

Excel 2010 Guide

To Accompany
UNDERSTANDING BASIC STATISTICS
SIXTH EDITION

Brase/Brase

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Preface

The use of computing technology can greatly enhance a student's learning experience in statistics. *Understanding Basic Statistics* is accompanied by four Technology Guides, which provide basic instructions, examples, and lab activities for four different tools:

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

Microsoft Excel ®2010 with Analysis ToolPak for Windows ®

MINITAB Version 15

SPSS Version 18

The TI-83 Plus, TI-84 Plus and TI-Nspire are versatile, widely available graphing calculators made by Texas Instruments. The calculator guide shows how to use their statistical functions, including plotting capabilities.

Excel is an all-purpose spreadsheet software package. The Excel guide shows how to use Excel's built-in statistical functions and how to produce some useful graphs. Excel is not designed to be a complete statistical software package. In many cases, macros can be created to produce special graphs, such as box-and-whisker plots. However, this guide only shows how to use the existing, built-in features. In most cases, the operations omitted from Excel are easily carried out on an ordinary calculator. The Analysis ToolPak is part of Excel and can be installed from the same source as the basic Excel program (normally, a CD-ROM) as an option on the installer program's list of Add-Ins. Details for getting started with the Analysis ToolPak are in Chapter 1 of the Excel guide. No additional software is required to use the Excel functions described.

MINITAB is a statistics software package suitable for solving problems. It can be packaged with the text. Contact Cengage Learning for details regarding price and platform options.

SPSS is a powerful tool that can perform many statistical procedures. The SPSS guide shows how to manage data and perform various statistical procedures using this software.

The lab activities that follow accompany the text *Understanding Basic Statistics*, 6th edition by Brase and Brase. On the following page is a table to coordinate this guide with *Understanding Statistics*, 10th edition by Brase and Brase. Both texts are published by Cengage Learning.

In addition, over one hundred data files from referenced sources are described in the Appendix. These data files are available via download from the Cengage Learning Web site:

<http://www.cengage.com/statistics/brase>

Understanding the Differences Between *Understanding Basic Statistics* 6/e and *Understandable Statistics* 10/e

Understandable Basic Statistics is the brief, one-semester version of the larger book. It is currently in its Sixth Edition.

Understandable Statistics is the full, two-semester introductory statistics textbook, which is now in its Tenth Edition.

Unlike other brief texts, *Understanding Basic Statistics* is not just the first six or seven chapters of the full text. Rather, topic coverage has been shortened in many cases and rearranged, so that the essential statistics concepts can be taught in one semester.

The major difference between the two tables of contents is that Regression and Correlation are covered much earlier in the brief textbook. In the full text, these topics are covered in Chapter 9. In the brief text, they are covered in Chapter 4.

Analysis of Variance (ANOVA) is not covered in the brief text.

Understanding Statistics has 11 chapters and *Understanding Basic Statistics* has 11. The full text is a hard cover book, while the brief is softcover.

The same pedagogical elements are used throughout both texts.

The same supplements package is shared by both texts.

Following are the two Tables of Contents, side-by-side:

	<i>Understandable Statistics</i> (full)	<i>Understanding Basic Statistics</i> (brief)
Chapter 1	Getting Started	Getting Started
Chapter 2	Organizing Data	Organizing Data
Chapter 3	Averages and Variation	Averages and Variation
Chapter 4	Elementary Probability Theory	Correlation and Regression
Chapter 5	The Binomial Probability Distribution and Related Topics	Elementary Probability Theory
Chapter 6	Normal Curves and Sampling Distributions	The Binomial Probability Distribution and Related Topics
Chapter 7	Estimation	Normal Curves and Sampling Distributions
Chapter 8	Hypothesis Testing	Estimation
Chapter 9	Correlation and Regression	Hypothesis Testing
Chapter 10	Chi-Square and F Distributions	Inference About Differences
Chapter 11	Nonparametric Statistics	Additional Topics Using Inference

Excel 2010 Guide

CHAPTER 1: GETTING STARTED

GETTING STARTED WITH EXCEL

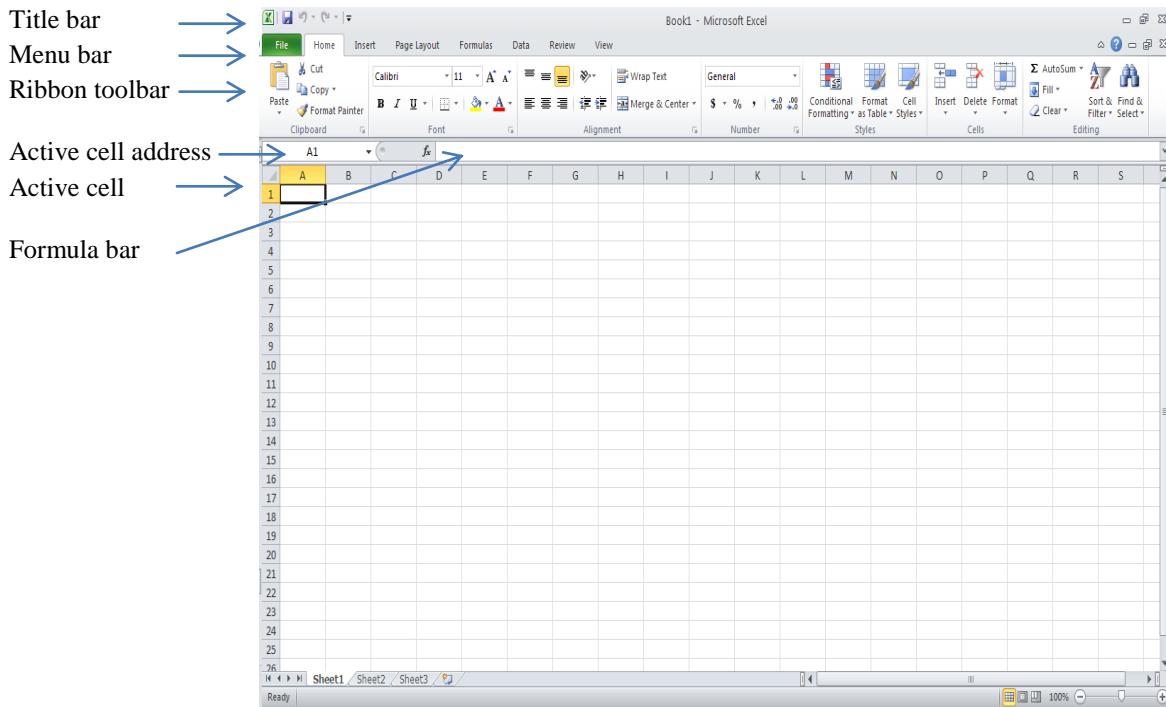
Microsoft Excel® is an all-purpose spreadsheet application with many functions. We will be using Excel 2010. This guide is not a general Excel manual, but it will show you how to use many of Excel's built-in statistical functions. You may need to install the Analysis ToolPak from the original Excel software if your computer does not have it. To determine if your installation of Excel includes the Analysis ToolPak, open Excel, click on File in the main menu, and then click on Options. Next, click on Add-Ins and see if the ToolPak is listed in the Active Application Add-Ins. If it is, the ToolPak is installed. If you do not see a listing for Analysis ToolPak in Active Application Add-Ins, then you will need to install it from the original Excel installation source. To do this, click Go. Then check the box next to Analysis ToolPak and click OK.

If you are familiar with Windows-based programs, you will find that many of the editing, formatting, and file-handling procedures of Excel are similar to those you have used before. You use the mouse to select, drag, click, and double-click as you would in any other Windows program.

If you have any questions about Excel not answered in this guide, consult the Excel manual or select Help on the menu bar.

The Excel Window

When you have opened Excel, you should see a window like this:



The Excel Workbook

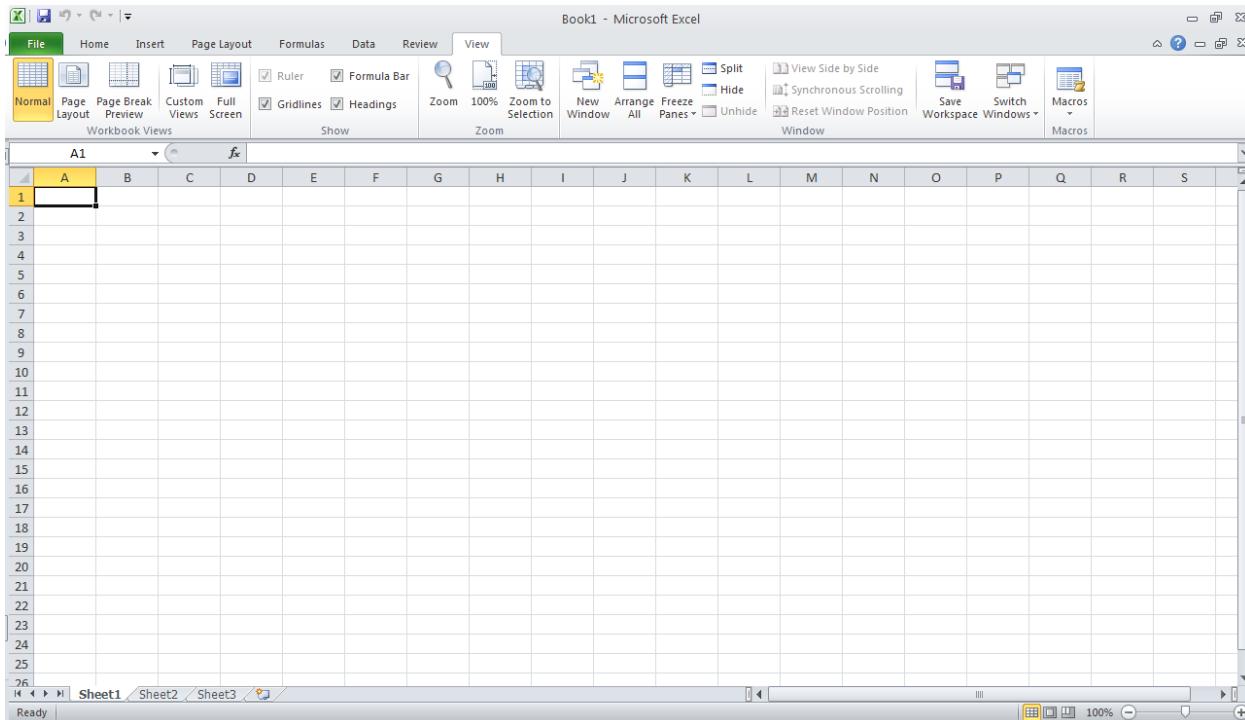
An Excel file is called a Workbook. Notice that in the display shown above, the title bar shows Microsoft Excel - Book1. This means that we are working in Book 1.

