

DID YOU FINISH?

THE CASE FOR THE TI-84™

INCLUDING UPDATES FOR THE TI-NSPIRE™

prepared by

Phill Kelley

Version 1.0, July 2006
Version 1.1, August 2006
Version 1.2, December 2006
Version 1.3, May 2010
Version 1.3a June 2010
Version 1.4 August 2010
Version 1.5 January 2011
Version 1.6 February 2013

Acknowledgement

The examples in this document are based upon the sample tests available on the unit web site. The material is used with permission.

Copyright

To the extent that I own any copyright in the material contained in this document, I hereby donate such copyright to the students of the University of Canberra in particular, and more generally to students pursuing studies in Statistics everywhere.

Disclaimer

I do not now and never have had any relationship with Texas Instruments Inc. In my opinion the TI-84 is an excellent calculator for students studying Statistics and I simply want to share my experience so that others who tread a similar path have the opportunity to enjoy its benefits whilst avoiding the arguably steep learning-curve that the device represents.

Did You Finish? THE CASE FOR THE TI-84

“Stop writing!” Those words invariably mark the end of another Statistics test. Shortly after that, someone near you is bound to ask, “Did you finish?” Whether you finish a test (or the final exam) obviously depends on many things. Unless you are a natural whiz at Statistics, there is no substitute for attending every lecture and tutorial, making the most of the help sessions in the Student Resource Centre, hard study, and lots and lots of practice.

That said, a lot of what you will be taught in this unit boils down to recognising a class of problem and then applying a logical series of steps to arrive at an answer. In the first two weeks of the semester, you can almost get by with mental arithmetic. After that, an ordinary \$20 scientific calculator is a must. It is not until your first encounter with Hugh Morton’s *Comprehensive Statistical Tables* book, and the prospect of Test 3 is staring you in the face, that you begin to think that there *must* be an easier way.

You can do what I did: start with an ordinary calculator, wait until a growing sense of unease fills you at the end of Week 7, and then consider the pros and cons of changing your calculator in mid-course. Or you can take my advice and buy a TI-84 right now.

Put simply: the TI-84 is optimised for Statistics and can save you time. A lot of time. If my experience is anything to go by, the saving is be-

tween 30 and 40 minutes in the final exam. Having more time translates to an opportunity for higher marks.

At the beginning of the semester, it is difficult to understand how the TI-84 can help you to save time. The section called *You Have Two Choices* works through some examples. The examples are not meant to scare you. They are only intended to show you the kinds of things you will learn to do, and how the TI-84 can help you do those things more efficiently.

The TI-84 is not cheap. The retail price is around \$220 (but you can do better than that with careful shopping). Also keep in mind that you may still need a \$20 calculator. Why? Because the TI-84 is *programmable* and that word is enough to cause some lecturers at this fine institution to fondle their worry beads. If you are doing another unit where you need a calculator, you should check with your lecturer *before* trying to use the TI-84 (you are welcome to try to use logic to change their position).

Lastly, you get a lot for your \$220, including a manual the size of *The Yellow Pages* (if you print it). Rather than shoving you in at the deep-end with trite advice to “just read the manual”, the latter sections of this

document give you a head start by explaining how you can put the TI-84 to good use during the semester.

Good luck with your studies!



TABLE OF CONTENTS

Did You Finish?	3
You Have Two Choices.....	7
Example 1 — The Hard Way.....	7
Example 1 — The Easy Way.....	9
Example 2 — The Hard Way.....	9
Example 2 — The Easy Way.....	10
How's Your Accuracy?	10
One Word of Advice	10
Conventions Used In This Document	11
Quick Reference.....	12
Summarising Data	13
Mean, Median and Standard Deviation	13
Additional Tricks With Lists	14
Correlation & Regression	15
Spearman's Rank Correlation Coefficient	15
Linear Regression	16
Probability	17
Probability Distribution.....	17
Binomial Distribution.....	18
Poisson Distribution	20
Confidence Intervals & Sampling Distributions	21
100(1- α)% Confidence Interval for a Mean	22
Sample Size for Estimating a Mean.....	23
100(1- α)% Confidence Interval Estimate for a Proportion.....	24
Sample Size for Estimating a Proportion	25
Normal Distribution	26
Hypothesis Testing.....	27
Mean, One Sample, σ unknown.....	29
Mean, One Sample, Two Paired Data Sets.....	30
Mean, Two Independent Samples, Equal Variances.....	32
with Raw Data and $\delta_0=0$	32
with Summary Data and $\delta_0=0$	34

Mean, Two Independent Samples, Unequal Variances	36
Mean, Two Independent Samples, where $\delta_0 \neq 0$	38
Proportion, One Sample.....	40
Proportion, Two Samples	41
Useful TI-84 Programs.....	43
Useful TI-nspire Programs	49
TI-nspire Crosswalk	55

LIST OF FIGURES

Figure 1 — Binomial-to-Normal Approximation	8
Figure 2 — Areas Under a Normal Curve	10
Figure 3 — TI-84 Commands for Normal and Student's "t" Distributions.....	21
Figure 4 — Graph of $p \cdot (1-p)$	25
Figure 5 — TI-84 Commands for Calculating Significance Levels.....	27

LIST OF TABLES

Table 1 — Common Keyboard Sequences	12
Table 2 — List Editor Basics	12
Table 3 — TI-84 Commands for Binomial and Poisson Distributions.....	19
Table 4 — TI-84 Commands for Normal and Student's "t" Distributions	21
Table 5 — Hypothesis Test Steps	27
Table 6 — Hypothesis Equivalentents	39

YOU HAVE TWO CHOICES

THE HARD WAY OR THE EASY WAY

Example 1 — The Hard Way

This is a question from a previous exam paper:

As part of a Christmas promotion, a department store offered a bonus gift to any shopper who spent over \$100 in any single transaction. Analysis of the data appears to show that:

- on average 180 customers made a purchase each hour;
 - the average amount spent by customers was \$91.45 with a standard deviation of \$8.30. The amount spent by customers was a normally distributed variable; and
 - 15% of customers received the bonus gift.
- If 50 customers were chosen at random, what would be the probability that no more than two would receive the bonus gift?*

We proceed as follows:

1. State the variable we are measuring:

Let X be the number of customers who receive the gift.

2. State the distribution we are using, together with its parameters. This is a binomial problem. We know that because it meets all four criteria:

- A fixed number of trials (50).
- Exactly two mutually-exclusive outcomes (each selected customer either received a gift or did not).
- The probability of success is known (15% or 0.15).
- The trials were random (the customers were selected randomly).

The general formula for the Binomial distribution is:

$$X \sim B(n, p)$$

where n is the number of trials and p is the probability of success. We were given both parameter values as part of the question, so we can substitute into the formula thus:

$$X \sim B(50, 0.15)$$

3. State what we are trying to calculate:

We want to calculate the probability that no more than two customers would receive the bonus gift. "No more than two" can

be expressed as "less than or equal to two", so what we are trying to calculate is the probability, using the given Binomial distribution, that X has a value less than or equal to 2 (customers):

$$P_B(X \leq 2)$$

4. We turn to the table book. Because this is a less-than-or-equal-to problem, we want to know the cumulative probabilities (ie the probability of exactly zero customers, plus the probability of exactly one customer, plus the probability of exactly two customers receiving the gift). We can obtain cumulative binomial probabilities from Table 2B which begins on page 13 of the book. We first need to search for $n=50$. As we turn the pages, we come to page 21 where $n=25$ but we find that the table book does not go beyond $n=25$. The solution for this is to use an approximation. There are two possibilities: Poisson and Normal. To decide which to use, we need to perform two calculations:

$$n \cdot p = 50 \cdot 0.15 = 7.5$$

$$n \cdot (1 - p) = 50 \cdot (1 - 0.15) = 42.5$$

If both numbers are greater than 5 (which they are), we have to use a Normal approximation.

5. The general formula for the Normal distribution is written as:

$$X \sim N(\mu, \sigma^2)$$

This tells us that we need to know the mean and variance before we can proceed. Fortunately, those two numbers can be calculated from the information we have:

$$\mu = n \cdot p = 50 \cdot 0.15 = 7.5$$

$$\begin{aligned} \sigma^2 &= n \cdot p \cdot (1 - p) \\ &= 50 \cdot 0.15 \cdot (1 - 0.15) \\ &= 6.375 \end{aligned}$$

Now we can write the distribution with its parameters:

$$X \sim N(7.5, 6.375)$$

6. Having changed the distribution, we also have to re-state what we are trying to calculate in terms of the new distribution:

$$P_B(X \leq 2) \equiv P_N(X < 2)$$

In words, “the Binomial probability that X is less than or equal to two is approximately equal to the Normal probability that X is less than two.”

- There is, however, a wrinkle. To understand it, we need to visualise the two distributions as shown in Figure 1. The Binomial distribution is discrete. In other words, it can only be calculated for integer values of the number of successes (ie, it makes no sense to ask if half a customer received a gift). The Normal distribution, on the other hand, is continuous. In using a Normal approximation, we are mapping between the sum of the heights of the blue bars and the area under the red curve. In order to make sure that we include sufficient area, we have to apply a “continuity correction factor”. The rule is simple: add 0.5. The result is the shaded area in Figure 1. We express that as follows:

$$P_N(X < 2.5)$$

The fact that the Normal distribution is continuous also explains why we have stopped using “ \leq ”. Imagine the lines coming up from the X -axis as being *infinitely thin* and you’ll see that “ $<$ ” and “ \leq ” really mean the same thing in this situation.

- We now go back to the table book and turn to Table 4C on page 34. We are trying to calculate the probability that X is less than 2.5 using a Normal distribution with a mean of

7.5 and variance 6.375. The problem we face now is that Table 4C only deals in something called Z-scores. That is just statistician-speak for using a normal curve with a mean of zero and a variance of 1. Before we can use Table 4C, we need to convert our problem into Z-scores. The formula for doing that is at the top of page 34:

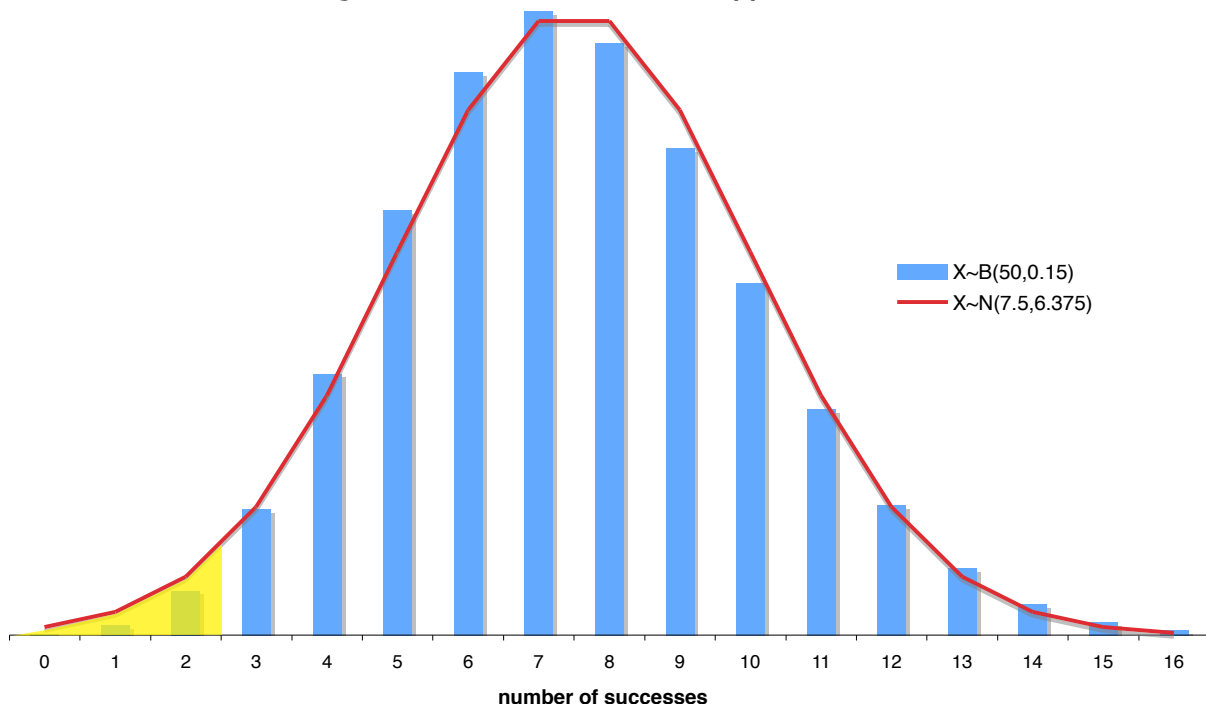
$$\begin{aligned} P_N\left(Z < \frac{x - \mu}{\sigma}\right) \\ &= P_N\left(Z < \frac{2.5 - 7.5}{\sqrt{6.375}}\right) \\ &= P_N(Z < -1.980295) \end{aligned}$$

I have given 6 decimal places to make the point that Table 4C only works to two decimal places, so we need to round to -1.98. Now, we can look down the Z column on page 34 until we find -1.90, then trace across to the .08 column (to give us -1.98) and read off the probability: 0.0239. At long last, we can actually answer the question:

“The probability that no more than two customers would receive the bonus gift is 0.0239 or around 2.4%.”

On the face of it, a very simple question but it took lots of mechanical steps to answer with numerous possibilities for silly mistakes.

Figure 1 — Binomial-to-Normal Approximation



Example 1 — The Easy Way

Now we will tackle the same problem with the TI-84. The first three steps are exactly the same:

1. Let X be the number of customers who receive the gift.
2. $X \sim B(50, 0.15)$
3. $P_B(X \leq 2)$
4. The TI-84 has the Binomial distribution built in, so we don't need to bother with approximations, means, variances, continuity correction factors or Z-scores. We use the *binomcdf*¹ function instead. The parameters are the number of trials (50), the probability of success (0.15), and the number of successes we are interested in (2). We type:

`binomcdf(50,0.15,2)`

and the TI-84 returns:

0.0141885166

which we can round to 0.0141 and use to answer the question:

"The probability that no more than two customers would receive the bonus gift is 0.0141 or around 1.4%."

Notice that this answer is different to the one we obtained from the table book. Why? Because of the combined effects of using the Normal approximation and the truncation of the Z-scores to two decimal places. Both answers are correct. The TI-84 is simply more precise.

Time taken to answer this question with the table book? Around 4 minutes 30 seconds. Time taken to answer this question with the TI-84? Less than 2 minutes. That's a saving of 2.5 minutes. Per question of this kind. Per test. That saving can be devoted to more time spent analysing and understanding each question.

Granted, not all probability problems are as convoluted as this one. Some are worse!

Example 2 — The Hard Way

Still not convinced? Let's try another part of the same exam question:

If one customer was chosen at random, what is the probability that the customer spent between \$85.00 and \$95.00?

We proceed as follows:

1. State the variable we are measuring:
Let X be the amount spent by customers (\$)

2. State the distribution we are using, together with its parameters. We have been told that the spending pattern was normally distributed, which is a giant clue that we should use the Normal distribution. We already know the general formula from the previous example, so we simply substitute the mean (\$91.45) and variance ($\8.30^2) from the question:

$$X \sim N(91.45, 8.30^2)$$

3. State what we are trying to calculate:
It always helps to visualise the problem. Figure 2 shows the distribution. What we need to find is the area under the curve between \$85 and \$95 dollars. That is simply another way of saying that we want to calculate the probability that X lies between \$85 and \$95 dollars:

$$P_N(85 < X < 95)$$

Remember that the Normal distribution is continuous, so we don't have to worry about less-than vs less-than-or-equal-to (trust me).

