.2, -...
The results follow.

Example 15.6 – Multiple Comparisons

The graphing calculator does not have the capability to produce multiple comparisons.

Example 15.10 – Block Design

The graphing calculator does not have the capability to compute ANOVA for block design.

Example 15.14 – Two Way ANOVA

The graphing calculator does not have the capability to compute Two Way ANOVA.
Chapter 16
Nonparametric (Distribution-Free) Statistical Methods

There are no examples or material from Chapter 16.