Each workbook consists of one or more worksheets. In the worksheet above, the tabs near the bottom of the screen show that we are working with Sheet 1. To change worksheets, click on the appropriate tab. Alternatively, you can right-click the arrows just to the left of the worksheet tabs to get a list of all the worksheets in the projects, and then select a worksheet.

The Cells in the Worksheet

When you look at a worksheet, you should notice horizontal and vertical grid lines. If they are missing, you will need to activate that feature. To do so,

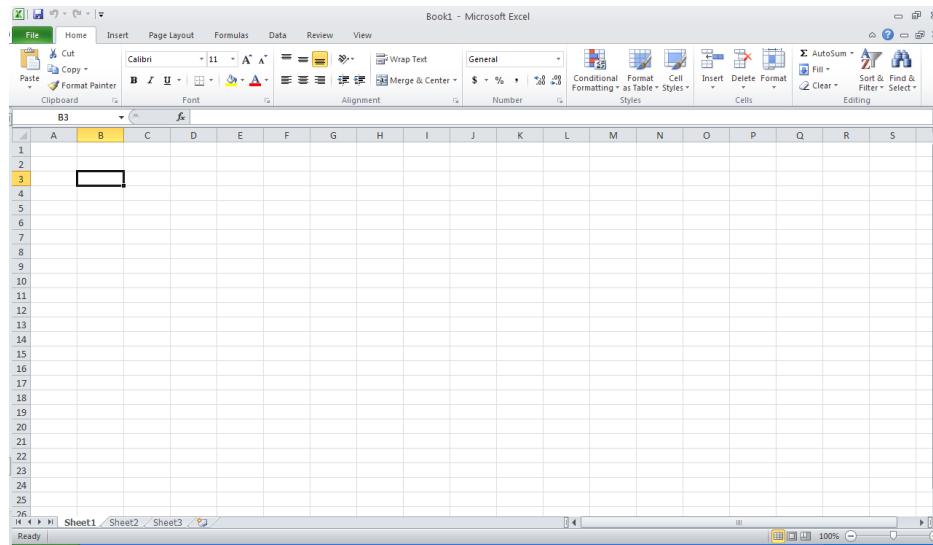
1. Select View from the menu .
2. Be sure that the Gridlines option is checked.



It is convenient to have checks by all the options shown above.

Cell Addresses

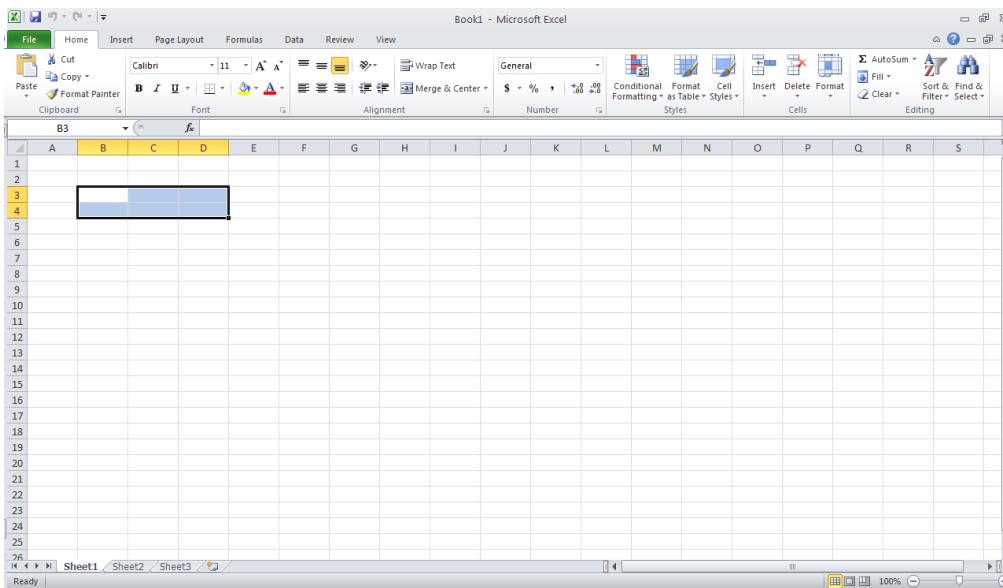
The cells are formed by intersecting rows and columns. A cell's address consists of a column letter followed by a row number. For example, the address B3 designates the cell that lies in Column B, Row 3. When Cell B3 is highlighted, it is the active cell. This means we can enter text or numbers into Cell B3.



Selecting Cells

To select a cell, position the cursor in the cell and click the left mouse button.

Sometimes you will want to select several cells at once, in order to format them (as described next). To select a rectangular block of cells, position the cursor in a corner cell of the block, hold down the left mouse button, drag the cursor to the cell in the block's opposite corner, and release the button. The selected cells will be highlighted, as shown below.



To select an entire column, click on the letter above it; to select an entire row, click on the number to its left. To select every cell in the worksheet, click on the gray blank rectangle in the upper left corner of the worksheet (above row header 1 and left of column header A).

You can also select a block of cells by typing the two corner cells into the active cell address window. The block highlighted on the preceding page would be selected by typing B3:E4 and pressing Enter.

Formatting Cell Contents

In Excel, you may place text or numbers in a cell. As in other Windows applications, you can format the text or numbers by using the formatting toolbar buttons for bold (**B**), italics (*I*), underline (U), etc. Other options include left, right, and centered alignment within a cell.

Numbers can be formatted to represent dollar amounts (\$) or percents (%) and can be shown with commas in large numbers (.). The number of decimal places to which numbers are carried is also adjustable. All these options appear on the formatting menu bar. Other options are accessible by right-clicking on a cell and selecting **Format Cells**.

Changing Cell Width

Column widths and row heights can be adjusted by placing the cursor between two columns letters or row numbers. When the cursor changes appearance, hold down the left mouse button, move the column or row boundary, and release.

All these instructions may seem a little mysterious. Once you try them, however, you will find that they are fairly easy to remember.

ENTERING DATA

In Excel we enter data and labels in the cells. It is common to select a column for the data and place a label as the first entry in the column.

Let's enter some data on television advertising. For each of twenty hours of prime-time viewing, both the number of ads and the time devoted to ads were recorded. We will enter the data in two columns, as shown:

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Ad Count	Min/Hour																
2	25	11.5																
3	23	10.7																
4	28	10.2																
5	15	9.3																
6	13	11.3																
7	24	11																
8	27	15																
9	22	12																
10	17	10																
11	19	10.5																
12	20	14.3																
13	22	11.7																
14	18	14.9																
15	19	10.7																
16	23	12.3																
17	13	10.1																
18	23	11.2																
19	21	10.8																
20	22	10.3																
21	25	15.7																
22																		
23																		
24																		
25																		
26																		

Entering and Correcting Data

To select a cell for content entry, move the mouse pointer to the cell and click. Then type the label or data and press Enter. Excel automatically moves to select the next cell in the same column. If you want to enter information in a different cell, just click on it.

Errors are easily fixed. If you notice a mistake before you press Enter, simply back-arrow to the mistake and correct it. If you notice the error after you have pressed Enter, select the affected cell and then click on the formula bar to add a typing cursor to the cell contents displayed. Use standard keyboard editing techniques to make corrections, then press Enter.

If you want to erase the contents of a cell or range of cells but keep the formatting, select the cells and click Home then click the arrow next to **Clear** and select **Clear Content**(or just press Delete). The >**Clear**>**Clear Formats** option keeps the content but clears the format. The >**Clear**>**Clear All** option clears both content and format. >**Clear**>**Formats** is especially useful for changing percent data back into decimal format.