4. Recall from the previous example that Table 4C deals with Z-scores, so we need to rewrite our problem in terms of Z-scores:

$$P_N\left(\frac{85 - 91.45}{8.30} < Z < \frac{95 - 91.45}{8.30}\right) \\ \approx P_N(-0.78 < Z < 0.43)$$

Once again, we have rounded each Z-score to two decimal places because that is all Table 4C can handle.

5. Table 4C returns all the area under the curve between minus infinity and the Z-score. We are looking for an area in the middle so we need to calculate all the area from minus infinity to $z=0.43$ (the green hatching in Figure 2) and subtract from that all the area between minus infinity and $z=-0.78$ (the orange hatching). In other words, we rewrite the equation as follows:

$$P_N(Z < 0.43) - P_N(Z < -0.78)$$

6. Now we can look up the value of those two Z-scores in Table 4C and perform the actual calculation:

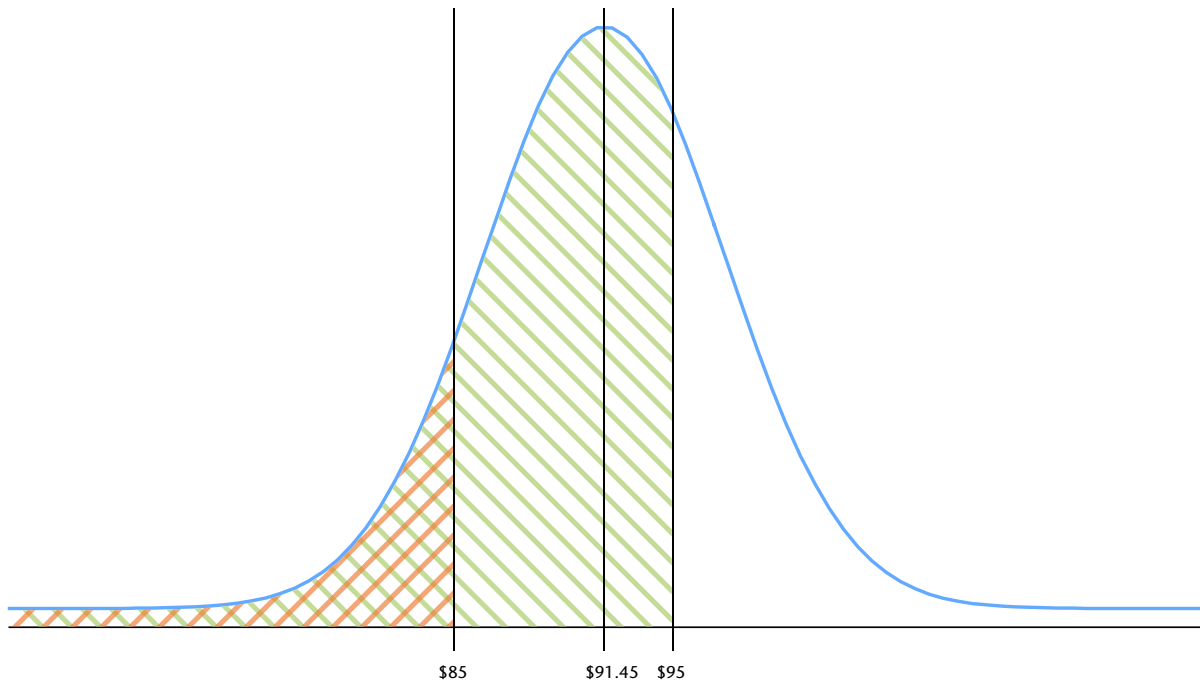
$$0.6664 - 0.2177 = 0.4487$$

The result enables us to answer the question:

"The probability that one customer chosen at random spent between \$85.00 and \$95.00 is 0.4487 or around 44.9%."

¹ Binomial Cumulative Distribution Function

Figure 2 — Areas Under a Normal Curve



Example 2 — The Easy Way

Now we will tackle the same problem with the TI-84. The first three steps are exactly the same:

1. Let X be the amount spent by customers (\$)
2. $X \sim N(91.45, 8.30^2)$
3. $P_N(85 < X < 95)$
4. The TI-84 has the *normalcdf*² function built in. The parameters are the minimum value (\$85), the maximum value (\$95), the mean (\$91.45), and the standard deviation (\$8.30). We type:

normalcdf(85,95,91.45,8.30)

and the TI-84 returns:

0.447021811

which we can round to four decimal places (0.4470) and use to answer the question:

“The probability that one customer chosen at random spent between \$85.00 and \$95.00 is 0.4470 or around 44.7%.”

There was no need to bother with Z-scores and there was no need to subtract the two probabilities. The TI-84 just gave us the answer.

Again, notice that the TI-84’s answer is slightly different to the one we obtained from the table book. Why? Because of the rounding when converting to Z-scores.

Time taken to answer this question with the table book? Around 3 minutes. Time taken to answer this question with the TI-84? Just over a minute. Another saving of the better part of two minutes.

How’s Your Accuracy?

Still weighing the pros and cons? Consider the following equation:

$$v = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1 - 1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2 - 1}}$$

Do you think you could enter that accurately into an ordinary calculator, time after time, and never make a mistake? The TI-84 just calculates that automatically when needed – you don’t even need to think about it.

One Word of Advice

I strongly recommend that you learn how to solve all these problems both ways. You will be able to use the TI-84 to check the results of the table-book methods and vice versa. That will help you to gain confidence in the TI-84 before the pressure of a test.

² Normal Cumulative Distribution Function

CONVENTIONS USED IN THIS DOCUMENT

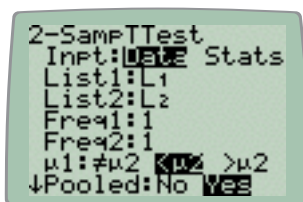
- Text written in *Handwriting* font is intended to show what you would actually write were you answering the question in a test. Where formulae are shown, you would also typically write those as part of your answer.
- A reference to a button on the TI-84 is given in blue condensed bold-face, such as “press **ENTER**”.
- A sequence of TI-84 commands such as “**STAT** ► **TESTS** 2 **ENTER**” means “press the **STAT** button, followed by one or more presses of the right arrow until the **TESTS** menu is selected, then press 2, then **ENTER**.”
- The expression “L1” means List 1. The easiest way to edit lists is with the List Editor. See Table 2 on the next page.
- Text written in mono-spaced font represents either commands to be given to the TI-84:

`invT(.05/2,df)`

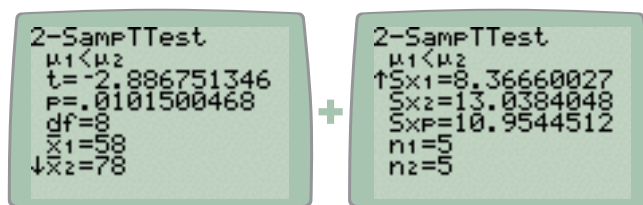
or responses from the TI-84:

`-2.235755908`

- A single screen image represents information that can stand alone:



- A dual screen image (note the “+” between the screens) represents information that forms a logical whole and which is typically viewed by using the up and down arrow keys or, if a program is paused, by pressing **ENTER** to move to the next screen:



QUICK REFERENCE

NOTE: THE MANUAL HAS A VERY GOOD INDEX

Table 1 — Common Keyboard Sequences

Button	Key Sequence	Notes
ANS	2ND (-)	Retrieves the last value calculated by the TI-84 and makes it available to the next calculation. Often supplied automatically.
CATALOG	2ND 0	For accessing all TI-84 functions. If you can't find something in another menu, this is where you should look. Note that the keyboard enters alpha-lock mode and that you can jump to various letters of the alphabet to speed your search.
DISTR	2ND VARS	Accesses the distribution functions (Normal, Binomial, Poisson, and their inverses). You will spend a lot of time here!
EE	2ND ,	"Ten to the power of". You will need this when working with Normal distributions to indicate negative and positive infinities. These are -1E99 and 1E99, respectively. Note that the "-" is the change sign key (-) and not the - subtraction key.
ENTRY	2ND ENTER	Retrieves the last command executed by the calculator and makes it available for editing. Very useful if you make a trivial mistake in a complex formula.
INS	2ND DEL	Enables insert mode. Remains in effect until cancelled by an arrow key, DEL , CLEAR or ENTER etc.
MEM	2ND +	Memory management. The most common command you will use from here is MEM 4 ENTER (Clear All Lists).
OFF	2ND ON	Turns the calculator off.
QUIT	2ND MODE	Exits the list editor, the program editor, and just about any other "modal" situation.
$\sqrt{\quad}$	2ND X²	Square root. Notice the automatic open parenthesis!

Table 2 — List Editor Basics

Action	Command						
Start the List Editor	STAT 1						
Quit the List Editor	QUIT						
Reset the List Editor	STAT 5 ENTER						
Clear All Lists	MEM 4 ENTER						
Clear One List (eg L1)	<table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th>From</th> <th>Do</th> </tr> </thead> <tbody> <tr> <td>Home Screen</td> <td>STAT 4 L1</td> </tr> <tr> <td>List Editor</td> <td>Place the cursor on the list title and press CLEAR ENTER</td> </tr> </tbody> </table>	From	Do	Home Screen	STAT 4 L1	List Editor	Place the cursor on the list title and press CLEAR ENTER
	From	Do					
	Home Screen	STAT 4 L1					
List Editor	Place the cursor on the list title and press CLEAR ENTER						
Clear Several Lists (eg L1, L2, L3)	STAT 4 L1 , L2 , L3 ENTER						
Remove One Entry From A List	Place the cursor on the entry to be removed and press DEL						
Insert One Entry Into a List	Place the cursor on an entry and press INS . A new entry with a value of zero is inserted <i>before</i> the selection. Type a new value and press ENTER						

SUMMARISING DATA

WHERE THE TI-84 IS PROBABLY OVERKILL

Mean, Median and Standard Deviation

A hotel has 200 guest rooms. The number of people currently occupying each guest room is summarized in the table below. (You may use the blank columns for your calculations.)

Number of Guests in the Guest Rooms

Number of Guests	Frequency				
0	50				
1	80				
2	40				
3	30				
Total	200				

(a) What is the mean, median and modal number of guests per room?

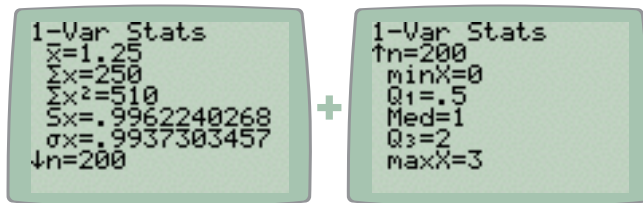
TI-84 Method

1. Enter the values for Number of Guests into L1. Enter the values for Frequency into L2.
2. Press **STAT** ► **CALC** 1. "1-Var Stats" is pasted to the main screen. We need to pass both lists as arguments, so append **L1** , **L2**. For the sake of clarity, the complete command you should see on screen is:

1-Var Stats L1,L2

Press **ENTER**.

3. The TI-84 responds:



Note: do not rely on the TI-84 to calculate Q1 or Q3 because it does not use the method that you will be taught in this unit.

4. Write the answers:

mean = 1.25 guests

median = 1 guest

mode = 1 guest¹

(b) What is the standard deviation of the number of guests per room?

TI-84 Method

1. Answer is already on the screen from the previous question. Write:

S_x = 0.9962240268

≈ 1 guest

¹ Of course, this comes from the class with the greatest frequency, not the TI-84.

Additional Tricks With Lists

Whole-of-List Operations

The TI-84 can work with lists directly. Assuming the hotel data from the previous page is still in the list editor, try the following:

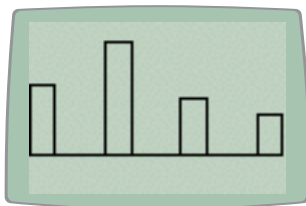
To Calculate	Use Command Sequence
fx	L1 * L2 STO L3
fx^2	L1 x² * L2 STO L4
Cumulative Frequency (x)	cumSum(L2) STO L5

The cumulative frequency command can be found in the **CATALOG**. After executing the above commands, the list editor (**STAT 1**) will show:

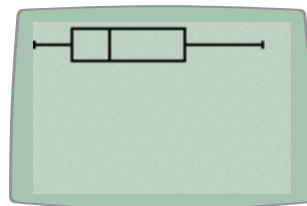
L1	L2	L3	L4	L5
0	50	0	0	50
1	80	80	80	130
2	40	80	160	170
3	30	90	270	200

Visualising Data In Lists

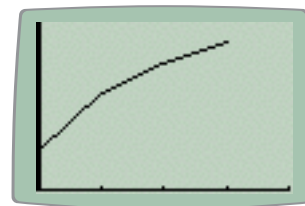
The TI-84 can plot data in lists. While not as sophisticated as, say, Microsoft Excel, you can still gain a quick impression of the overall distribution of small data sets. Explore the **STATPLOT** menu and see if you can produce the following:



Bar Chart



Box Plot

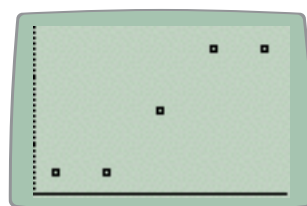


Ogive

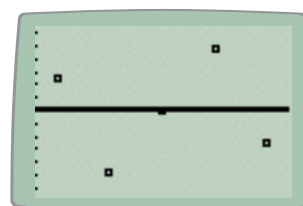
Hints:

- Use **ZOOM 9** to automatically scale to fit statistical plots.
- Use **WINDOW** to adjust origin, range and scaling factors.
- Use **FORMAT** to control presentation.
- Use **TRACE** to identify coordinates on screen².
- Note that you can combine plots (eg the bar chart and the box plot on the same screen).

Scatter plots to try with the data on page 16:



GDP vs Imports



Predicted vs Residuals

² If you trace the box-plot, remember that the TI-84 uses its own method to calculate Q1 & Q3.

CORRELATION & REGRESSION

START YOUR ENGINES!

Spearman's Rank Correlation Coefficient

The production manager of a firm wants to examine the relationship between aptitude test scores given prior to hiring of production-line workers and performance ratings received by the employees three months after starting work. The results of the study would allow the firm to decide how much weight to give these aptitude tests relative to other work history information obtained, including references. The aptitude test scores range from 0 to 100. The performance ratings range from 1 to 5 where 1 is *Employee has performed well below average* and 5 is *Employee has performed well above average*. The results are displayed in the table below. (Use the blank columns for your calculations)

Aptitude Test Score and Performance Ratings

Employee	Aptitude Test Score	Performance Rating	Rank Score	Rank Rating	Diffs	Diffs ²
1	56	2				
2	96	2				
3	36	1				
4	80	4				
5	56	2				

- (a) Calculate and interpret Spearman's rank correlation coefficient for the aptitude test scores and the performance ratings.

TI-84 Method

1. Entering the values for Aptitude Test Score into L₁, and those for Performance Rating into L₂.
2. Execute program RSX. The answers returned are, in order, N, Σd^2 (as Σx^2) and R_s displayed as 5, 5.5 and 0.725, respectively.
4. Write the answer and the interpretation:

$$r_s = 0.725$$

There appears to be a strong positive monotonic relationship between aptitude test score and performance rating.