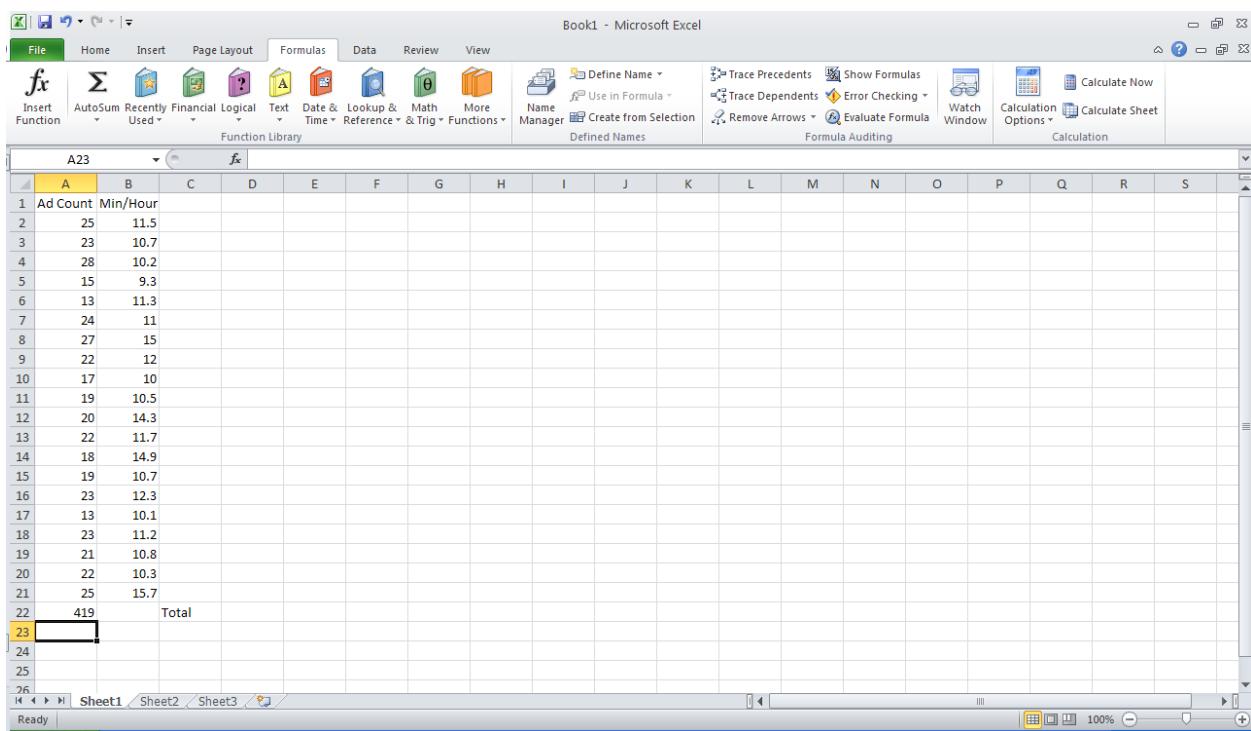
Arithmetic Options on the Standard Toolbar

Summing Data in a Column

On the Formula Ribbon, the  button automatically sums the values in the selected cells. When we

sum the contents of an entire column, Excel places the sum under the selected cells. It is a good idea to type the label *total* next to the cell where the total appears. Below, we selected cells in Column A containing numerical values

(a2:a21), pressed the  button, and then typed the word *total* in the corresponding row of Column C. We see that the total of Column A is 419.

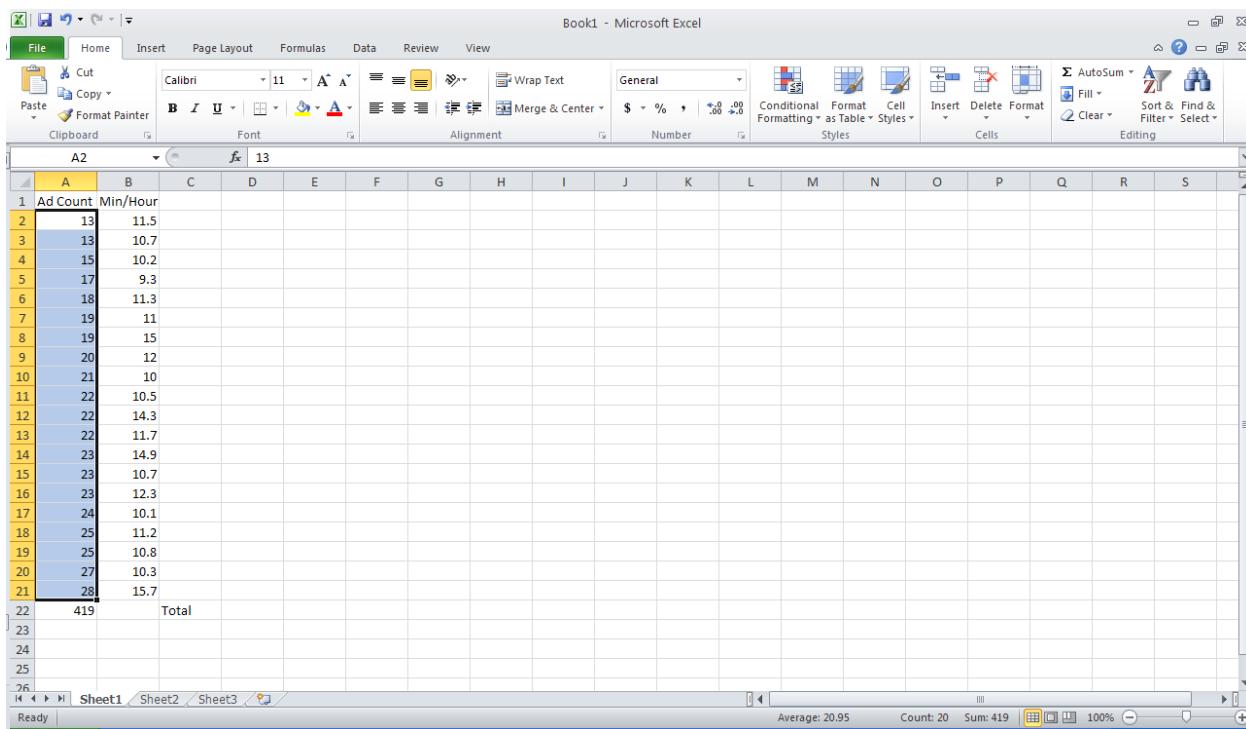


The screenshot shows a Microsoft Excel spreadsheet titled "Book1 - Microsoft Excel". The ribbon is visible at the top with the "Formulas" tab selected. In the formula bar, the cell reference "A23" is displayed. The spreadsheet contains data in columns A and B. Column A is labeled "Ad Count" and contains numerical values from 1 to 22. Column B is labeled "Min/Hour" and contains corresponding numerical values. Row 23 is highlighted in yellow and contains the value "419" in cell A23 and the word "Total" in cell B23. The status bar at the bottom right shows "100%".

Ad Count	Min/Hour
1	
2	25
3	23
4	28
5	15
6	13
7	24
8	27
9	22
10	17
11	19
12	20
13	22
14	18
15	19
16	23
17	13
18	23
19	21
20	22
21	25
22	419
23	Total
24	
25	

Sorting Data

The Sort and Filter button on the Home Ribbon sort the data in ascending or descending depending on the selection from the submenu. To sort just one column, highlight that column and press the button and select the sort order. To sort two or more columns by ascending or descending order of the data in the first column, highlight all the columns and click the appropriate button. In general, we will simply sort one column of data at a time, as shown.



Notice that the data in the first column is now in ascending order. The data in the second column has not moved.

If you decide that it was a mistake to sort the data this way, and you have not made any other changes since you did the sort, you can use (Undo) from the Title Bar from the main menu. The data will appear in their original order.

Copying Cells

To copy one cell or a block of cells to another location on the worksheet,

- Select the cells you wish to copy
- From the Home Ribbon, select **Copy**. (The shortcut for this process is Ctrl-C.) Notice that the range of cells being copied now has a blinking border around it.
- Select the upper-left cell of the block that will receive the copy.
- Press Enter. When you press Enter, the copy process is complete and the blinking border around the original cells disappears.

Note: Even if you use **Paste** or the shortcut Ctrl-V to paste, you must still press Enter to remove the blinking border around the original cells.

To copy one cell or a range of cells to another worksheet or workbook, follow steps (a) and (b) above. For step (c), be sure you are in the destination worksheet or workbook and that the worksheet or workbook is activated. Then proceed to step (d).

USING FORMULAS

A formula is an expression that generates a numerical value in a cell, usually based on values in other cells. Formulas usually involve standard arithmetic operations. Excel uses + for addition, - (hyphen) for subtraction, * for multiplication, / for division, and ^ (carat) for exponentiation (raising to a power).

For instance, if we want to divide the contents of Cell A2 by the contents of Cell B2 and place the results in Cell C2, we do the following:

- (a) Make Cell C2 the active cell.
- (b) Click in the formula bar and type =A2/B2.
- (c) Press Enter

The value in Cell C2 will be the quotient of the values in Cells A2 and B2.

If, for a whole series of rows, we wanted to divide the entry in Column A by the entry in Column B and put the results in Column C, we could repeat the above process over and over. However, the typing would be tedious. We can accomplish the same thing more easily by copying and pasting:

- (a) Enter =A2/B2 in Cell C2 as described above
- (b) Move the cursor to the lower right corner of Cell C2. The cursor should change shape to small black cross (+). Now hold down the left mouse button and drag the + down until all the cells in Column C in which you want the calculation done are highlighted.
- (c) Release the mouse button and press Enter. The cell entries in Column C should equal the quotients of the same-row entries in Columns A and B.

The screenshot shows a Microsoft Excel spreadsheet titled "Book1 - Microsoft Excel". The data is organized into three columns: "Ad Count" (Column A), "Min/Hour" (Column B), and "Rate" (Column C). The formula $=A3/B3$ is entered in cell C3 and copied down to cell C21. The formula in cell C21 is $=A21/B21$. The total value for all rows is displayed in cell C22, which contains the formula $=SUM(C3:C21)$.

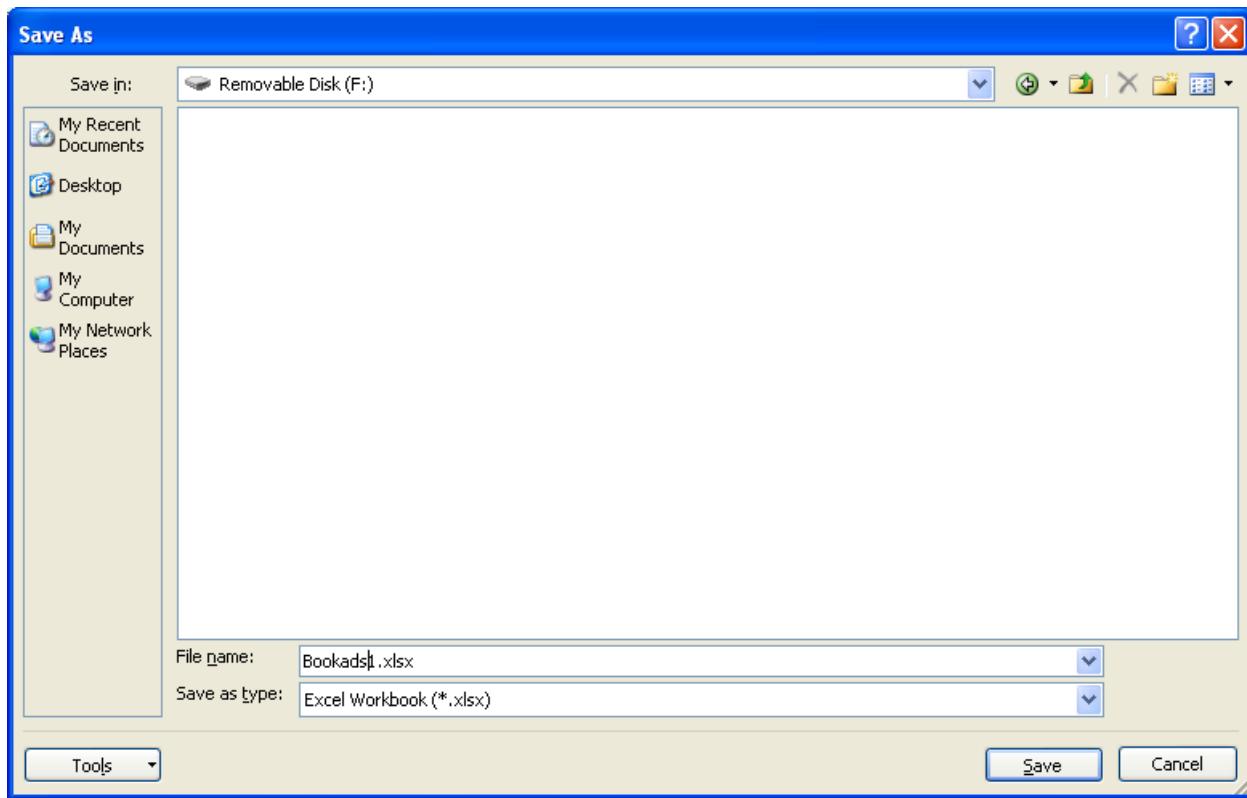
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Ad Count	Min/Hour		D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
2	25	11.5	2.173913																
3	23	10.7	2.149533																
4	28	10.2	2.745098																
5	15	9.3	1.612903																
6	13	11.3	1.150442																
7	24	11	2.181818																
8	27	15	1.8																
9	22	12	1.833333																
10	17	10	1.7																
11	19	10.5	1.809524																
12	20	14.3	1.398601																
13	22	11.7	1.880342																
14	18	14.9	1.208054																
15	19	10.7	1.775701																
16	23	12.3	1.869919																
17	13	10.1	1.287129																
18	23	11.2	2.053571																
19	21	10.8	1.944444																
20	22	10.3	2.135922																
21	25	15.7	1.592357																
22	419		Total																
23																			
24																			
25																			
26																			
27																			

Now, if you click on one of the lower cells in Column C, you will notice that the row number in the cell addresses is not 2, but rather the number of the new cell's row. In general, when a formula is copied from one cell to another, the cell addresses in the formula are automatically adjusted. If the formula $=D3+C7$ is copied to a new cell three columns right and two rows up from the old one, the pasted formula comes out as $=G1+F5$. (Three columns right from D is G, two rows up from 3 is 1, and so on.)

Sometimes you will want to prevent the automatic address adjustment. To do this put a dollar sign before any row or column number you want to keep from changing. When the formula $=D$3+$C7$ is copied to a new cell three columns right and two rows up from the old one, the pasted formula comes out as $=G$3+$C5$. We will call an address with two \$ signs in an absolute address, because it always refers to the same cell, no matter where the formula is copy/pasted to. A cell with only one \$ sign in it, or none at all, we will call a relative address, because the cell referred to can change as the formula is pasted from one location to another.

SAVING WORKBOOKS

After you have entered data into an Excel spreadsheet, it is a good idea to save it. On the main menu, click **>File>Save As**. A dialog box will appear, similar to the one at the top of the next page.



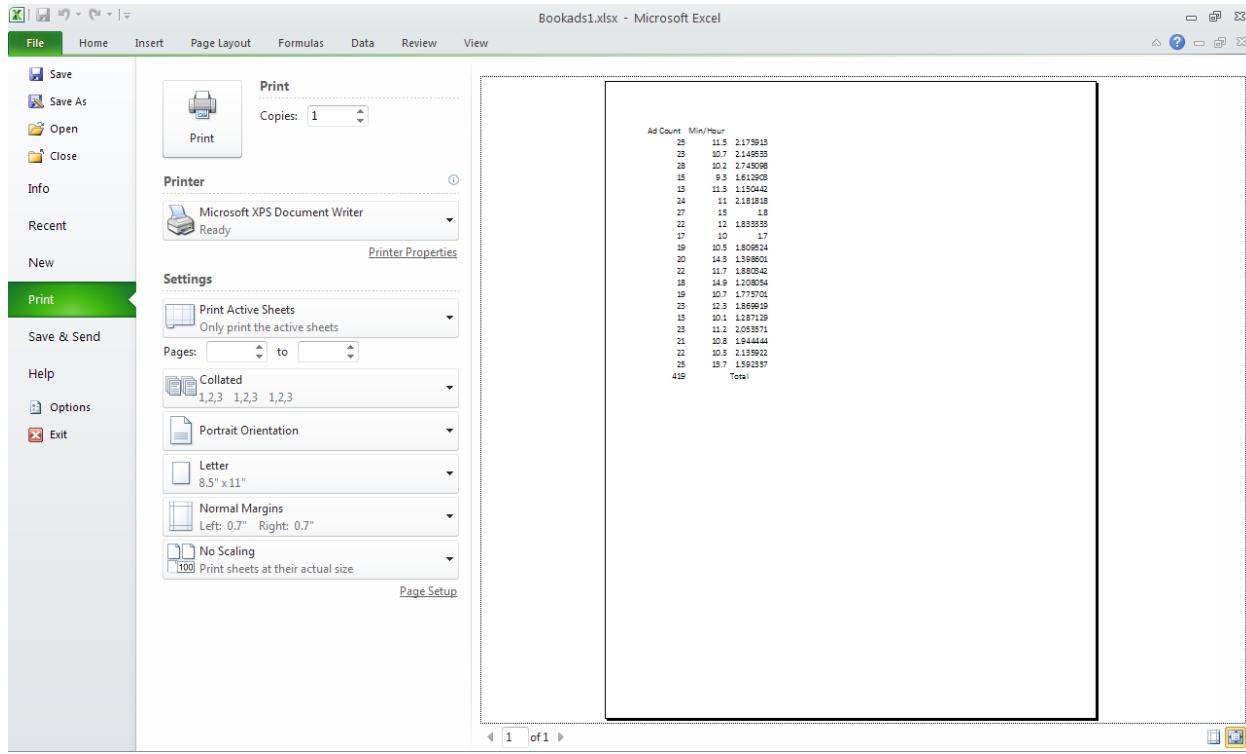
If you are in a college computer lab, you might save your files to a floppy disk. We named the workbook on TV ads Book1ads.

It is a good idea to save your workbook periodically as you are working on it. After you have saved the workbook for the first time, you can save updates during your working session by using the save button on the title toolbar. This is the second button from the left; it looks like a diskette.

To retrieve an Excel workbook, go to the main menu and click >**File>Open**. Select the drive containing your workbook and then the desired workbook file.

Printing Your Worksheets

Clicking >**File>Print** will open printer options.



If you select a range of cells on the worksheet before you print, you may print the selected material. Notice that you can tell the printer what to print by clicking under Settings Print Active sheet, Print Entire Workbook or Print Selection.

A preview is shown to the right.