5. Note that L₅ contains the differences between the two ranks. If the question had required you to calculate the differences, you could now transcribe those numbers.

- (b) Calculate and interpret the covariance for the aptitude test scores and the performance ratings.

TI-84 Method

1. The data was already entered into L₁ and L₂.
2. Execute program LR. Among the many variables displayed, one is $COV(X,Y) = 14.8$.
3. Write the answer and the interpretation:

$$COV(X,Y) = 14.8$$

The sign of the covariance is positive so the monotonic relationship is positive.

Linear Regression

The GDP imports of a small, open island economy over a 5 year period were as shown in the table below. A trainee economist estimated the import function as $\hat{m} = 2.4 + 0.6g$

GDP and Imports of a Small Island Economy

GDP (\$M) g	Imports (\$M) m	<i>predicted values</i>	<i>explained deviations</i>	<i>residuals</i>	<i>observed deviations</i>
48	36	31.2	7.2	4.8	12
24	12	16.8	-7.2	-4.8	-12
36	24	24.0	0	0	0
12	12	9.6	-14.4	2.4	-12
60	36	38.4	14.4	-2.4	12

(a) For each observation, calculate the predicted value, the observed deviation from the mean, the explained deviation from the mean, and the residual. Enter the figures in the blank columns of the table. Label each column.

TI-84 Method

1. Enter the values for GDP into L₁, and the values for Imports into L₂.
2. Execute program LR. Values for SSR, SSE and SST are displayed on the first screen. You need them for part (b) of the question so write them down now:

$$SSR = 518.4$$

$$SSE = 57.6$$

$$SST = 576$$

3. The program is paused, so press **ENTER** to continue. Ignore the second screen because it does not contain any values you will need to answer this question. The program pauses again, so press **ENTER** to continue. The last screen includes R^2 , so you could simply write "0.9" to answer (c) but the question is obviously aimed at having you show that you understand that R^2 can be calculated by dividing SSR by SST, so it is probably better to show that, together with the interpretation:

$$R^2 = SSR/SST = 518.4/576 = 0.9$$

90% of the observed variation in imports can be explained by the observed differences in GDP with 10% due to other factors.

4. The last step is to transcribe the values from the TI-84's lists into the table. Press **STAT 1** to view the lists. L₃ contains the predicted values, L₄ the explained deviations from the mean, L₅ the residuals, and L₆ the observed deviations from the mean. Press **QUIT** to exit the list editor.

(b) Calculate the SST, SSR and SSE.

Already done at step 2 above.

(c) Calculate the coefficient of determination. Interpret this value.

Already done at step 3 above.

Note that we have answered the various parts of this question out of order. There is nothing wrong with this. However, if it worries you, simply observe that the data remains in the lists until you clear it, so you can do step 1, execute LR, allow the program to run to completion and transcribe the answers for (a) from the lists, then execute LR again to answer (b) and (c).

PROBABILITY

CRUISIN' DOWN THE HIGHWAY

Probability Distribution

A newspaper company sometimes makes printing errors in its advertising and is forced to provide correct advertising in the next issue of the paper. The managing editor has done a study of this problem and has found the following data.

Let X = the number of errors.

The estimated probability distribution of X is displayed in the table below. (Use the blank columns for your calculations.)

Probability Distribution of the Number of Errors in Advertising

X	P(X)				
0	0.70				
1	0.10				
2	0.10				
3	0.05				
4	0.05				

(a) Calculate the mean of X .

TI-84 Method

1. Enter the values for X into L_1 . Enter the values for $P(X)$ into L_2 .
2. Press **STAT** ► **CALC** 1. "1-Var Stats" is pasted to the main screen. We need to pass both lists as arguments, so type **L1** , **L2**. For the sake of clarity, the complete command you should see on screen is:

1-Var Stats L1, L2

Press **ENTER**.

3. The results screen includes two values of interest:

$$\bar{x} = 0.65$$

$$\sigma_x = 1.152171862$$

4. Write the answer:

0.65 errors

(b) Calculate the variance of X .

TI-84 Method

1. The standard deviation is already on the screen from the previous step. You can either re-type it then square it, or retrieve the actual value and square it. The second approach is more reliable. Press **VARS** 5 4, which pastes σ_x to the screen, then press the **X²** button followed by **ENTER**. The answer is 1.3275:

$$1.3275 \text{ errors}^2$$

Binomial Distribution

Leakage from underground petrol tanks at service stations can damage the environment. This can result in large clean-up and legal bills. It is estimated that 20% of these tanks leak. You examine 15 tanks chosen at random, independently of each other. Let X be the number of tanks that leak.

(a) Give the name of the probability distribution of X and the value of its parameters.

$$X \sim B(15, 0.2) \text{ (a binomial distribution)}$$

(b) What is the probability that exactly 5 of the 15 tanks leak?

TI-84 Method

1. Consult Table 3. "Exactly 5" means $P(X=5)$ which means we need the TI-84's "binompdf" function. The parameters are the number of trials (15), the probability of success (0.2) and the number of events (5). The required command is:

```
binompdf(15,0.2,5)
```

The TI-84 returns:

```
0.1031822943
```

which we round and answer:

$$P = 0.1032$$

(b) What is the probability that 8 or more of the tanks leak?

TI-84 Method

1. "Eight or more" means $P(X \geq 8)$. The formula and parameters are available in Table 3. The required command is:

```
1-binomcdf(15,0.2,8-1)
```

The TI-84 returns:

```
0.0042397497
```

which we round and answer:

$$P = 0.0042$$

(c) What is the probability that more than 2 and less than 7 of the tanks leak?

TI-84 Method

1. The easiest way to understand this is to write out a number-line and underline the values we are interested in:

```
1 2 3 4 5 6 7
```

2. We can conceptualise that as the probability that X is less than or equal to 6, minus the probability that X is less than or equal to 2, or $P(X \leq 6) - P(X \leq 2)$. Once again, refer to Table 3. The required command is:

```
binomcdf(15,0.2,6)-binomcdf(15,0.2,2)
```

The TI-84 returns:

```
0.5839179814
```

which we round and answer:

$$P = 0.5839$$

It is just as easy to do question (c) using the table book. You will even get exactly the same answer. The above simply demonstrates the TI-84 technique.

Binomial Distribution (continued)

Mail articles posted using express post should be delivered the next day after posting. It has been found that 1.5% of express post articles are not delivered the next day after posting. A firm posts 150 letters by express post to various destinations on the same day. What is the probability that more than five of the letters are not delivered the next day?

TI-84 Method

1. This is a binomial problem: a fixed number of trials (150), exactly two mutually-exclusive outcomes (delivered, not delivered), probability of success known (0.015) and random events (assumed).
2. "More than five" means $P(X > 5)$. The formula and parameters are available in Table 3. The required command is:

`1-binomcdf(150,0.015,5)`

The TI-84 returns:

`0.026318526`

which we round and answer:

$P = 0.0263$

This example is included because, if you were using the table book, it is one where you would have to use both the complement rule and a Poisson approximation. Congratulations! By using the TI-84, you have just saved yourself both a headache and a minute or so in the test.

Table 3 — TI-84 Commands for Binomial and Poisson Distributions

Question	=	Binomial	Poisson
$P(X < k)$	$P(X \leq k-1)$	<code>binomcdf(n,p,k-1)</code>	<code>poissoncdf(μ,k-1)</code>
$P(X \leq k)$		<code>binomcdf(n,p,k)</code>	<code>poissoncdf(μ,k)</code>
$P(X = k)$		<code>binompdf(n,p,k)</code>	<code>poissonpdf(μ,k)</code>
$P(X \geq k)$	$1-P(X \leq k-1)$	<code>1-binomcdf(n,p,k-1)</code>	<code>1-poissoncdf(μ,k-1)</code>
$P(x > k)$	$1-P(X \leq k)$	<code>1-binomcdf(n,p,k)</code>	<code>1-poissoncdf(μ,k)</code>

Poisson Distribution

Lillian works for an accounting firm. Occasionally she makes errors. Looking over her past work it has been determined that on average she makes 4 errors per month. Let X be the number of errors Lillian makes in one month.

(a) Give the name of the probability distribution of X and the value of its parameters.

$$X \sim \text{Po}(4) \quad (\text{a Poisson distribution})$$

(b) What is the probability that Lillian makes exactly 5 errors in a randomly chosen month?

TI-84 Method

1. Consult Table 3. "Exactly 5" means $P(X=5)$ which means we need the TI-84's "poissonpdf" function. Press **DISTR**, scroll down until you find that function and press **ENTER**. The parameters are the mean (4) and the number of events we are interested in (5). Type:

```
poissonpdf(4,5)
```

The TI-84 returns:

```
0.1562934519
```

which we round and answer:

$$P = 0.1563$$

(b) What is the probability that Lillian makes no more than 5 errors in a randomly chosen month?

TI-84 Method

1. "No more than five" means $P(X \leq 5)$. The formula and parameters are available in Table 3. The required command is:

```
poissoncdf(4,5)
```

The TI-84 returns:

```
0.7851303874
```

which we round and answer:

$$P = 0.7851$$

CONFIDENCE INTERVALS & SAMPLING DISTRIBUTIONS

PEDAL TO THE METAL!

During the semester, you will be given the formulae below. The TI-84 equivalents are shown alongside. Figure 3 shows the relationship between TI-84 commands and the Normal & “t” distributions. Table 4 contains similar information but from the perspective of “What is the probability that...?” questions.

FORMULAE

1. 100(1-α)% confidence interval estimate for a mean

$$P\left(\bar{x} - t_{\alpha/2} \frac{s}{\sqrt{n}} < \mu < \bar{x} + t_{\alpha/2} \frac{s}{\sqrt{n}}\right) = 1 - \alpha \quad \text{with } v = n - 1 \quad \text{T-Interval}$$

2. Sample size for estimating a mean

$$n \geq \left[\frac{z_{\alpha/2} \hat{\sigma}}{B} \right]^2 \quad \text{SSM}$$

3. 100(1-α)% confidence interval estimate for a proportion

$$P\left(\hat{p} - z_{\alpha/2} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} < p < \hat{p} + z_{\alpha/2} \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}\right) = 1 - \alpha \quad \text{CIP}$$

4. Sample size for estimating a proportion

$$n \geq p^*(1-p)^* \left[\frac{z_{\alpha/2}}{B} \right]^2 \quad \text{SSP}$$

Figure 3 — TI-84 Commands for Normal and Student’s “t” Distributions

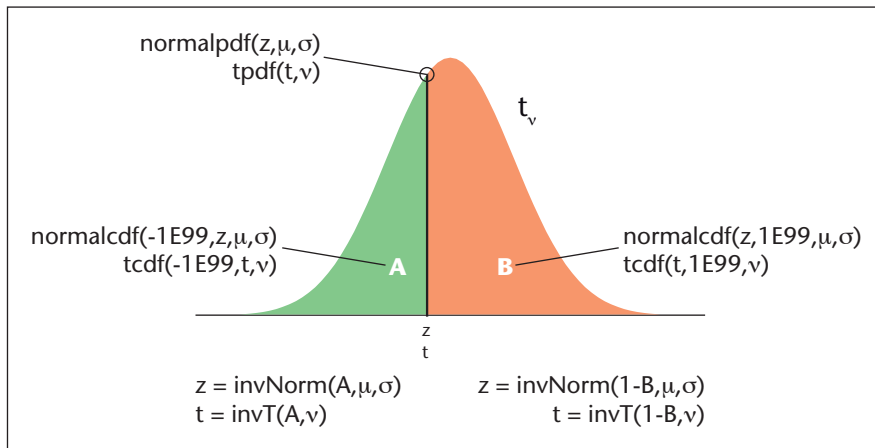


Table 4 — TI-84 Commands for Normal and Student’s “t” Distributions

Question	=	Normal	Student’s “t”
$P(X \leq k)$	$P(X < k)$	normalcdf(-1E99, k, μ, σ)	tcdf(-1E99, k, v)
$P(X = k)$		normalpdf(k, μ, σ)	tpdf(k, v)
$P(X \geq k)$	$P(X > k)$	normalcdf(k, 1E99, μ, σ)	tcdf(k, 1E99, v)

100(1- α)% Confidence Interval for a Mean

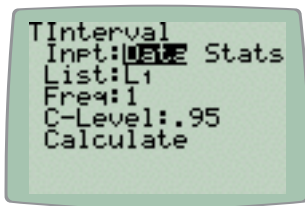
Welton Corporation makes dynamic random access memory chips (DRAMs) for use in personal computers. DRAMs are made on silicon wafers. The company's goal is to yield as many good chips from each wafer as possible in order to make more profit from its production operations. They collected the number of usable DRAMs from each of a sample 15 wafers. The results are as follows:

413 436 474 477 485 485 488 497 497 497 551 551 554 569 579

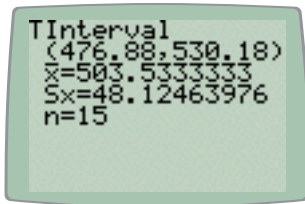
Give a point and 95% confidence interval estimate for the mean number of usable DRAMs.

TI-84 Method

1. Enter the values into L1.
2. Press **STAT** \blacktriangleright **TESTS** 8. The input sheet for the T-Interval test appears on the screen. Set the parameters as follows:



3. Put the cursor on top of "Calculate" and press **ENTER**. The TI-84 returns:



The second row contains the confidence interval and the third row (the mean) contains the point estimate.

4. Round the mean to give the point estimate:

The point estimate is 504 usable DRAMs per wafer.

5. Although you could simply write down the confidence interval, it is always better to show how you would have arrived at the answer had you not been using the TI-84. Apart from anything else, if you make a mistake entering the data, your answer will be wrong. A wrong answer with no method will get you no marks. If you show your method, you will still pick up some marks even if your answer is wrong. You don't have to do too much extra work. First, calculate the value of $t_{n-1,\alpha/2}$ then use that along with the other variables you already have on screen:

$$\begin{aligned}
 t_{n-1,\alpha/2} &= \text{invT}((1 + 0.95) / 2, 15 - 1) & \bar{x} \pm t_{n-1,\alpha/2} \cdot \frac{s}{\sqrt{n}} \\
 &= 2.1448 & &= 503.5333 \pm 2.1448 \cdot \frac{48.1246}{\sqrt{15}} \\
 & & &= (476.88, 530.18)
 \end{aligned}$$

Because you are simply transcribing values into the formula on the right hand side, be careful about rounding too much!

6. Round the confidence interval outwards and answer:

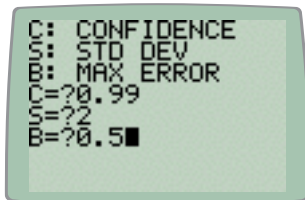
We can be 95% confident that the true mean number of usable DRAMs per wafer lies between 476 and 531.

Sample Size for Estimating a Mean

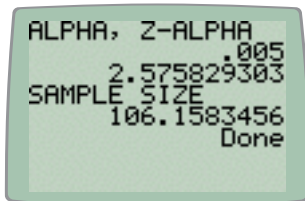
A company with a large fleet of cars hopes to keep petrol costs down and sets a goal of attaining a fleet average of 9 litres per 100 km. A preliminary survey gives a sample mean of 9.5 litres per 100 km and a sample standard deviation of 2 litres per 100 km. How large a sample is required to determine the mean fuel consumption with an error of no more than 0.5 litres per 100 km with 99% confidence?