LAB ACTIVITIES FOR GETTING STARTED

1. Go to your computer lab (or use your own computer) and open Excel. Check to see if you have the Analysis ToolPak add-in. If so, be sure it is activated.
2. If you have not already done so, enter the TV Ad Count and Min/Hour data into the workbook. Use Column A for the Ad Count and Column B for the Min/Hour data.
3. Save the workbook as Book1ads.
4. Select the cells containing the labels and data and print.
 5.
 - (a) In Column C, place the quotients A/B for the Rows 2 through 21. Use the formula bar in Cell C2, and drag with the little + symbol to complete the quotients for all rows. Note that if the calculation mode (see Chapter 2) has been set to Manual, you may need to use the key combination Shift-F9 after the cells are highlighted.
 - (b) Use the sum button to total up the Ad Count column and to total up the Min/Hour column. Place a label in Column D adjacent to the totals.
 - (c) Select the data in Columns A, B, C, and D and print it.
 6. In this problem we will copy a column of data and sort the copy.
 - (a) Select Column A (Ad Count) and copy it to Column D.
 - (b) Select Column D and sort it in ascending order (use only the original data, not the sum).

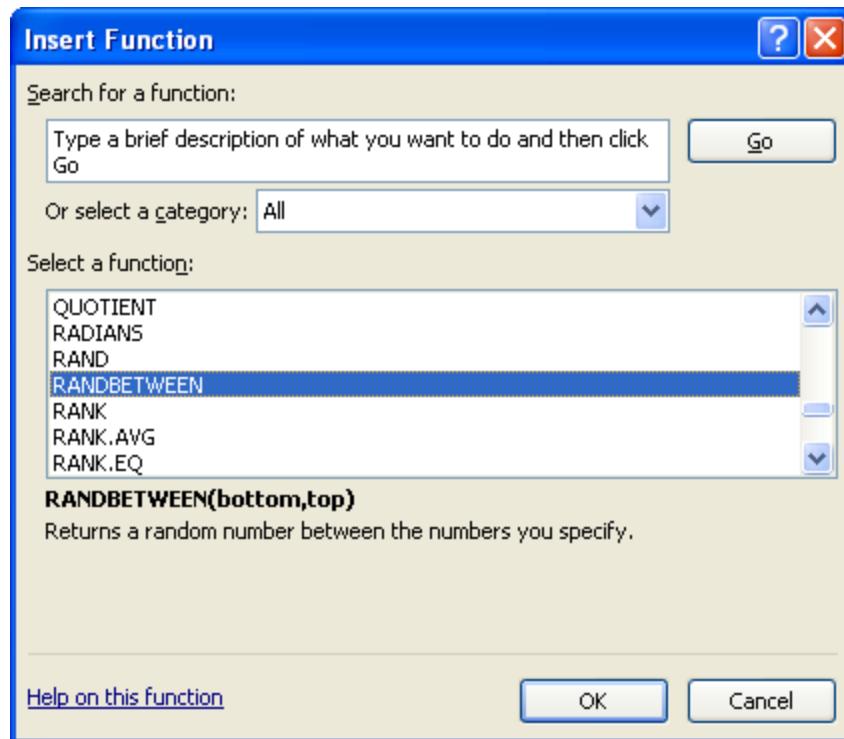
- (c) Select both Column A (Ad Count) and Column B (Min/Hour). Sort these columns by Column A in descending order. Are the data entries of 13 in Column A still next to the data entries 11.3 and 10.1 in Column B? Are the data in Column B sorted?

RANDOM SAMPLES (SECTION 1.2 OF UNDERSTANDING BASIC STATISTICS)

Excel has several random number generators. The one we will find most convenient is the function **RANDBETWEEN(bottom,top)**. This function generates a random integer between (inclusively) whatever integer is put in for “bottom” and whatever integer is put in for “top.”

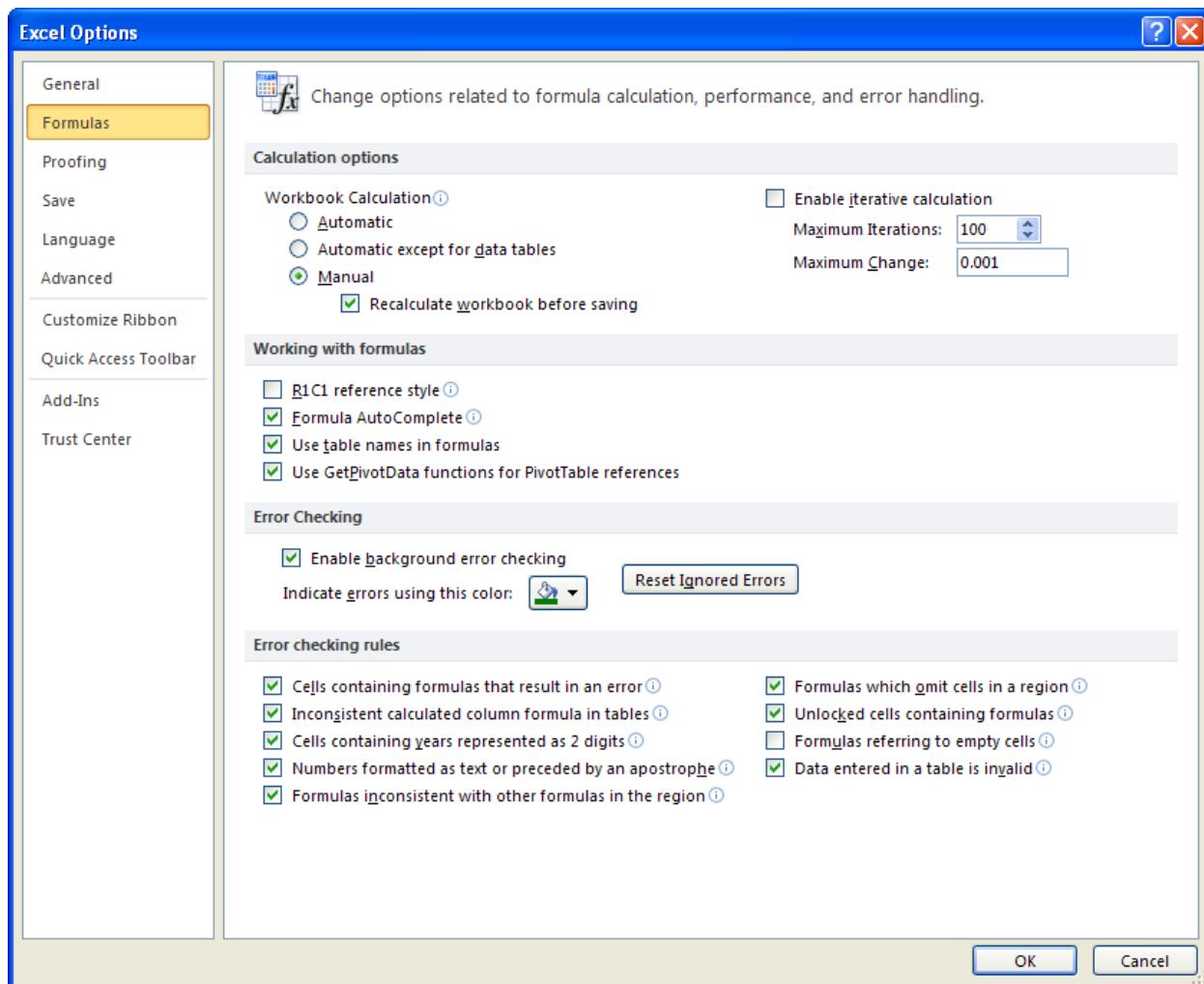
To use RANDBETWEEN, select a cell in the active worksheet. Click in the formula bar, type an equals sign, and on the standard toolbar click the Insert Function button: 

Pressing this button calls up a two-column menu, similar to the one at the top of the next page. Select All in the Function category, and then scroll down on the Function name side until you reach RANDBETWEEN. Note that this command is present only if you have the Analysis ToolPak installed.



Select RANDBETWEEN and then fill in the bottom and top numbers. Alternatively, you may simply type =RANDBETWEEN(bottom,top) in the formula bar, with numbers in place of bottom and top.

The random number generators of Excel have the characteristic that whenever a command is entered anywhere in the active workbook, the random numbers change because they are recalculated. To prevent this from happening, change the recalculate mode from automatic to manual. Select >File>Options, and then click on the tab labeled Formulas. Select Manual calculation, then press OK.



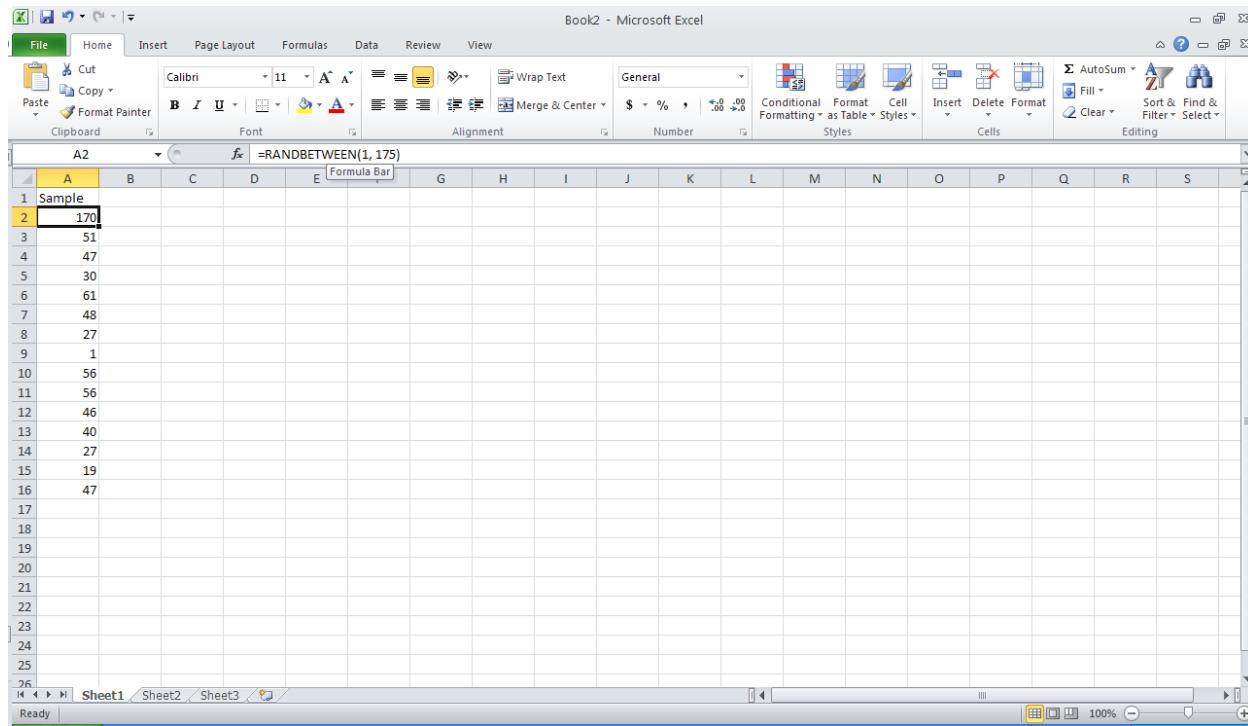
With automatic recalculation disabled, you can still recalculate by pressing the Shift-F9 key combination. Let us see this in an example, where we select a list of random numbers in a designated range and sort the list in ascending order.

Example

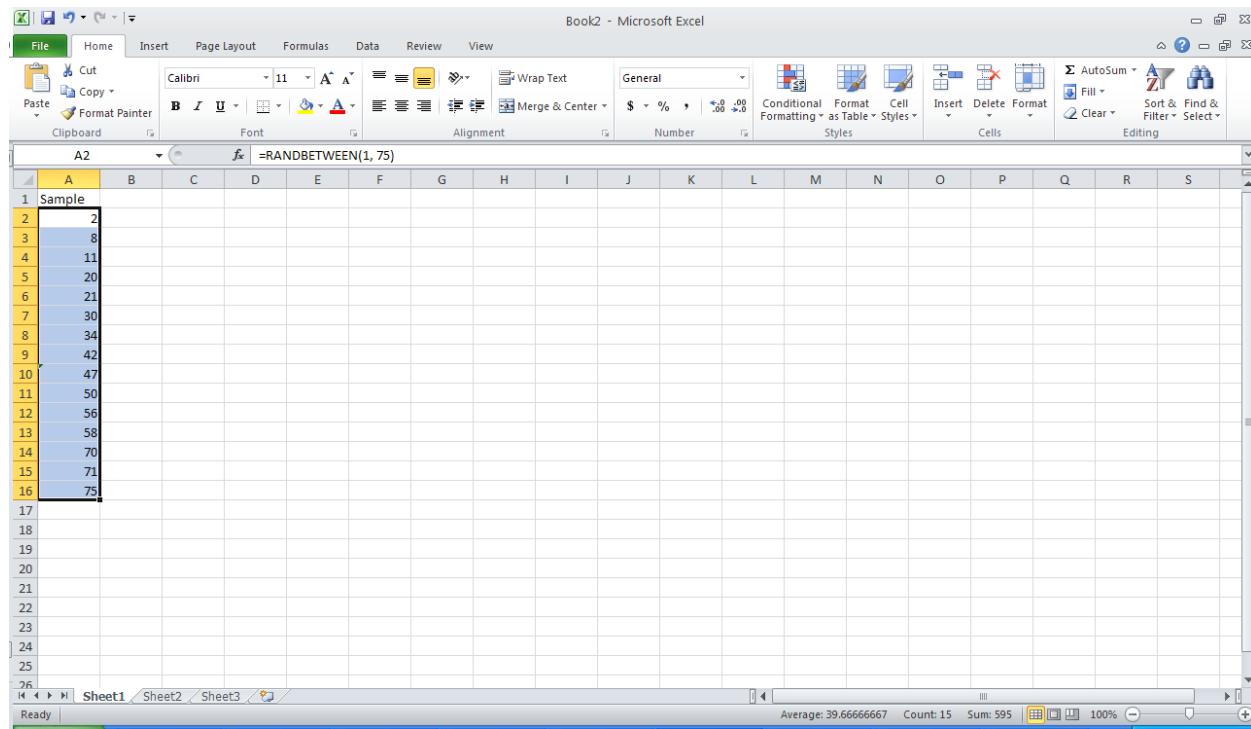
There are 175 students enrolled in a large section of introductory statistics. Draw a random sample of fifteen of the students.

We assign each of the students a distinct number between 1 and 175. To find the numbers of the fifteen students to be included in the sample, we do the following steps.

- Change the Calculation mode to Manual.
- Type the label Sample in Cell A1.
- Select Cell A2.
- Type =RANDBETWEEN(1,175) in the formula bar and press Enter.
- Position the mouse pointer in the lower right corner of Cell A2 until it becomes a + sign, and click-drag downward until you reach Cell A16. Release. Then press Shift-F9.



- Use one of the Sort buttons to sort the data, so you can easily check for repetitions. If there are repetitions, press Shift-F9 again and re-sort. Below, with the data sorted, we can verify that there are no repetitions.



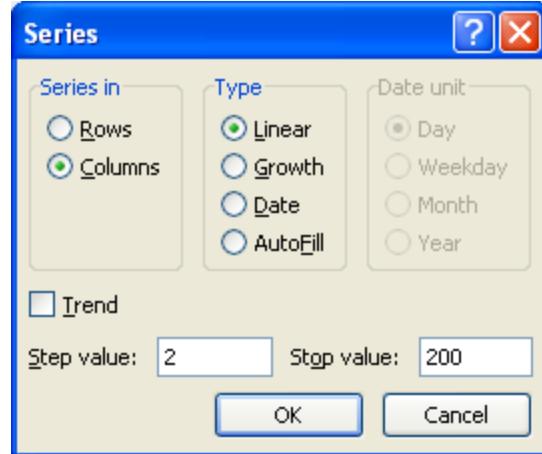
Sometimes we will want to sample from data already in our worksheet. In such case, we can use the **Sampling** dialog box. To reach the **Sampling** dialog box, use the man menu toolbar and select Sampling under >**Data>Data Analysis**.

Example

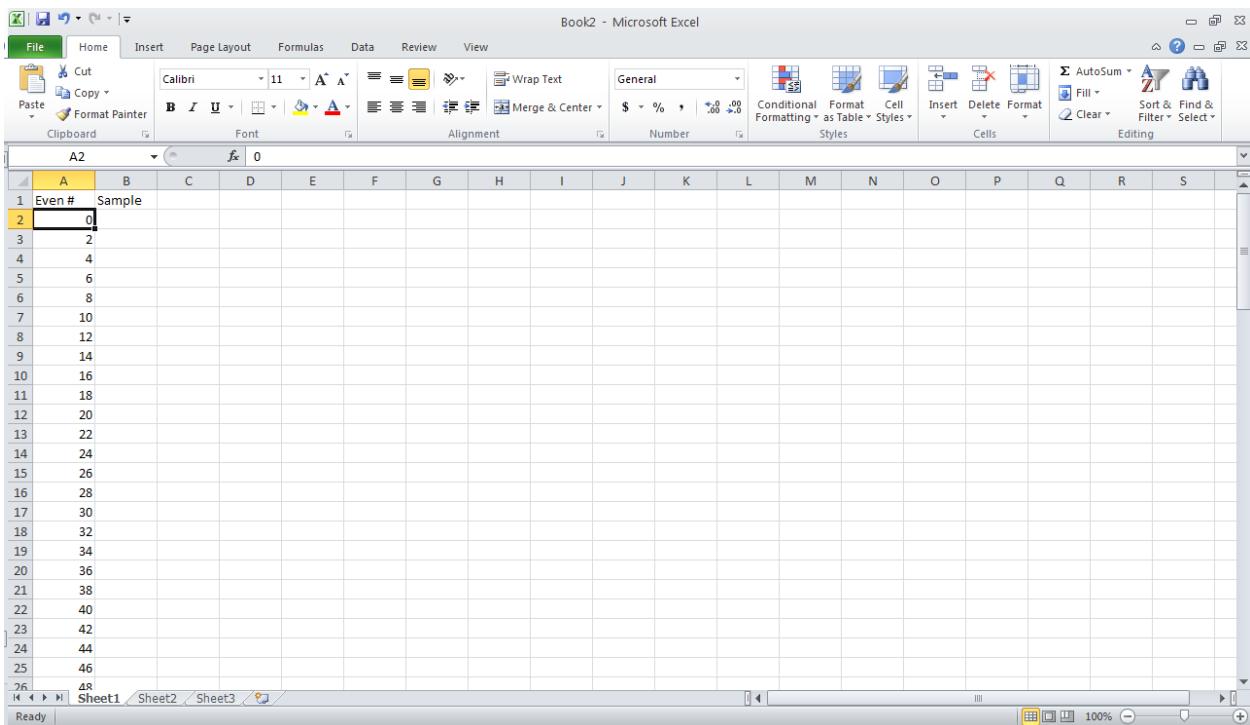
Enter the even numbers from 0 through 200 in Column A. Then take a sample of size ten, without replacement, from the population of even numbers 0 through 200, and place the results in Column B.