TI-84 Method

- Execute program SSM. Supply the requested parameters:

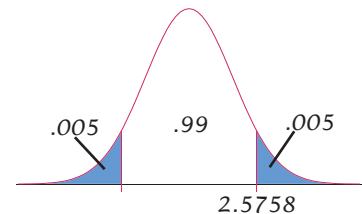


The TI-84 returns:



- Show your method. You would usually draw a Normal curve with 0.99 (the confidence interval) in the middle, two tails each containing 0.005, and the 2.5758 value of Z-alpha (the TI-84 has just given you both numbers). Using the information on screen and from the question, you can transcribe:

$$\begin{aligned}
 Z_{\alpha/2} &= \text{invNorm}(1 - 0.005) \\
 &= 2.5758 \\
 n &\geq \left(\frac{Z_{\alpha/2} \cdot \hat{\sigma}}{B} \right)^2 \\
 &= \left(\frac{2.5758 \cdot 2}{0.5} \right)^2 \\
 &= 106.1583
 \end{aligned}$$



then round upwards and write the conclusion. There is no need to actually recalculate anything unless you want to double-check that SSM is working properly.

- Round upwards and answer the question:

We require one sample of 107 cars.

100(1-)% Confidence Interval Estimate for a Proportion

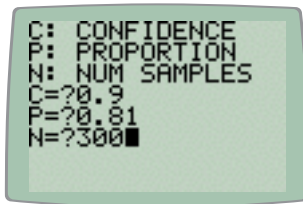
A bank is interested in estimating the proportion of its customers who have credit cards with one or more other banks. A simple random sample of 300 customers showed that 243 have credit cards with one or more other banks. Give a point and 90% confidence interval estimate for the proportion of the bank's customers who have credit cards with one or more other banks.

TI-84 Method

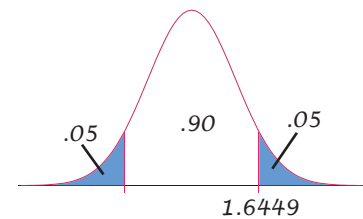
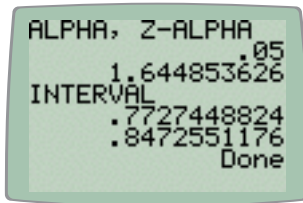
1. Calculate the point estimate by dividing 243 by 300 = 0.81 and answer the first part of the question:

Point estimate: 81% of the bank's customers have credit cards with one or more other banks.

2. Execute program CIP. Supply the requested parameters:



The TI-84 returns:



3. Show your method. Draw a Normal curve with 0.90 in the middle, two tails each containing 0.05, and the 1.6449 value of Z-alpha (the TI-84 has just given you both numbers). Then expand the formula by transcribing:

$$\begin{aligned}
 Z_{\alpha/2} &= \text{invNorm}(1 - 0.05) \\
 &= 1.6449 \\
 \hat{p} \pm Z_{\alpha/2} \cdot \sqrt{\frac{\hat{p} \cdot (1 - \hat{p})}{n}} &= 0.81 \pm 1.6449 \cdot \sqrt{\frac{0.81 \cdot (1 - 0.81)}{300}} \\
 &= (0.7727, 0.8473)
 \end{aligned}$$

As before, you can do this just by transcribing the numbers on screen and in the original question. There is no need to actually recalculate the answer unless you want to double-check that CIP is working properly.

4. Round outwards and answer the question:

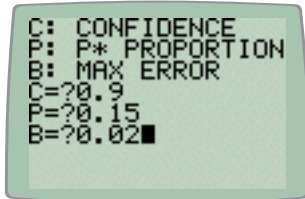
There is a 90% probability that the true proportion of the bank's customers who have one or more credit cards with other banks lies between 77% and 85%.

Sample Size for Estimating a Proportion

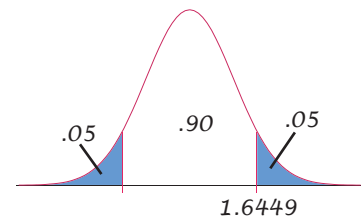
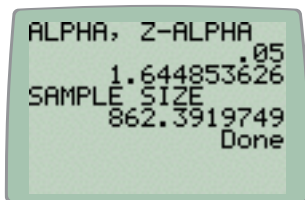
A researcher plans to conduct a survey to estimate the proportion of the workforce that has 2 or more jobs. She believes this proportion is between 0.10 and 0.15. She wants her estimate to be within 0.02 of the population value with 90% confidence. How large a sample should she take?

TI-84 Method

1. Determine the appropriate estimate to use from Figure 4. The value 0.15 clearly results in a higher point on the curve than 0.10, so 0.15 is the appropriate choice.
2. Execute program SSP. Supply the requested parameters:



The TI-84 returns:



3. Show your method. Draw a Normal curve with 0.90 in the middle, two tails each containing 0.05, and the 1.6449 value of Z-alpha (the TI-84 has just given you both numbers). Then expand the formula by transcribing:

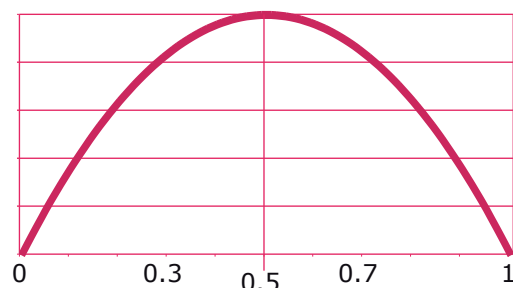
$$\begin{aligned}
 Z_{\alpha/2} &= \text{invNorm}(1 - 0.05) \\
 &= 1.6449 \\
 n &\geq p^* \cdot (1 - p^*) \cdot \left(\frac{Z_{\alpha/2}}{B} \right)^2 \\
 &= 0.15 \cdot (1 - 0.15) \cdot \left(\frac{1.6449}{0.02} \right)^2 \\
 &= 862.392
 \end{aligned}$$

As before, you can do this just by transcribing the numbers on screen and in the original question. There is no need to actually recalculate the answer unless you want to double-check that SSP is working properly.

4. Round upwards and answer the question:

The researcher requires one sample of 863 workers.

Figure 4 — Graph of $p \cdot (1-p)$



Normal Distribution

The annual rate of return on a mutual fund is normally distributed with a mean of 14% and a standard deviation of 18%.

(a) What is the probability that the fund returns more than 25% next year?

TI-84 Method

1. Show what we are calculating:

Let X be the percentage returned by the fund next year.

$$X \sim N(0.14, 0.18)$$

$$P(X > 0.25)$$

2. Draw a normal distribution with a mean of 0.14. Mark the 0.25 position and shade the area to the right. In other words, we want all the area under the curve to the right of 25%. Calculate:

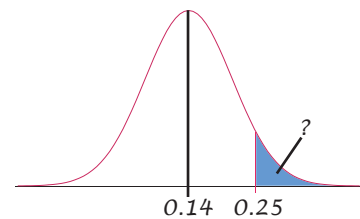
$$\text{normalcdf}(0.25, 1E99, 0.14, 0.18)$$

The TI-84 returns:

$$0.2705629552$$

which we round and answer:

$$P = 0.2706$$



(b) What is the probability that the fund loses money next year?

TI-84 Method

1. Show what we are calculating:

Let X be the percentage returned by the fund next year.

$$X \sim N(0.14, 0.18)$$

$$P(X < 0) \quad (\text{ie, less than break-even})$$

2. Draw a normal distribution with a mean of 0.14. Mark the 0 position and shade the area to the left. Calculate:

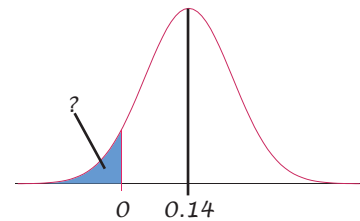
$$\text{normalcdf}(-1E99, 0, 0.14, 0.18)$$

The TI-84 returns:

$$0.2183499461$$

which we round and answer:

$$P = 0.2183$$



(c) There is only a 15% chance of the fund earning more than $x\%$ next year. What is x ?

TI-84 Method

1. Draw a normal distribution with a mean of 0.14. Mark an arbitrary point called " x ", shade the area to the right and label it 0.15. Like the table book, the TI-84's inverse normal function is concerned with the area to the left so we need to use the complement rule. Calculate:

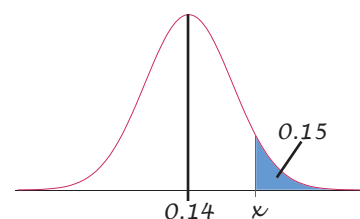
$$\text{invNorm}(1 - 0.15, 0.14, 0.18)$$

The TI-84 returns:

$$0.3265580084$$

which we round and answer:

$$X = \text{an annual rate of return of } 32.66\%$$



HYPOTHESIS TESTING

ROADS? WHERE WE'RE GOING, WE DON'T NEED ROADS!

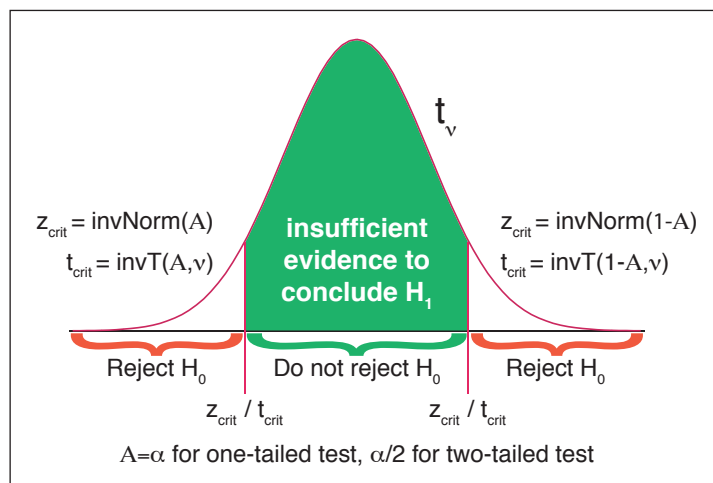
The chart on the next page is similar to the Hypothesis Testing Decision Tree you will be given in class. The difference is that this chart is optimised for the TI-84. Figure 5 is a useful reference for calculating critical values during hypothesis tests.

There are no examples for *Mean, One Sample, σ known*. If you encounter one of those, simply follow *Mean, One Sample, σ unknown* but substitute the TI-84's "ZTest" function where you see "TTest". Do remember, however, that σ means the *population* standard deviation. If the question gives you the standard deviation from a sample, you still need to use "TTest".

Table 5 — Hypothesis Test Steps

1. State the hypothesis.
2. State the test statistic and the sampling distribution.
Note the degrees of freedom (v) where appropriate.
3. State the level of significance: α
4. State the decision rule ("reject H_0 if...")
5. Calculate the test statistic and make the decision.
6. Make a full written conclusion.

Figure 5 — TI-84 Commands for Calculating Significance Levels



Type	Samples	Qualifier	Step 1	Test Statistic	TI-84	ν
	one	one data set σ known	Let $\mu =$ mean of $\mu_0 = x$ $H_0: \mu \leq \mu_0$ $H_1: \mu < \# > \mu_0$	$z_{obs} = \frac{\bar{x} - \mu_0}{\sigma / \sqrt{n}}$	Z-Test	
		one data set σ unknown		$t_{obs} = \frac{\bar{x} - \mu_0}{s / \sqrt{n}}$	T-Test	$\nu = n - 1$
Mean	two	two paired data sets		$t_{obs} = \frac{\bar{d} - \delta_0}{s_d / \sqrt{n_d}}$	$L_1 = \{x_1, x_2, \dots, x_n\}$ $L_2 = \{x_1, x_2, \dots, x_n\}$ $L_1 - L_2 \gg L_3$ T-Test ($\mu_0 = \delta_0$)	$\nu = n_d - 1$
		$\frac{s_{larger}^2}{s_{smaller}^2} < 10$ $s_2^2 = s_1^2$ (pooled=yes)	Let $\mu_1 =$ mean of Let $\mu_2 =$ mean of if $\delta_0 = 0$ $H_0: \mu_1 \leq \mu_2$ $H_1: \mu_1 < \# > \mu_2$ if $\delta_0 \neq 0$ $H_0: \mu_1 - \mu_2 \leq \delta_0$ $H_1: \mu_1 - \mu_2 < \# > \delta_0$	$t_{obs} = \frac{(\bar{x}_1 - \bar{x}_2) - \delta_0}{\sqrt{s_p^2 \left(\frac{1}{n_1} + \frac{1}{n_2} \right)}}$ $s_p^2 = \frac{(n_1 - 1) \bullet s_1^2 + (n_2 - 1) \bullet s_2^2}{n_1 + n_2 - 2}$	1. Ignore δ_0 . 2. Run 2-SampTTest (either DATA or STATS) (set hypothesis) 3. If $\delta_0 \neq 0$, run M2(δ_0).	$\nu = n_1 + n_2 - 2$
Proportion	one		Let $p =$ proportion of $p_0 = x/n$ $H_0: p \leq \mu_0$ $H_1: p < \# > p_0$	$z_{obs} = \frac{\hat{p} - p_0}{\sqrt{p_0 \bullet q_0 / n}}$	1-PropZTest	
	two		Let $p_1 =$ proportion of (x_1/n_1) Let $p_2 =$ proportion of (x_2/n_2) $H_0: p_1 \leq \mu_2$ $H_1: p_1 < \# > p_2$	$z_{obs} = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\hat{p}_c \bullet \hat{q}_c \left[\frac{1}{n_1} + \frac{1}{n_2} \right]}}$ $\hat{p}_c = \frac{x_1 + x_2}{n_1 + n_2}$	2-PropZTest	
Linear Relationship			Let $b_1 =$ slope of $\beta_1 = 0$ (usually) $H_0: \beta_1 \leq \mu_0$ $H_1: \beta_1 < \# > 0$	$t_{obs} = \frac{b_1 - \beta_1}{s_{b_1}}$		$\nu = n - 2$

Mean, One Sample, σ unknown

The liquid chlorine added to swimming pools to combat algae has a relatively short shelf life before it loses its effectiveness. Records indicate that the mean shelf life of a 20 litre container is 2160 hours (90 days). An additive, *Holdlonger*, has been developed to increase the shelf life of chlorine. As an experiment, *Holdlonger* was added to 9 containers of chlorine. The shelf lives (in hours) were:

2158 2179 2180 2169 2160 2167 2174 2161 2165

Has *Holdlonger* increased the shelf life of the chlorine? Use a 5% test. What is the p-value?

TI-84 Method

1. State the hypothesis:

Let μ be the mean shelf life of all containers with Holdlonger.

$$\mu_0 = 2160$$

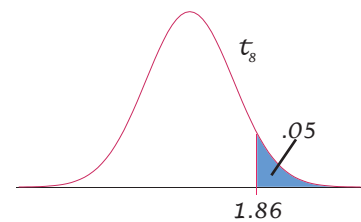
$$\mathcal{H}_0: \mu \leq \mu_0$$

$$\mathcal{H}_1: \mu > \mu_0$$

2. State the test statistic:

$$t_{obs} = \frac{\bar{x} - \mu_0}{s / \sqrt{n}}$$

$$\begin{aligned} v &= n - 1 \\ &= 9 - 1 = 8 \end{aligned}$$



3. State the level of significance:

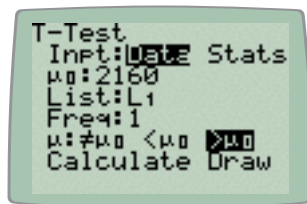
$$\alpha = .05$$

4. State the decision rule (consult Figure 5 for the TI-84 formula for calculating t_{crit}):

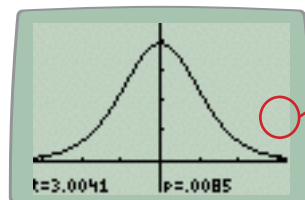
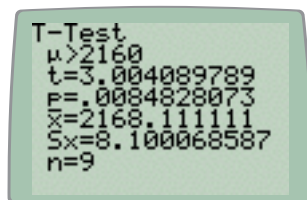
$$t_{crit} = \text{inv}T(1 - 0.05, 8) \approx 1.86$$

Reject \mathcal{H}_0 if $t_{obs} > 1.86$

5. Enter the data into L1. Calculate the test statistic. Run "TTest" (STAT ► TESTS 2 ENTER). The TI-84 responds with an entry sheet. Set the parameters as follows:



Place the cursor on top of either "Calculate" or "Draw" and press **ENTER**. The TI-84 responds:



Really small area filled in here

Make the decision:

$$t_{obs} = 3.00 \text{ (from TI-84 TTest); } 3.00 > 1.86 \therefore \text{reject } \mathcal{H}_0.$$

6. Write the conclusion:

Based on the sample, there is sufficient evidence at the 5% significance level to conclude that Holdlonger has increased the shelf life of the chlorine. The p-value is 0.0085.

Mean, One Sample, Two Paired Data Sets

A spokesperson for a charity asserts that the Canberra show is becoming too expensive for the average Canberra household to attend. The spokesperson claims that the cost of attending the show has risen by more than \$15 since last year. A simple random sample of ten households attending the show reported the following expenditures at this year's show (\$):

115 130 106 124 169 121 133 112 111 154

The same 10 households were asked how much they spent last year and the replies (in the same order as above) were (\$):

92 124 82 110 150 102 112 95 110 120

(a) Has the average cost risen by more than \$15? Use a 5% test.

TI-84 Method

1. Show what we are calculating:

Let μ_1 be the mean household expenditure this year.

Let μ_2 be the mean household expenditure last year.

$$\mathcal{H}_0: \mu_1 - \mu_2 \leq 15$$

$$\mathcal{H}_1: \mu_1 - \mu_2 > 15$$

2. State the test statistic:

$$t_{obs} = \frac{\bar{d} - \delta_0}{s_d / \sqrt{n_d}} \quad v = n_d - 1 = 10 - 1 = 9 \quad \delta_0 = 15$$

3. State the level of significance:

$$\alpha = .05$$

4. State the decision rule:

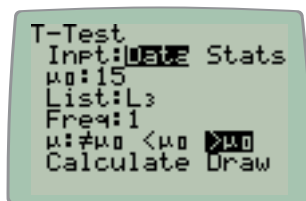
$$t_{crit} = \text{inv}T(0.05, 9) \approx -1.833$$

Reject \mathcal{H}_0 if $t_{obs} < -1.833$

5. Calculate the test statistic. Enter the data from this year into L1 and the data from last year into L2. Now we need to compute the differences and **STO** (store) the result into L3. The TI-84 command we need is:

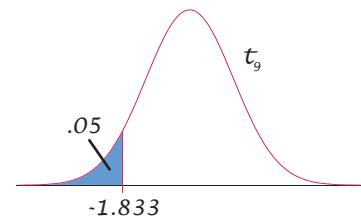
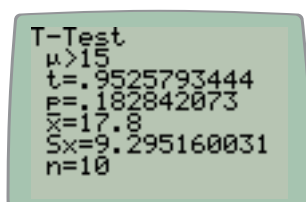
$$L1 - L2 \rightarrow L3$$

Run "TTest" (**STAT** ► **TESTS** 2 **ENTER**). The TI-84 provides an entry sheet. Set the parameters as follows:



Note how μ_0 is set to the value of δ_0 (15) and the data source is set to L₃ which contains the differences.

Place the cursor over "Calculate" and press **ENTER**. The TI-84 responds:



6. Make the decision:

$$t_{obs} = 0.953 \text{ (from TI-84)}$$
$$t_{obs} > -1.833 \therefore \text{do not reject } H_0.$$

7. Write the conclusion:

Based on the sample, there is insufficient evidence at the 5% significance level to conclude that the average cost of attending the Canberra show has risen by more than \$15.

You may be wondering why we can use TTest for both the “Mean, One Sample, σ unknown” and “Mean, One Sample, Two Paired Data Sets” cases.

The answer lies in the similarity of the two test statistics:

$$t_{obs} = \frac{\bar{x} - \mu_0}{s_x / \sqrt{n_x}} = \frac{\bar{d} - \delta_0}{s_d / \sqrt{n_d}}$$

All that is required is to cross-map the equivalent terms by specifying the list of differences (L_3 in this example) which supplies \bar{x} , s_x and n_x , and entering the value of δ_0 for μ_0 .

Mean, Two Independent Samples, Equal Variances

with Raw Data and $\delta_0=0$

A lecturer in statistics believes that students performed better in the second test than in the first test. He randomly selected 5 marks from the first test and 5 marks from the second test. The selected marks are given in the table below. Can the lecturer conclude that students had a higher average mark in the second test than in the first test? Use a 10% test.

Randomly Selected Marks from Tests 1 and 2

Student	First Test Mark	Second Test Mark
1	60	70
2	50	90
3	60	80
4	70	60
5	50	90

TI-84 Method

1. State the hypothesis:

Let μ_1 be the average mark from test 1.

Let μ_2 be the average mark from test 2.

$$H_0: \mu_1 \geq \mu_2$$

$$H_1: \mu_1 < \mu_2$$

2. Enter the data from the first test mark into L₁, and the data from the second test mark into L₂. Before we can choose the test statistic, we need to know whether we are dealing with equal or unequal variances. There are several ways to do that but the simplest is to pre-flight the test. Run "2-SampTTest" (**STAT** ► **TESTS** 4 **ENTER**). The TI-84 responds with an entry sheet. Set the parameters as follows:

```
2-SampTTest
Inpt: DATA Stats
List1:L1
List2:L2
Freq1:1
Freq2:1
μ1:≠μ2 μ1 > μ2
↓Pooled:No Yes
```

Note that by setting Pooled=Yes, we have assumed equal variances. If the variances turn out to be unequal, we will need to change this to Pooled=No in step 6.

Scroll down, place the cursor on "Calculate" and press **ENTER**. The TI-84 responds with:

```
2-SampTTest
μ1<μ2
t=-2.886751346
P=.0101500468
df=8
x̄1=58
↓x̄2=78
```

```
2-SampTTest
μ1<μ2
↑Sx1=8.36660027
Sx2=13.0384048
SxP=10.9544512
n1=5
n2=5
```

Notice how Sx_1 and Sx_2 have been calculated by the TI-84.

Execute program EV to test for equal variances:

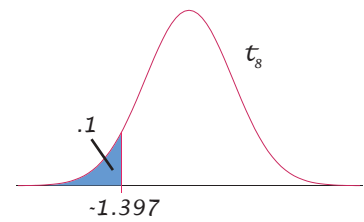
```
Sx22/Sx12
2.428571429
POOLED=YES
Done
```

$2.43 < 10 \therefore$ assume equal variances

3. Write the test statistic:

$$s_p^2 = \frac{(n_1 - 1) \cdot s_1^2 + (n_2 - 1) \cdot s_2^2}{n_1 + n_2 - 2}$$

$$t_{obs} = \frac{(\bar{x}_1 - \bar{x}_2) - \delta_0}{\sqrt{s_p^2 \cdot (1/n_1 + 1/n_2)}} \quad v=8$$



4. State the level of significance:

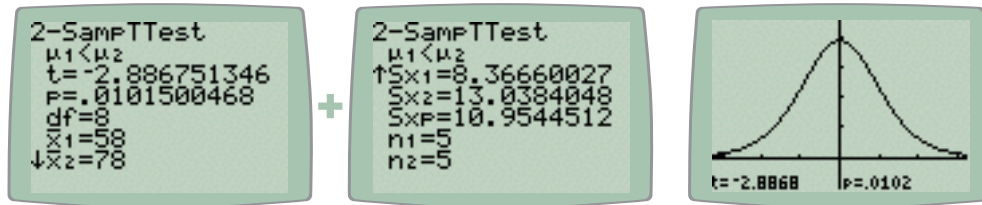
$$\alpha = .1$$

5. State the decision rule (consult Figure 5 for the TI-84 formula for calculating t_{crit}):

$$t_{crit} = \text{invT}(0.1, 8) \approx -1.397$$

Reject H_0 if $t_{obs} < -1.397$

6. Calculate the test statistic. Re-run "2-SampTTest" (STAT ► TESTS 4 ENTER). We already set the parameters correctly 1 in step 2, so simply place the cursor on top of either "Calculate" or "Draw" and press ENTER. The TI-84 responds:



7. Make the decision:

$$t_{obs} = -2.887 \text{ (from TI-84 2-SampTTest)}$$

$$t_{obs} < -1.397 \therefore \text{reject } H_0.$$

8. Write the conclusion:

Based on the sample, there is sufficient evidence at the 10% significance level to conclude that the students had a higher average mark in the second test than in the first test.

1 Keep in mind that if we had concluded that the variances were unequal, we would now have to change to Pooled=No.

Mean, Two Independent Samples, Equal Variances (continued)

with Summary Data and $\delta_0=0$

To compare the “stock-picking” ability of two brokerage firms, the annual gain (excluding brokerage fees) for a \$1000 investment of each of 30 stocks listed on each of the two firms’ “most recommended” list of stocks was compared. The means and standard deviations for each of the two samples are shown in the table below:

	Firm 1	Firm 2
Sample Size	30	30
Mean (\$)	264	199
Standard deviation (\$)	157	111

Can it be concluded that there is a difference between the two brokerage firms in the mean return per recommended stock? Use a 1% test.

TI-84 Method

1. State the hypothesis:

Let μ_1 be the mean return per recommended stock from Firm 1.

Let μ_2 be the mean return per recommended stock from Firm 2.

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

2. Test for equal variances (pooled=yes vs pooled=no) like this::

$$\frac{s_2^2}{s_1^2} = \frac{157^2}{111^2} = 2.00$$

$2.00 < 10 \therefore$ assume equal variances

3. Write the test statistic:

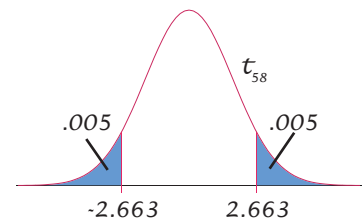
$$s_p^2 = \frac{(n_1 - 1) \cdot s_1^2 + (n_2 - 1) \cdot s_2^2}{n_1 + n_2 - 2}$$

$$v = n_1 + n_2 - 2$$

$$= 30 + 30 - 2$$

$$= 58$$

$$t_{obs} = \frac{(\bar{x}_1 - \bar{x}_2) - \delta_0}{\sqrt{s_p^2 \cdot (1/n_1 + 1/n_2)}}$$



4. State the level of significance:

$$\alpha = .01$$

5. State the decision rule (consult Figure 5 for the TI-84 formula for calculating t_{crit}):

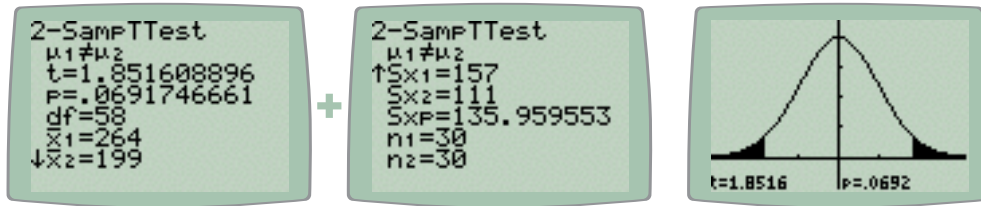
$$t_{crit} = \pm \text{inv}T(0.005, 58) \approx \pm 2.663$$

Reject H_0 if $t_{obs} < -2.663$ or $t_{obs} > 2.663$

6. Calculate the test statistic. Run “2-SampTTest” (STAT ► TESTS 4 ENTER). The TI-84 responds with an entry sheet. Set the parameters as follows:



Place the cursor on top of either "Calculate" or "Draw" and press **ENTER**. The TI-84 responds:



7. Make the decision:

$$t_{obs} = -1.8516 \text{ (from TI-84 2-SampTTest)}$$
$$-2.663 < t_{obs} < 2.663 \therefore \text{do not reject } H_0.$$

8. Write the conclusion:

Based on the sample, there is insufficient evidence at the 1% significance level to conclude that there is a difference between the two firms in the mean return per recommended stock.

Mean, Two Independent Samples, Unequal Variances

A simple random sample of 10 large firms revealed that they had re-invested an average of 30% of their gross profits with a standard deviation of 12%. A random sample of 15 smaller firms showed they had a mean re-investment rate of 20% with a standard deviation of 3%. Is there a difference in the percentage of profits re-invested by large and small firms? Use a 5% test.

TI-84 Method

1. State the hypothesis:

Let μ_1 be the mean profit percentage reinvested by larger firms.

Let μ_2 be the mean profit percentage reinvested by smaller firms.

$$H_0: \mu_1 = \mu_2$$

$$H_1: \mu_1 \neq \mu_2$$

2. Calculate:

$$\frac{S_2^2}{S_1^2} = \frac{12^2}{3^2} = 16$$

$16 > 10 \therefore$ assume unequal variances

3. Write the test statistic:

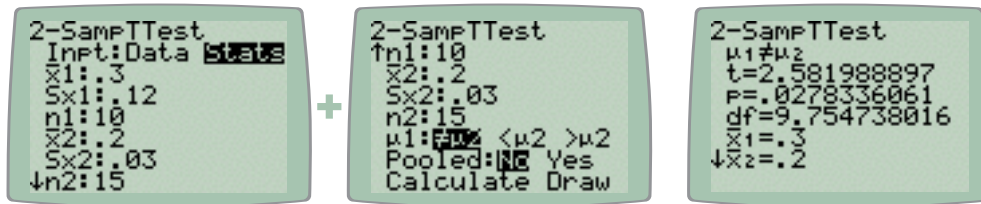
$$t_{obs} = \frac{(\bar{x}_1 - \bar{x}_2) - \delta_0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$$v = \frac{(s_1^2 / n_1 + s_2^2 / n_2)^2}{\frac{(s_1^2 / n_1)^2}{n_1 - 1} + \frac{(s_2^2 / n_2)^2}{n_2 - 1}}$$

4. State the level of significance:

$$\alpha = .05$$

5. If you really want to calculate v by hand, go ahead. A better way is to pre-flight the test. Run "2-SampTTest" (**STAT** \blacktriangleright **TESTS** **4** **ENTER**). The first two screens below are the entry sheets which should be set as shown, then place the cursor on "Calculate" and press **ENTER**. The rightmost screen is the result and contains the value of v in the "df" field:



Now that we know v, we can calculate the values of t_{crit} . Referring to Figure 5, the TI-84 formula we need is:

$$t_{crit} = \text{invT}(\alpha/2, v)$$

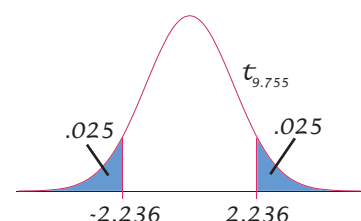
Note that transcribing 9.754738016 can be error-prone, so it is probably better to paste the stored value. The "df" in the following is obtained by pressing **VARS** **5** \blacktriangleright **TEST** **6**:

$$\text{invT}(.05/2, df)$$

To which the TI-84 responds:

$$-2.235755908$$

Now you are in a position where you can draw the distribution.