First we need to enter the even numbers 0 through 200 in Column A. Let's type the label Even # in Cell A1. The easiest way to generate the even numbers from 0 through 200 is to use the Fill menu selection. To do this, we

- (a) Place the value 0 into Cell A2, and finish with Cell A2 highlighted.
- (b) From the main menu, select >**Home>Fill>Series**. In the dialog box, select Series in Columns, Type Linear. Enter 2 as the Step value and 200 as the Stop value. Press OK.

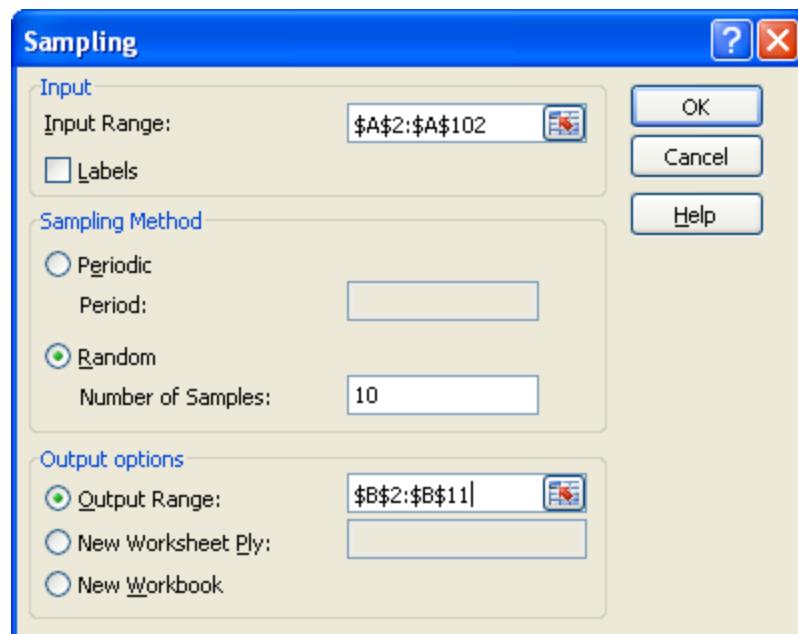


Now Column A should contain the even numbers from 0 to 200.

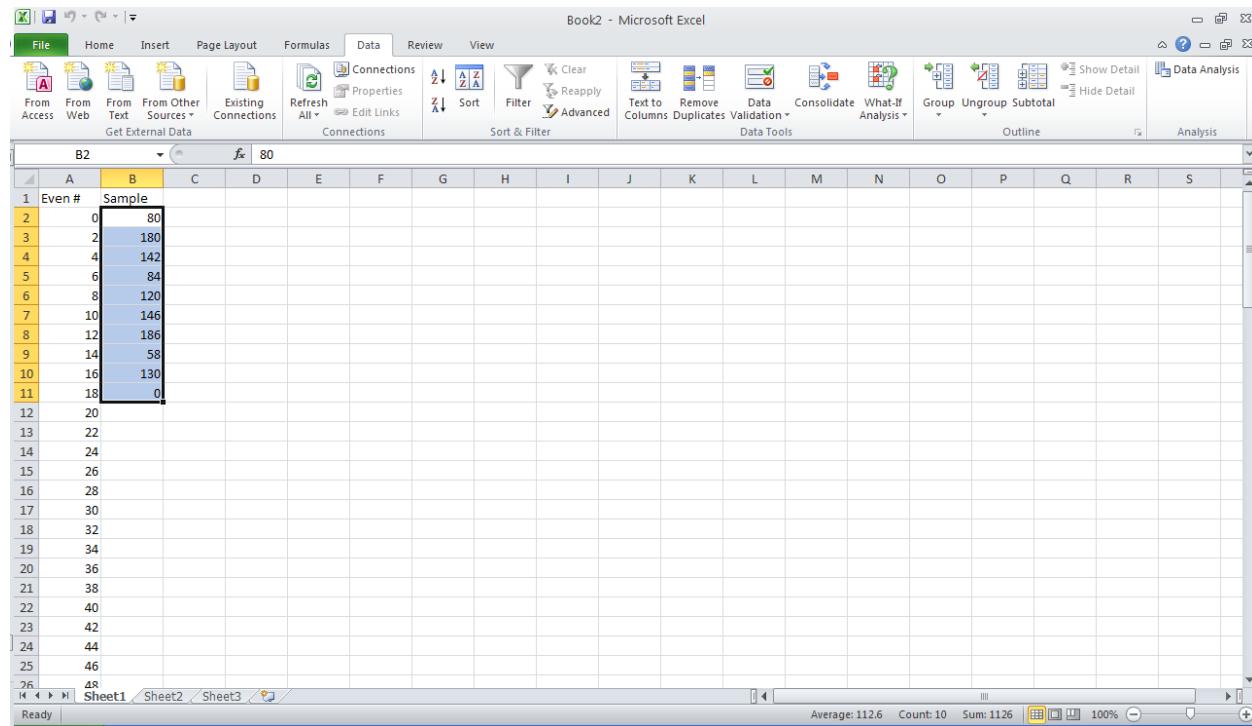


Now we will use the Sampling dialog box to select a sample of size ten from Column A, and we will place the sample in Column B. Notice that we labeled Column B as Sample. To draw the sample,

- From the main menu select >Data>Data Analysis>Sampling.
- In the dialog box, designate the data range from which we are sampling as A1:A102. Also, specify that the range contains a label. Select Random and enter 10 as the Number of Samples. Finally select the output range and type the destination B2:B11. Note that B1 already contains the label. Press Enter.



The worksheet now shows the random sample in Column B.



Note: After you finish the random number examples and the lab activities, you may want to set the calculation mode back to Automatic, especially if you are using a school computer.

LAB ACTIVITIES FOR RANDOM SAMPLES

1. Out of a population of 8173 eligible county residents, select a random sample of fifty for prospective jury duty. (Should you sample with or without replacement?) Use the RANDBETWEEN command with bottom value 1 and top value 8173. Then sort the data to check for repetitions. Note: Be sure that Calculation mode is set to manual. Use the Shift-F9 key combination to generate the sample in Rows 2 through 51 of Column A.
2. Retrieve the Excel worksheet Svls02.xls from the student website. This file contains weights of a random sample of linebackers on professional football teams. The data is in column form. Use the SAMPLING dialog box to take a random sample of ten of these weights. Print the ten weights included in the sample.

Simulating experiments in which outcomes are equally likely is another important use of random numbers.

3. We can simulate dealing bridge hands by numbering the cards in a bridge deck from 1 to 52. Then we draw a random sample of thirteen numbers without replacement from the population of 52 numbers. A bridge deck has four suits: hearts, diamonds, clubs, and spades. Each suit contains thirteen cards; those numbered 2 through 10, a jack, a queen, a king, and an ace. Decide how to assign the numbers 1 through 52 to the cards in the deck.
 - (a) Use RANDBETWEEN to generate the numbers of the thirteen cards in one hand. Translate the numbers to specific cards and tell what cards are in the hand. For a second game, the cards would be collected and reshuffled. Use the computer to determine the hand you might get in a second game.

- (b) Generate the numbers 1-52 in Column A, and then use the SAMPLING dialog box to sample thirteen cards. Put the results in Column B, Label Column B as “My hand” and print the results. Repeat this process to determine the hand you might get in a second game.
 - (c) Compare the four hands you have generated. Are they different? Would you expect this result?
4. We can also simulate the experiment of tossing a fair coin. The possible outcomes resulting from tossing a coin are heads or tails. Assign the outcome heads the number 2 and the outcome tails the number 1. Use RANDBETWEEN(1,2) to simulate the act of tossing a coin ten times. Simulate the experiment another time. Do you get the same sequence of outcomes? Do you expect to? Why or why not?

CHAPTER 2: ORGANIZING DATA

FREQUENCY DISTRIBUTIONS AND HISTOGRAMS (SECTION 2.1 OF *UNDERSTANDING BASIC STATISTICS*)

Excel's Histogram dialog box is found under >Data>Data Analysis>Histogram.

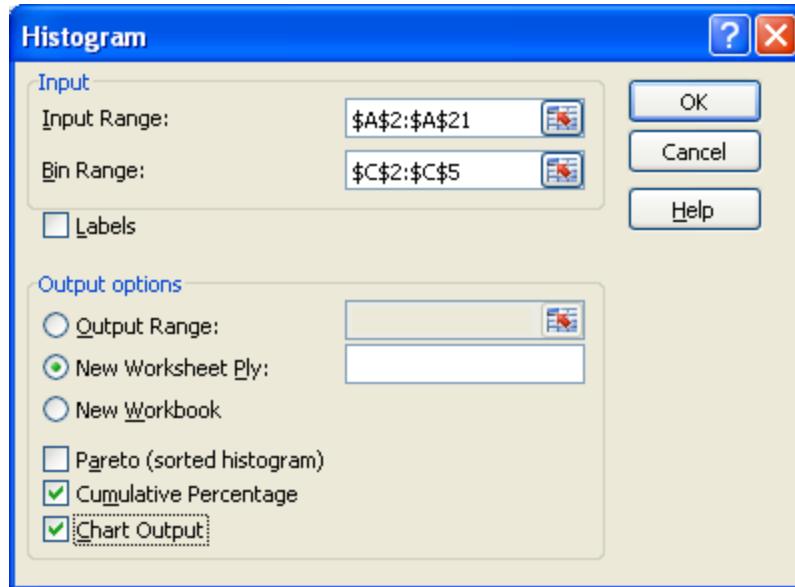
Example

Let's make a histogram with four classes, using the data we stored in the workbook Book1ads (created in Chapter 1). Use >File>Open to locate the workbook, and click on it.