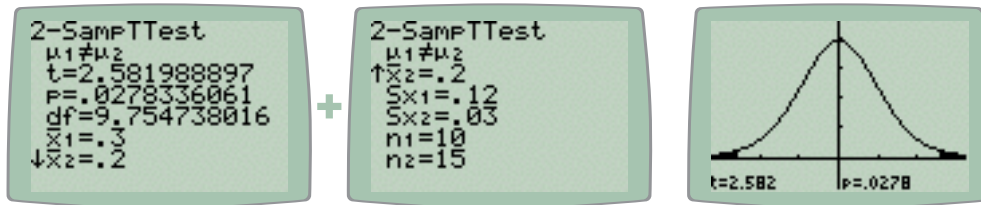


6. State the decision rule:

$$t_{crit} = \pm invT(0.05/2, 9.755) \approx \pm 2.236$$

Reject H_0 if $t_{obs} < -2.236$ or $t_{obs} > 2.236$

7. Calculate the test statistic. Run "2-SampTTest" (STAT ► TESTS 4 ENTER). The parameters on the entry sheet will already be correct, so just move the cursor on top of either "Calculate" or "Draw" and press ENTER. The TI-84 responds:



8. Make the decision:

$$t_{obs} = 2.5819 \text{ (from TI-84 2-SampTTest)}$$

$t_{obs} > 2.236 \therefore$ reject H_0 .

9. Write the conclusion:

Based on the sample, there is sufficient evidence at the 5% significance level to conclude that there is a difference between large and small brokerage firms in the mean reinvestment rate.

Note that people using the table book will get different critical values. This is because the table book only deals in integer values of v , so they will round down to $v=9$, which will yield $t_{crit}=2.262$. Occasionally, this small difference may change the result of the hypothesis test.

As discussed previously, 2SampTTest does not cater for the situation where $\delta_0 \neq 0$. If you encounter such a problem, use program H4 instead. The only difference between H3 and H4 is in the calculation of v .

Mean, Two Independent Samples, where $\delta_0 \neq 0$

The TI-84's 2-SampTTest does not have a built-in option for the case where $\delta_0 \neq 0$. If you encounter a problem like that, deal with it like this:

1. Set up the hypothesis test in exactly the same way as you would for any other case of Mean, Two Independent Samples. State the hypotheses in terms of δ_0 (ie, use the $H_1: \mu_1 - \mu_2 \neq \delta_0$ form). This does not actually affect how you use the TI-84 because the relationship is still in the same direction (see Table 6). Otherwise, just ignore δ_0 .
2. After you have calculated the test statistic (ignoring δ_0), execute program M2 and supply δ_0 when prompted. M2 re-runs the test with the adjustment needed for δ_0 . You must always calculate the test statistic before you can run M2 because M2 depends on the previous results. You also can't run M2 twice in succession (eg if you make a mistake entering δ_0). You must always have run 2-SampTTest immediately before you run M2.

Suppose the earlier question about test marks had asked whether the lecturer could conclude that the average mark in the second test was more than 10 greater than the average mark in the first test. In this case, $\delta_0=10$. The hypotheses would become:

$$H_0: \mu_1 - \mu_2 \geq -10$$

$$H_1: \mu_1 - \mu_2 < -10$$

The direction of the alternative hypothesis in the above is "<" so the TI-84 should be set up to use the same direction ($\mu_1 < \mu_2$). Otherwise, proceed as though $\delta_0=0$.

```
2-SampTTest
Inpt: DATA Stats
List1:L1
List2:L2
Freq1:1
Freq2:1
μ1:≠μ2 < μ2
↓Pooled:No YES
```

Put the cursor on "Calculate" and press **ENTER**. The TI-84 responds:

```
2-SampTTest
μ1<μ2
t=-2.886751346
P=.0101500468
df=8
x̄1=58
↓x̄2=78
```

+

```
2-SampTTest
μ1<μ2
↑Sx1=8.36660027
Sx2=13.0384048
SxP=10.9544512
n1=5
n2=5
```

Note the value of \bar{x}_2 (78).

Now the TI-84 is primed for M2. Execute that program:

```
PrgrM2
D: DELTA0?
D=? -10
```

Enter the value of δ_0 at the prompt and press **ENTER**.

The TI-84 responds with:

```
2-SampTTest
μ1<μ2
t=-1.443375673
P=.0934524052
df=8
x̄1=58
↓x̄2=68
```

+

```
2-SampTTest
μ1<μ2
↑Sx1=8.36660027
Sx2=13.0384048
SxP=10.9544512
n1=5
n2=5
```

Compare the results here with those above. Only \bar{x}_2 is different (the previous value plus δ_0).

The value of t_{crit} remains the same as in the original question, so it is now a matter of making the decision and writing the conclusion:

$$t_{obs} = -1.443 \text{ (from TI-84 2-SampTTest)}$$

$$t_{obs} < -1.397 \therefore \text{reject } H_0.$$

Based on the sample, there is sufficient evidence at the 10% significance level to conclude that the average mark of students in the second test was more than 10 marks higher than in the first test.

Table 6 — Hypothesis Equivalents

Hypothesis	if $\delta_0 \neq 0$	if $\delta_0 = 0$
null	$\mu_1 - \mu_2 \leq \delta_0$	$\mu_1 \leq \mu_2$
	$\mu_1 - \mu_2 = \delta_0$	$\mu_1 = \mu_2$
	$\mu_1 - \mu_2 \geq \delta_0$	$\mu_1 \geq \mu_2$
alternate	$\mu_1 - \mu_2 < \delta_0$	$\mu_1 < \mu_2$
	$\mu_1 - \mu_2 \neq \delta_0$	$\mu_1 \neq \mu_2$
	$\mu_1 - \mu_2 > \delta_0$	$\mu_1 > \mu_2$

Proportion, One Sample

A recent article stated that 80% of all employees play video games at work at least once a week. A large company anonymously surveyed 100 of its employees and found that 75 of them had played video games at work in the past week. Can the company conclude that the proportion of its employees who play video games at work is different from the proportion stated in the article? Use a 10% test. What is the p-value for this test?

TI-84 Method

1. State the hypothesis:

Let P be the proportion of employees who play games at work.

$$H_0: P=0.8$$

$$H_1: P \neq 0.8$$

2. State the test statistic:

$$Z_{obs} = \frac{\hat{p} - p_0}{\sqrt{p_0 \cdot (1 - p_0) / n}}$$

3. State the level of significance:

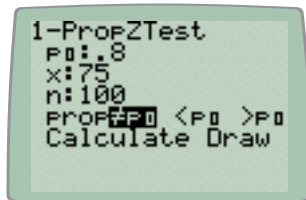
$$\alpha = .1$$

4. State the decision rule (consult Figure 5 for the TI-84 formula for calculating z_{crit}):

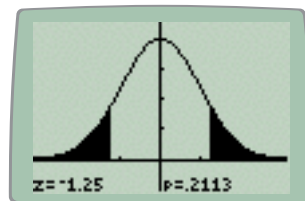
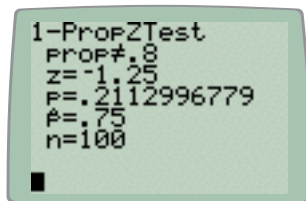
$$z_{crit} = \pm \text{invNorm}(0.05) \approx \pm 1.6449$$

Reject H_0 if $z_{obs} < -1.6449$ or $z_{obs} > 1.6449$

5. Calculate the test statistic. Run "1-PropZTest" (**STAT** ► **TESTS** 5 **ENTER**). The TI-84 responds with an entry sheet. Set the parameters as follows:



Place the cursor on top of either "Calculate" or "Draw" and press **ENTER**. The TI-84 responds:

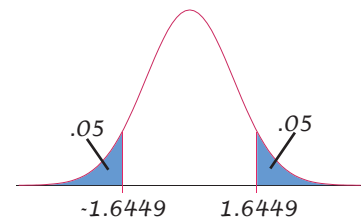


Make the decision:

$z_{obs} = -1.25$ (from TI-84 1-PropZTest)
 $-1.6449 < z_{obs} < 1.6449 \therefore$ do not reject H_0 .

6. Write the conclusion:

Based on the sample, there is insufficient evidence at the 10% significance level to conclude that the proportion of the company's employees who played video games at work in the last week is different from the proportion stated in the article. The p-value is 0.2113.



Proportion, Two Samples

In the first week of an election campaign 60% of 500 randomly selected voters said that they would vote for Party A. A second sample of 400 voters taken in the second week of the campaign showed that only 200 would vote for Party A. Did the percentage of voters who would vote for Party A change between week 1 and week 2? Use a 5% test. What is the p-value for this test?

TI-84 Method

1. State the hypothesis:

Let P_1 be the proportion of voters voting for Party A in week 1.

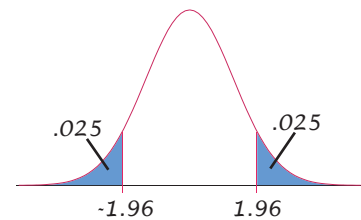
Let P_2 be the proportion of voters voting for Party A in week 2.

$$H_0: P_1 = P_2$$

$$H_1: P_1 \neq P_2$$

2. State the test statistic:

$$p_c = \frac{x_1 + x_2}{n_1 + n_2} \quad Z_{obs} = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{p_c \cdot (1 - p_c) \cdot (1/n_1 + 1/n_2)}}$$



3. State the level of significance:

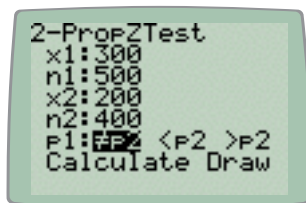
$$\alpha = .05$$

4. State the decision rule (consult Figure 5 for the TI-84 formula for calculating z_{crit}):

$$z_{crit} = \pm \text{invNorm}(0.025) \approx \pm 1.96$$

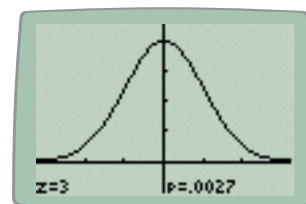
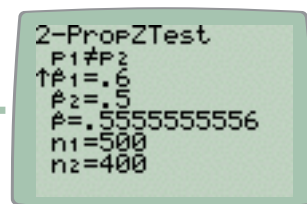
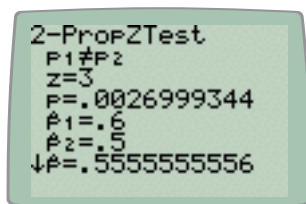
Reject H_0 if $z_{obs} < -1.96$ or $z_{obs} > 1.96$

5. Calculate the test statistic. Run "2-PropZTest" (STAT ► TESTS 6 ENTER). The TI-84 responds with an entry sheet. Set the parameters as follows:



*Note that the value of 300 for x_1 was entered by typing "500*0.6". In other words, you can do calculations during data entry!*

Place the cursor on top of either "Calculate" or "Draw" and press **ENTER**. The TI-84 responds:



Make the decision:

$$z_{obs} = 3 \text{ (from TI-84 2-PropZTest)}$$

$$-1.96 < z_{obs} < 1.96 \therefore \text{do not reject } H_0.$$

6. Write the conclusion:

Based on the sample, there is insufficient evidence at the 10% significance level to conclude that the proportion of voters changed between week 1 and week 2. The p-value is 0.0027.

USEFUL TI-84 PROGRAMS

PROMOTING THE SALE OF WORRY-BEADS

The programs listed here can be entered by hand or downloaded and copied to your TI-84 via its USB cable. In either case, you will need to consult the TI-84's manual for the necessary instructions. I am reasonably confident that each program works as documented but I make no warranty as to correctness. In other words, it is up to you to verify that each is fit for purpose *before* you rely on it.

The URL for downloading these programs is:

<http://www.lgosys.com/uc/SADMG/TI84/Programs.html>

If you enter the program steps by hand, the convention is that each line in this printout represents one logical line of code within the TI-84. However, if a line in this printout is indented, it should be treated as a continuation of the immediately preceding line.

SSM

This program calculates the sample size for estimating a mean.

Usage:

1. Execute SSM.
2. Enter the confidence interval (eg .95).
3. Enter the standard deviation.
4. Enter the maximum error value B.

Results:

1. The values of α and $z_{\alpha/2}$.
2. The required sample size.

Program Steps:

```
ClrHome
Disp "C: CONFIDENCE"
Disp "S: STD DEV"
Disp "B: MAX ERROR"
Prompt C,S,B
(1+C)/2→A
invNorm(A)→Z
(Z*S/B)2→0
ClrHome
Disp "ALPHA, Z-ALPHA",1-A,Z
Disp "SAMPLE SIZE",0
```

CIP

This program calculates a 100(1- α)% confidence interval estimate for a proportion.

Usage:

1. Execute CIP.
2. Enter the confidence interval (eg .95).
3. Enter the proportion (eg .5).
4. Enter the sample size n.

Results:

1. The values of α and $z_{\alpha/2}$.
2. The lower and upper limits of the confidence interval (you have to do your own rounding).

Program Steps:

```
ClrHome
Disp "C: CONFIDENCE"
Disp "P: PROPORTION"
Disp "N: NUM SAMPLES"
Prompt C,P,N
(1+C)/2→A
invNorm(A)→Z
Z*√(P*(1-P)/N)→X
ClrHome
Disp "ALPHA, Z-ALPHA",1-A,Z
Disp "INTERVAL",P-X,P+X
```

SSP

This program calculates a sample size for estimating a proportion.

Usage:

1. Execute SSP.
2. Enter the confidence interval (eg .95).
3. Enter the estimated value of p^* (eg .5)
4. Enter the maximum error value B.

Results:

1. The values of α and $z_{\alpha/2}$.
2. The required sample size.

Program Steps:

```
ClrHome
Disp "C: CONFIDENCE"
Disp "P: P* PROPORTION"
Disp "B: MAX ERROR"
Prompt C,P,B
(1+C)/2→A
invNorm(A)→Z
P*(1-P)*(Z/B)2→N
ClrHome
Disp "ALPHA, Z-ALPHA",1-A,Z
Disp "SAMPLE SIZE",N
```

M2

Calculates the test statistic for two independent means where $\delta_0 \neq 0$.

Usage:

1. Ignore δ_0 .
2. Set up the calculator for a 2-Sample T Test. You can use either *Data* or *Stats* mode. Make sure you set the hypothesis and *pooled* correctly.
3. Execute M2.
4. Enter δ_0 .

Results:

1. As for a 2-SampTTest.

Notes:

1. Relies on the results of a 2-SampTTest that you run immediately before. The result is undefined if you do not do this.
2. You can not run M2 twice in succession. You must always run 2-SampTTest before running M2.

Program Steps:

```
Disp "D: DELTA?"
Prompt D
∅→H
tcdf(-1E99,t,df)→P
If P=p:Then:-1→H:End
If P=(1-p):Then:1→H:End
∅→P
If n1+n2-2=df:Then:1→P:End
2-SampTTest
 $\bar{x}_1, Sx_1, n_1, \bar{x}_2+D, Sx_2, n_2, H, P, \emptyset$ 
```

Entering Programs by Hand

The manual covers this topic quite well so think of this as a quick overview.

To start a new program, press **PRGM**, select **NEW** and press **ENTER**. The calculator is in alpha-lock mode so type a name like **H W** and press **ENTER**. The screen now shows a ":" prompt which means it is waiting for a line of your program. Press **PRGM**, choose **I/O**, scroll down to "3: Disp" and press **ENTER**. Put the keyboard into alpha-lock mode by pressing **2ND ALPHA**. Type a quote mark (the **+** key), fol-

lowed by the letters **HELLO**, then a space (the **0** key), then the letters **WORLD**, and finish with another quote mark.

You get out of programming mode by pressing **2ND QUIT**.

Now you can run the program. Press **PRGM**. The default option is **EXEC** and if you have only written one program, it will be selected by default. Press **ENTER**. That pastes the program name to the main screen. Press **ENTER** to run it. If you entered the program correctly, the screen will show "HELLO WORLD" followed by "Done".

To edit a program, press **PRGM**, choose **EDIT**, select the name of the program to be edited, and press **ENTER**. Use the arrow keys to move around. Edit using a combination of the **INS** and **DEL** keys, plus overwriting the existing program text.

To delete a program, press **2ND MEM 2 7**, scroll down to the program you want to delete and press **ENTER** (which marks the program with an asterisk). Press **DEL** then **2**.

At this point, it really will help if you read the manual.

EV

Convenience routine to determine whether variances should be pooled.

Usage:

1. Enter the data into two lists (typically L_1 and L_2).
2. Execute any function that computes Sx_1 and Sx_2 for the two lists. The most logical is 2-SampTTest in Data mode.
3. Execute POOLED.

Results:

1. The value of Sx_2^2/Sx_1^2 (larger \div smaller)
2. Either "POOLED=YES" or "POOLED=NO" reflecting the decision.

Notes:

1. Program will fail with an error if Sx_1 and Sx_2 are not set.

Program Steps:

```
ClrHome
If  $Sx_2 > Sx_1$ 
Then
 $Sx_2^2 / Sx_1^2 \rightarrow S$ 
Else
 $Sx_1^2 / Sx_2^2 \rightarrow S$ 
End
Disp " $Sx_2^2 / Sx_1^2$ ", S
If  $S < 10$ 
Then
Disp "POOLED=YES"
Else
Disp "POOLED=NO"
End
```

LR

Performs an extended linear regression.

Usage:

1. Enter the data for the independent variable into List 1.
2. Enter the data for the dependent variable into List 2.
3. Execute LR.

Results:

1. The values of SSR, SSE and SST (after which the program pauses).
2. The covariance and the coefficients of variation for X and Y (after which the program pauses).
3. The values of a, b, R^2 and r.
4. List 3 contains the predicted values.
5. List 4 contains the explained deviations from the mean.
6. List 5 contains the residuals.
7. List 6 contains the observed deviations from the mean.

Notes:

1. Performs LinReg(a+bx) on Lists 1 and 2, so all statistical variables normally associated with that test (a, b, r and R^2) will be valid.

Program Steps:

```
DiagnosticOn
LinReg(a+bx) L1, L2
 $a+b*L1 \rightarrow L3$ 
 $L3 - \bar{y} \rightarrow L4$ 
 $L2 - L3 \rightarrow L5$ 
 $L2 - \bar{y} \rightarrow L6$ 
 $\text{sum}(L4^2) \rightarrow R$ 
 $\text{sum}(L5^2) \rightarrow E$ 
 $\text{sum}(L6^2) \rightarrow T$ 
ClrHome
Disp "SSR(L4)", R, "SSE(L5)", E, "SST(L6)", T
Pause
ClrHome
 $r*Sx*Sy \rightarrow C$ 
 $100*Sx/\bar{x} \rightarrow X$ 
 $100*Sy/\bar{y} \rightarrow Y$ 
Disp "COV(X,Y)", C, "CV(X)", X, "CV(Y)", Y
Pause
LinReg(a+bx) L1, L2
```

RSX

This program calculates Spearman's Rank Correlation Coefficient, r_s .

Usage:

1. Enter data for the independent variable into List 1 (required).
2. Enter data for the dependent variable into List 2 (required).
3. Execute RSX.

Results:

1. The values of n , Σd^2 (as Σx^2), r_s .
2. List 3 contains the rankings for the independent variable.
3. List 4 contains the rankings for the dependent variable.
4. List 5 contains the differences between the two ranks (L_3-L_4).
5. List 6 contains the squares of the differences between the two ranks.

Notes:

1. Lists must be the same size. If not, reports "L3/L4 UNEQUAL".
2. The differences between the two ranks must sum to zero. If not, reports "RANK ERROR".
3. Calls program RANK.

Program Steps:

```
ClrHome
L1→LELEM
prgmRANK
LRANK→L3
L2→LELEM
prgmRANK
LRANK→L4
ClrList LELEM, LORDS, LRANK
dim(L3)→N
dim(L4)→M
If (N=M):Then
L3-L4→L5:L52→L6:sum(L6)→S
If sum(L5)=0:Then
Disp "N, Σx2, RS",N,S,(1-(6*S/
(N*(N2-1))),""
Else
Disp "RANK ERROR L3/L4"
End
Else
Disp "L3/L4 UNEQUAL"
End
```

RANK

Calculates ranks for Spearman's Rank Correlation Coefficient.

Usage:

1. Calling function copies a list into the named list "ELEM".
2. Calling function invokes RANK.
3. Calling function retrieves ranks from named list "RANK".

Results:

1. Named list "RANK" contains ranks for input data supplied in named list "ELEM".
2. Creates and uses named list "ORDS". This list should be considered private.

Notes:

1. This program expects to be called by program RSX. It is not intended for users.

Program Steps:

```
dim(LELEM)→C
C→dim(LORDS)
C→dim(LRANK)
seq(I+1,I,0,C-1,1)→LORDS
SortA(LELEM,LORDS)
1→I
While I<C
I→A:1→N:I+1→J:0→K
If LELEM(I)=LELEM(J):Then:
1→K:End
While K=1
A+J→A:N+1→N:0→K
If J<C:Then
J+1→J
If LELEM(I)=LELEM(J):Then:
1→K:End
End
End
A/N→A
For(J,I,I+N-1,1)
A→LRANK(J)
End
I+N→I
End
If I=C:Then:I→LRANK(I):End
SortA(LORDS,LRANK)
```

Z

Calculates a Z-score.

Usage:

1. Execute a function which sets correct values for the mean and standard deviation (eg 1-VarStats).
2. Enter the number you wish to calculate the Z-score for and press enter. The number becomes the "last answer".
3. Execute program Z.

Results:

1. Displays the "last answer" expressed as a Z-score.

Notes:

1. This is really just a convenience function to avoid having to retrieve the mean and standard deviation from **VAR ► STATS**.
2. The results are undefined if the mean and standard deviation have not been set.

Program Steps:

```
(Ans- $\bar{x}$ )/Sx→Z  
Disp "Z",Z
```

VERSION

Reports a version number for these programs.

Usage:

1. Execute program VERSION.

Results:

1. Displays a version number and release date.

Program Steps:

```
ClrHome  
Disp "V2.0 2010-07-28"  
Disp "(UC BS+SADMG)"
```


USEFUL TI-NSPIRE PROGRAMS

DOUBLING THE SALES OF WORRY-BEADS

The programs listed here can be entered by hand or downloaded and copied to your TI-nspire via its USB cable. In either case, you will need to consult the calculator's manual for the necessary instructions. I am reasonably confident that each program works as documented but I make no warranty as to correctness. In other words, it is up to you to verify that each is fit for purpose *before* you rely on it.

The URL for downloading these programs is (and, yes, the "TI84" in this URL is correct):

<http://www.lgosys.com/uc/SADMG/TI84/Programs.html>

If you enter the program steps by hand, the convention is that each line in this printout represents one logical line of code within the TI-nspire. However, if a line in this printout is indented, it should be treated as a continuation of the immediately preceding line.

Note that many of the programs described here assume the existence of TI-84-equivalent lists L1..L6. As distributed, the Business Stats document contains a spreadsheet where the first six columns are labelled L1..L6. You should avoid interfering with this arrangement until you are proficient with the TI-nspire.

SSM

This program calculates the sample size for estimating a mean.

Calling sequence:

ssm(c,σ,b)

c Confidence interval (eg .95).

σ Standard deviation.

b Maximum error value B.

Results:

1. The values of α and $z_{\alpha/2}$.
2. The required sample size.

Program Steps:

```
Define LibPub ssm(c,σ,b)=
Prgm
© ssm(Confidence,σ,B)
Local α:((1+c)/(2))→α
Local z:invNorm(α)→z
Local n:(((z*σ)/(b))^2)→n
Disp [{"SSM","Results"}["α",approx(1-α)]
      [{"Zα",approx(z)}["Sample
      size",approx(n)]]
EndPrgm
```

CIP

This program calculates a 100(1-α)% confidence interval estimate for a proportion.

Calling sequence:

cip(c,p,n)

c Confidence interval (eg .95).

p Proportioo (eg .5).

n Sample size.

Results:

1. The values of α and $z_{\alpha/2}$.
2. The lower and upper limits of the confidence interval (you have to do your own rounding).

Program Steps:

```
Define LibPub cip(c,p,n)=
Prgm
© cip(Confidence,Proportion,SampleSize)
Local α:((1+c)/(2))→α
Local z:invNorm(α)→z
Local x:z*√(((p*(1-p))/(n)))→x
Disp [{"CIP","Results"}["α",approx(1-α)]
      [{"Zα",approx(z)}["LCL",approx(p-x)]
      [{"UCL",approx(p+x)]]
EndPrgm
```

SSP

This program calculates a sample size for estimating a proportion.

Calling sequence:

ssp(c,p,b)

c Confidence interval (eg .95).

p estimated value of p^* (eg .5).

b Maximum error value B.

Results:

1. The values of α and $z_{\alpha/2}$.
2. The required sample size.

Program Steps:

```
Define LibPub ssp(c,p,b)=
Prgm
© ssp(Confidence,Proportion,B)
Local  $\alpha$ ::((1+c)/(2))→ $\alpha$ 
Local z:invNorm( $\alpha$ )→z
Local n:p*(1-p)*(((z)/(b)))^2→n
Disp [[“SSP”,“Results”][“ $\alpha$ ”,approx(1- $\alpha$ )]
      [“Z $\alpha$ ”,approx(z)][“Sample
      size”,approx(n)]]
EndPrgm
```

M2

Calculates the test statistic for two independent means where $\delta_0 \neq 0$.

Usage:

1. Ignore δ_0 .
2. Set up the calculator for a 2-Sample T Test. You can use either *Data* or *Stats* mode. Make sure you set the hypothesis and *pooled* correctly.
3. Execute m2(δ_0)

Calling sequence:

m2(δ_0)

Results:

1. As for a 2-SampTTest.

Program Steps:

```
Define LibPub m2( $\delta_0$ )=
Prgm
:© m2( $\delta_0$ )
:Local h:0→h
:Local p:tCdf(- $\infty$ ,stat.t,stat.df)→p
:If p=stat.PVal Then:-1→h:EndIf
:If p=1-stat.PVal Then:1→h:EndIf
:0→p
:If stat.n1+stat.n2-2=stat.df
  Then:1→p:EndIf
:tTest_2Samp stat. $\bar{x}$ 1,stat.sx1,
  stat.n1,stat. $\bar{x}$ 2+ $\delta_0$ ,stat.sx2,stat.n2,h,p
:Disp stat.results
:EndPrgm
```

EV

Convenience routine to determine whether variances should be pooled.

Usage:

1. Enter the data into two lists (typically L_1 and L_2).
2. Execute any function that computes Sx_1 and Sx_2 for the two lists. The most logical is 2-SampTTest in Data mode.
3. Execute pooled().

Calling sequence:

pooled()

Results:

1. The value of Sx_2^2/Sx_1^2 (larger \div smaller)
2. Either "Pooled=Yes" or "Pooled=No", reflecting the decision.

Notes:

1. Program will fail with an error if Sx_1 and Sx_2 are not set.

Program Steps:

```
Define LibPub pooled()=
Prgm
:© pooled()
:Local s
:If stat.sx2>stat.sx1 Then
:((stat.sx2^2)/(stat.sx1^2))→s
:Else
:((stat.sx1^2)/(stat.sx2^2))→s
:EndIf
:Disp "sx2^2/sx1^2=",s
:If s<10 Then
:Disp "Pooled=No"
:Else
:Disp "Pooled=Yes"
:EndIf
:EndPrgm
```

LR

Performs an extended linear regression.

Usage:

1. Enter the data for the independent variable into List 1.
2. Enter the data for the dependent variable into List 2.
3. Execute lr()

Calling sequence:

lr()

Results:

1. The values of a , b , R^2 and r , the values of SSR, SSE and SST, the covariance and the coefficients of variation for X and Y .
2. List 3 contains the predicted values. List 4 contains the explained deviations from the mean. List 5 contains the residuals. List 6 contains the observed deviations from the mean.

Notes:

1. Performs LinRegBx on Lists 1 and 2, so all statistical variables normally associated with that test (a , b , r , R^2) will be valid.

Program Steps:

```
Define LibPub lr()=
Prgm
:© lr() assumes l1,l2
:LinRegBx l1,l2,1
:stat.a+stat.b*l1→l3
:TwoVar l1,l2,1
:l3-stat.y→l4
:l2-l3→l5
:l2-stat.y→l6
:Local ssr:sum(l4^2)→ssr
:Local sse:sum(l5^2)→sse
:Local sst:sum(l6^2)→sst
:Local cov:stat.r*stat.sx*stat.sy→cov
:Local cvx:((100*stat.sx)/(stat.x̄))→cvx
:Local cvy:((100*stat.sy)/(stat.ȳ))→cvy
:LinRegBx l1,l2,1
:Disp [{"lr() assuming l1,l2","y=a+bx"}
["a",approx(stat.a)][["b",approx(stat.b)]
["r^2",approx(stat.r^2)][["r",approx(stat.r)]
["SSR {l4}",approx(ssr)][["SSE
{l5}",approx(sse)][["SST {l6}",approx(sst)]
["COV(X,Y)",approx(cov)]
["CV(X)",approx(cvx)]
["CV(Y)",approx(cvy)]]
:EndPrgm
```

RSX

Calculates Spearman's Rank Correlation Coefficient, r_s .

Usage:

1. Enter data for the independent variable into List 1 (required).
2. Enter data for the dependent variable into List 2 (required).
3. Execute `rsx()`.

Calling sequence:

`rsx()`

Results:

1. The values of n , $\sum d^2$ and r_s .
2. List 3 contains the rankings for the independent variable, List 4 the rankings for the dependent variable, List 5 the differences and List 6, the differences squared.

Notes:

1. Calls programs RANK and RS.
2. This program has not had extensive testing. Use with caution.

Program Steps:

```
Define LibPub rsx()=  
Prgm  
© rsx() assumes l1,l2  
Local n:dim(l1)→n  
If n≠dim(l2) Then  
Disp "l1/l2 unequal size"  
Return  
EndIf  
Local lords:seq(i+1,i,0,n-1,1)→lords  
Local lelem:l1→lelem  
SortA lelem,lords  
getranks(lelem)→l3  
SortA lords,l3  
l2→lelem  
SortA lelem,lords  
getranks(lelem)→l4  
SortA lords,l4  
l3-l4→l5:l5^(2)→l6  
Local s:sum(l6)→s  
Local rs:1-((6*s)/(n*(n^2-1)))→rs  
If sum(l5)=0 Then  
Disp [{"RSX","Results"}][{"n",n}  
["Σd²",approx(s)][{"RS",approx(rs)}]  
Else  
Disp "Rank error l3,l4"  
EndIf  
EndPrgm
```

GETRANKS

Calculates ranks for Spearman's Rank Correlation Coefficient.

Calling sequence:

`getranks(l)`

- l the name of a list containing elements that have been sorted into ascending order.

Results:

1. Returns a list of ranks as a function result.

Notes:

1. Intended as a service routine. Should be considered private.:
2. This program has not had extensive testing. Use with caution.
3. Results are undefined if the input list does not exist or if its contents are not in ascending order.

Program Steps:

```
Define LibPriv getranks(list)=  
Func  
Local c:dim(list)→c  
Local lrank  
Local i:1→i  
Local a:Local j:Local k:Local n  
While i<c  
i→a:1→n: i+1→j:0→k  
If list[i]=list[j] Then:1→k:EndIf  
While k=1  
a+j→a:n+1→n:0→k  
If j<c Then  
j+1→j  
If list[i]=list[j] Then:1→k:EndIf  
EndIf  
EndWhile  
((a)/(n))→a  
For j,i,i+n-1,1  
a→lrank[j]  
EndFor  
i+n→i  
EndWhile  
If i=c Then:i→lrank[i]:EndIf  
Return lrank  
EndFunc  
)
```

CLEARLISTS

A convenience function to clear all the TI-84 lists L1..L6.

Calling sequence:

clearlists()

Results:

1. Lists 1..6 are cleared.

Notes:

1. Results are undefined if the lists do not exist. Note that the existence of a list is independent of a column with that title in the spreadsheet view. If you accidentally delete a column title, re-entering that title will display the contents of that list.

Program Steps:

```
Define LibPub clearlists(=
Prgm
© clear all TI-84 lists l1..l6
{}→l1:{}→l2:{}→l3
{}→l4:{}→l5:{}→l6
EndPrgm
```

VERSION

Reports a version number for these programs.

Calling sequence:

version()

Results:

1. Displays a version number and release date.

Program Steps:

```
Define LibPub version(=
Prgm
:© version()
:Disp "V2.0 2010-07-28"
:Disp "(UC BS+SADMG)"
:EndPrgm
```


TI-NSPIRE CROSSWALK

TRANSLATING TI-84-LINGO TO TI-NSPIRE-DIALECT

If you have a TI-Nspire, you may think that this entire document is not much use to you. You would be wrong. The TI-84 and TI-Nspire are very close cousins. Although the menu structures and commands are not identical, there is close to a 1:1 correspondence between what you can achieve with the two calculators. If you have the Business Stats document installed, the correspondence is even closer.

This chapter follows the same structure as the first part of the document. Where the earlier chapters explain how to use the TI-84, this chapter provides the instructions for the TI-Nspire so that you can learn to understand how to find the equivalent TI-Nspire functions.

Note that this chapter assumes that you are running OS version 2.0.1.60 and have the current Business Stats document installed.

Page 13

Mean, Median and Standard Deviation

Command

MENU 6 1 1

Data Entry

One list
 X1 List (L₁)
 Frequency List (1)
 [default remaining parameters]

Results

OneVar I1,I2

["Title"	"One-Variable Statistics"]
["x̄"	1.25]
["Σx"	250.]
["Σx ² "	510.]
["sx := sC-1x"	0.99622402679206]
["σx := σCx"	0.99373034571759]
["n"	200.]
["MinX"	0.]
["Q ₁ X"	0.5]
["MedianX"	1.]
["Q ₃ X"	2.]
["MaxX"	3.]
["SSX := Σ(x-x̄) ² "	197.5]

Page 15

Spearman's Rank Correlation Coefficient

Command

VAR rsx

Parameters

none

Results

rsx()			
["RSX"	"Results"]	
["n"	5]	
["Σd ² "	5.5]	
["Rs"	0.725]	

Command

VAR lr

Results

lr()			
["lr() assuming l1,l2"	"y=a+bx"]	
["a"	0.447368]	
["b"	0.027047]	
["r ² "	0.333577]	
["r"	0.577561]	
["SSR {l _s }"	1.60117]	
["SSE {l _s }"	3.19883]	
["SST {l _s }"	4.8]	
["COV(X,Y)"	14.8]	
["CV(X)"	36.0992]	
["CV(Y)"	49.793]	

Command

VAR lr

Parameters

none

Results

lr()

["lr() assuming l1,l2" "y=a+bx"]
["a"	2.4]
["b"	0.6]
["r ² "	0.9]
["r"	0.948683]
["SSR {l ₁ }"	518.4]
["SSE {l ₁ }"	57.6]
["SST {l ₁ }"	576.]
["COV(X,Y)"	216.]
["CV(X)"	52.7046]
["CV(Y)"	50.]

Command

MENU 6 1 1

Data Entry

One list
X1 List (L₁)
Frequency List (L₂)
[default remaining parameters]

Results

OneVar l1,l2

["Title"	"One-Variable Statistics"]
["x̄"	0.65]
["Σx"	0.65]
["Σx ² "	1.75]
["s _x := sC ₋₁ x"	undef]
["σ _x := σC _x "	1.1521718621803]
["n"	1.]
["MinX"	0.]
["Q ₁ X"	0.]
["MedianX"	0.]
["Q ₃ X"	1.]
["MaxX"	4.]
["SSX := Σ(x- \bar{x}) ² "	1.3275]

Command

VAR stat.Σx²

Results

stat.Σx²

1.3275

Command

MENU 6 5 D

Data Entry

n (15)
p (0.2)
k (5)

Results

binomPdf(15,0.2,5)

0.10318229431911

Command

MENU 6 5 E

Data Entry

n (15)
p (0.2)
k (8-1)

Results

1-binomCdf(15,0.2,8-1)

0.00423974970042

binomCdf(15,0.2,6)-binomCdf(15,0.2,2)

0.58391798142159

1-binomCdf(15,0.015,5)

0.02631852599131

Command

MENU 6 5 H

Data Entry

lambda (4)
k (5)

Results

poissPdf(4,5)

0.15629345185053

Command

MENU 6 5 I

Data Entry

lambda (4)
lower k (0)
upper k (5)

Results

poissCdf(4,0,5)

0.7851303873768

Command

MENU 6 6 2

Data Entry

Data
List (L₁)
Frequency List (1)
Confidence Level (0.95)

Results

Interval I1,1,0.95

["Title"	"t Interval"]
["CLower"	476.88279621976]
["CUpper"	530.18387044691]
["x̄"	503.53333333333]
["ME"	26.650537113575]
["df"	14.]
["sx := sC-1x"	48.124639763649]
["n"	15.]

Command

VAR ssm

Parameters

(confidence, sigma, B)

Results

ssm(0.99,2,0.5)

["SSM"	"Results"]
["α"	0.005]
["Zα"	2.57583]
["Sample size"	106.158]

Command

((243)/(300))

Results

0.81

Command

VAR cip

Parameters

(confidence, proportion, n)

Results

cip(0.9,0.81,300)

["CIP"	"Results"]
["α"	0.05]
["Zα"	1.64485]
["LCL"	0.772745]
["UCL"	0.847255]

Command

VAR ssp

Parameters

(confidence, proportion, B)

Results

ssp(0.9,0.15,0.02)

["SSP"	"Results"]
["α"	0.05]
["Zα"	1.64485]
["Sample size"	862.392]

Command

MENU 6 5 2

Data Entry

Lower Bound (0.25)
Upper Bound (infinity)
 μ (0.14)
 σ (0.18)

Note

infinity symbol can be accessed from:

CATALOG 4

Results

normCdf(0.25,∞,0.14,0.18)

0.27056295524656

normCdf(-∞,0,0.14,0.18)

0.21834994609951

Command

MENU 6 5 3

Data Entry

Area (1-0.15)
 μ (0.14)
 σ (0.18)

Results

invNorm(1-0.15,0.14,0.18)

0.32655800835831

Command

MENU 6 5 6

Data Entry

Area (1-0.05)
Degrees of freedom (8)

Results

invt(1-0.05,8)

1.8595480333508

Command

MENU 6 7 2

Data Entry

Data
 μ_0 (2160)
List (L_1)
Frequency List (1)
Alternate Hypothesis ($\mu > \mu_0$)

Results

tTest 2160,I1,1,1

["Title"	"t Test"]
["Alternate Hyp"	" $\mu > \mu_0$ "]
["t"	3.0040897891829]
["PVal"	0.0084828072513452]
["df"	8.]
[" \bar{x} "	2168.1111111111]
["sx := sC-1x"	8.1000685868152]
["n"	9.]

Command

MENU 6 5 6

Data Entry

Area (0.05)
 Degrees of freedom (9)

Results

invt(0.05,9)
 -1.8331129225965

Command

I1-I2 → I3

Results

{23,6,24,14,19,19,21,17,1,34}

Command

MENU 6 7 2

Data Entry

μ_0 (15)
 List (L_3)
 Frequency (1)
 Alternate Hypothesis ($\mu > \mu_0$)

Results

tTest 15,I3,1,1

["Title"	"t Test"]
["Alternate Hyp"	" $\mu > \mu_0$ "]
["t"	0.95257934441568]
["PVal"	0.18284207296536]
["df"	9.]
[" \bar{x} "	17.8]
["sx := $s_{n-1}x$ "	9.2951600308978]
["n"	10.]

Command

MENU 6 7 4

Data Entry

Data
 List 1 (L_1)
 List 2 (L_2)
 Frequency 1 (1)
 Frequency 2 (1)
 Alternate Hypothesis ($\mu_1 < \mu_2$)
 Pooled (yes)

Results

tTest_2Samp I1,I2,1,1,-1,1

["Title"	"2-Sample t Test"]
["Alternate Hyp"	" $\mu_1 < \mu_2$ "]
["t"	-2.8867513459481]
["PVal"	0.010150046786233]
["df"	8.]
[" \bar{x}_1 "	58.]
[" \bar{x}_2 "	78.]
["sx1"	8.3666002653408]
["sx2"	13.038404810405]
["sp"	10.954451150103]
["n1"	5.]
["n2"	5.]

Command

VAR ev

Results

ev()
 $sx_2^2/sx_1^2=2.4285714285713$
 Pooled=Yes

Command

MENU 6 5 6

Data Entry

Area (0.1)
 Degrees of freedom (8)

Results

invt(0.1,8)
 -1.3968153097438

Command

$((157^2)/(111^2))$

Results

2.0005681357033

Command

MENU 6 5 6

Data Entry

Area (0.005)
 Degrees of freedom (58)

Results

$\pm\text{inv}t(0.005,58)$
 ± 2.6632869395268

Command

MENU 6 7 4

Data Entry

Stats
 $\bar{x}1$ (264)
 $Sx1$ (157)
 $n1$ (30)
 $\bar{x}2$ (199)
 $Sx2$ (111)
 $n2$ (30)
 Alternate Hypothesis ($\mu1 \neq \mu2$)
 Pooled (yes)

Results

tTest_2Samp 264,157,30,199,111,30,0,1

["Title"	"2-Sample t Test"]
["Alternate Hyp"	" $\mu1 \neq \mu2$ "]
["t"	1.8516088961935]
["PVal"	0.069174666126434]
["df"	58.]
[" $\bar{x}1$ "	264.]
[" $\bar{x}2$ "	199.]
[" $sx1$ "	157.]
[" $sx2$ "	111.]
["sp"	135.95955280891]
["n1"	30.]
["n2"	30.]

Command

$((12^2)/(3^2))$

Results

16

Command

MENU 6 7 4

Data Entry

Stats
 $\bar{x}1$ (0.3)
 $Sx1$ (0.12)
 $n1$ (1)
 $\bar{x}2$ (0.2)
 $Sx2$ (0.03)
 $n2$ (15)
 Alternate Hypothesis ($\mu1 \neq \mu2$)
 Pooled (no)

Results

tTest_2Samp 0.3,0.12,10,0.2,0.03,15,0,0

["Title"	"2-Sample t Test"]
["Alternate Hyp"	" $\mu1 \neq \mu2$ "]
["t"	2.5819888974716]
["PVal"	0.027833606052405]
["df"	9.7547380156076]
[" $\bar{x}1$ "	0.3]
[" $\bar{x}2$ "	0.2]
[" $sx1$ "	0.12]
[" $sx2$ "	0.03]
["n1"	10.]
["n2"	15.]

Command

MENU 6 5 6

Data Entry

Area (0.05/2)
 Degrees of freedom (from VAR menu)

Results

$\pm\text{inv}t(((0.05)/(2)),\text{stat.df})$
 ± 2.235755908208

Command**MENU 6 7 4****Data Entry**

Data
 List 1 (L_1)
 List 2 (L_2)
 Frequency 1 (1)
 Frequency 2 (1)
 Alternate Hypothesis ($\mu_1 < \mu_2$)
 Pooled (yes)

Results**tTest_2Samp I1,I2,1,1,-1,1**

["Title"	"2-Sample t Test"]
["Alternate Hyp"	" $\mu_1 < \mu_2$ "]
["t"	-2.8867513459481]
["PVal"	0.010150046786233]
["df"	8.]
[" \bar{x}_1 "	58.]
[" \bar{x}_2 "	78.]
["sx1"	8.3666002653408]
["sx2"	13.038404810405]
["sp"	10.954451150103]
["n1"	5.]
["n2"	5.]

Command**VAR m2****Parameters** (δ_0) **Results****m2(-10)**

["Title"	"2-Sample t Test"]
["Alternate Hyp"	" $\mu_1 \neq \mu_2$ "]
["t"	-1.44338]
["PVal"	0.186905]
["df"	8.]
[" \bar{x}_1 "	58.]
[" \bar{x}_2 "	68.]
["sx1"	8.3666]
["sx2"	13.0384]
["sp"	10.9545]
["n1"	5.]
["n2"	5.]

Command**MENU 6 5 3****Data Entry**

Area (0.05)
 μ (0)
 σ (1)

Results **\pm invNorm(0.05,0,1)** ± 1.6448536259066 **Command****MENU 6 7 5****Data Entry**

P_0 (0.8)
 Successes (75)
 n (100)
 Alternate Hypothesis (prop $\neq p_0$)

Results**zTest_1Prop 0.8,75,100,0**

["Title"	"1-Prop z Test"]
["Alternate Hyp"	"prop $\neq p_0$ "]
["z"	-1.25]
["PVal"	0.21129967792531]
["D"	0.75]
["n"	100.]

Command

MENU 6 5 3

Data Entry

Area (0.025)
 μ (0)
 σ (1)

Results

\pm invNorm(0.025,0,1)

± 1.9599639859915

Command

MENU 6 7 6

Data Entry

Successes X1 (300)
n1 (500)
Successes X2 (200)
n2 (400)
Alternate Hypothesis ($p1 \neq p2$)

Results

zTest_2Prop 300,500,200,400,0

["Title"	"2-Prop z Test"]
["Alternate Hyp"	" $p1 \neq p2$ "]
["z"	3.]
["PVal"	0.0026999344444704]
["D1"	0.6]
["D2"	0.5]
["D"	0.55555555555556]
["n1"	500.]
["n2"	400.]