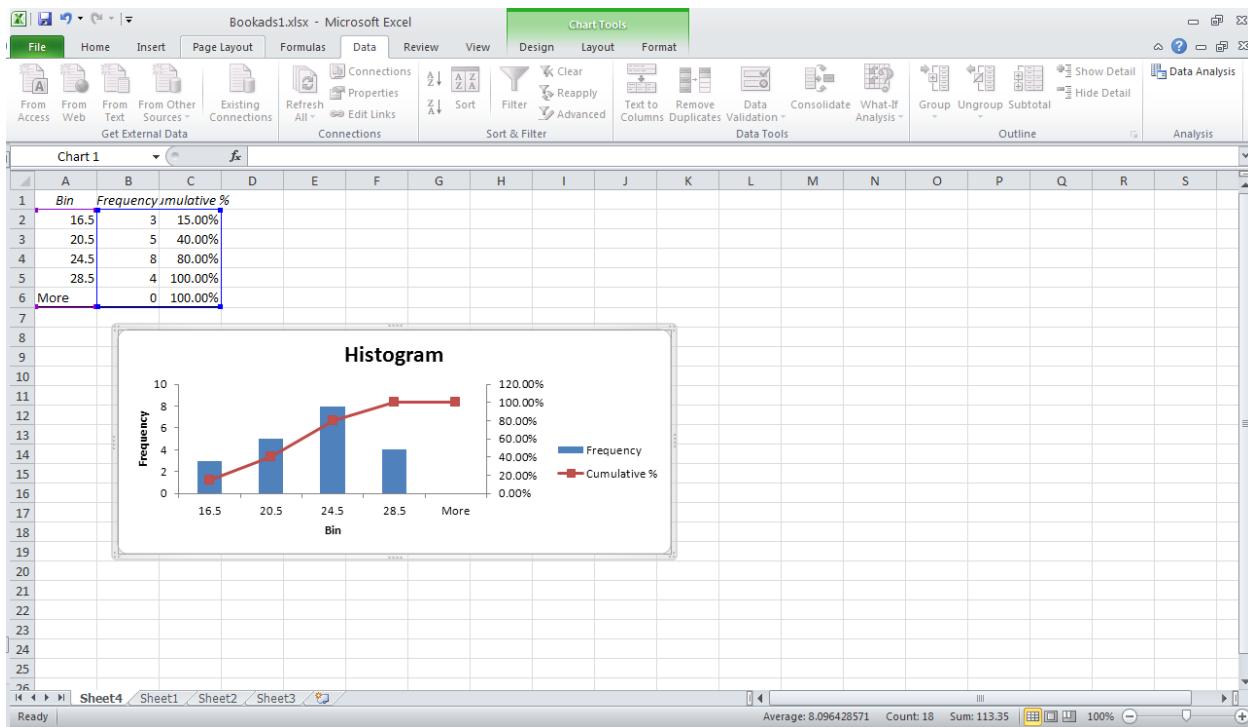
The number of ads per hour of TV is in Column A; we will represent these values in the histogram. We also need to specify class boundaries, and for this we will use Column C. Using methods shown in the text *Understanding Basic Statistics*, we see that the upper class boundaries for four classes are 16.5, 20.5, 24.5, and 28.5.

Label Column C as Ad Count, and below the label enter these values, smallest to largest. The horizontal axis of the histogram will carry the label Ad Count. Note: Excel follows the convention that a data value is counted in a class if the value is less than or equal to the upper boundary (upper bin value) of the class.

Now select >Data>Data Analysis>Histogram. Check the Labels option, and select New Workbook for the output option. Finally, check Chart output for the histogram, and check Cumulative percentage to produce an ogive. Note that you can select either both options or just one of them. Your dialog box should look similar to the one below.



In the resulting worksheet, we moved and resized the chart window. Notice that the class boundaries are not shown directly under the tick marks. The first bar represents all the values less than or equal to 16.5, the second bar is for values greater than 16.5 and less than or equal to 20.5, and so on. There are no values above 28.5.



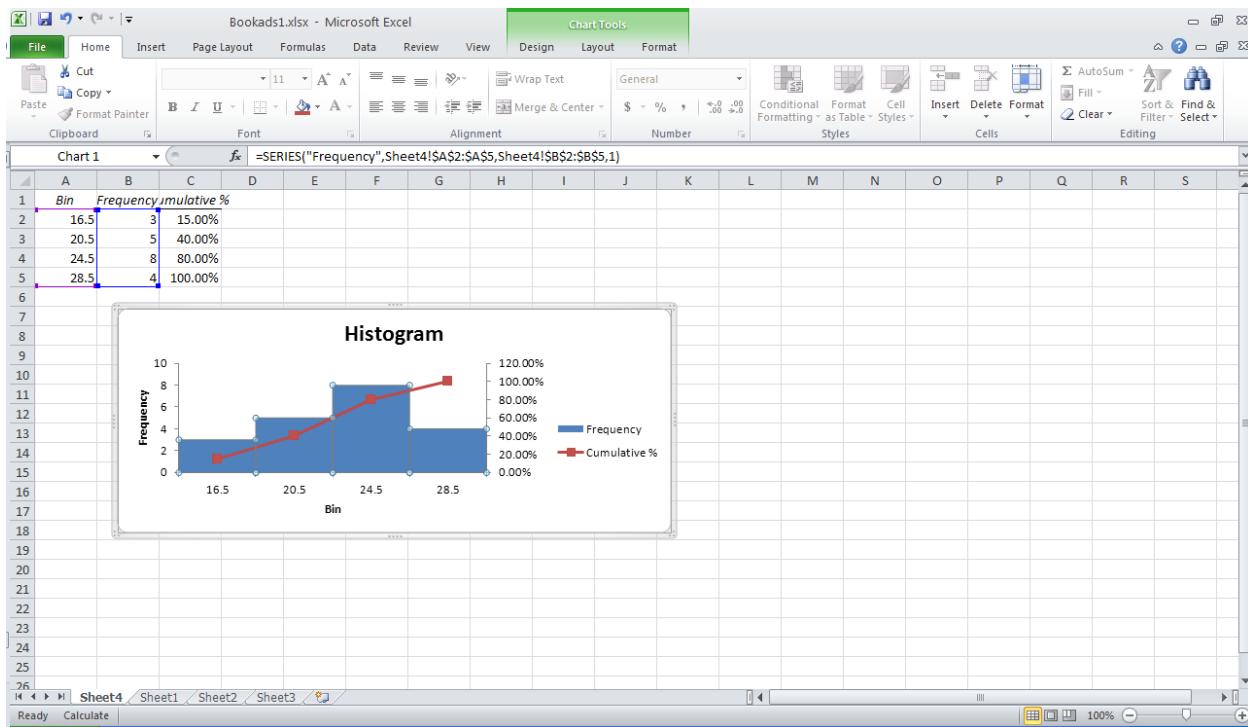
If you do not specify the cells containing the bin range, Excel automatically creates enough bins (classes) to show the data distribution.

Adjusting the Histogram

Excel automatically supplies the “more” category (which will be empty if you specify upper class boundaries). To remove the “more” category, select the cells in the row of the frequency table that contains “more”. Then, on the main menu bar select **Home>Delete**. Right-click on the chart area and click Select Data. Then press Cancel. This will update the chart to contain only data shown in the table.

To make the bars touch, right-click on one of the bars of the histogram. Then click Format Data Series. Set Gap width to 0. Then press Close.

The results should be similar to this:



LAB ACTIVITIES FOR FREQUENCY DISTRIBUTIONS AND HISTOGRAMS

1. The Book1ads workbook contains a second column of data, with the minutes of ads per hour of prime time TV. Retrieve the workbook again and use column B to
 - (a) Make a histogram letting Excel determine the number of classes (bins).
 - (b) Use the Sort button on the Home Ribbon, then find the highest and lowest data values. Use the techniques in the text to find the upper class boundaries for five classes. Make a column in your worksheet that contains these boundaries, and label the column Min/Hr. In the Histogram dialog box, use the column containing these upper boundaries as the bin range. Generate a histogram.
2. As a project for her finance class, Linda gathered data about the number of cash requests made between the hours of 6 P.M. and 11 P.M at an automatic teller machine located in the student center. She made a count every day for four weeks. The results follow.

25	17	33	47	22	32	18	21	12	26	43	25
19	27	26	29	39	12	19	27	10	15	21	20
32	24	17	181								

- (a) Enter the data.
 - (b) Repeat part (b) of Problem 1.
3. Choose one of the following workbooks from the Excel data disk.

DISNEY STOCK VOLUME: Sv01.xls

WEIGHTS OF PRO FOOTBALL PLAYERS: Sv02.xls

HEIGHTS OF PRO BASKETBALL PLAYERS: Sv03.xls

MILES PER GALLON GASOLINE CONSUMPTION: Sv04.xls

FASTING GLUCOSE BLOOD TESTS: Sv05.xls

NUMBER OF CHILDREN IN RURAL CANADIAN FAMILIES: Sv06.xls

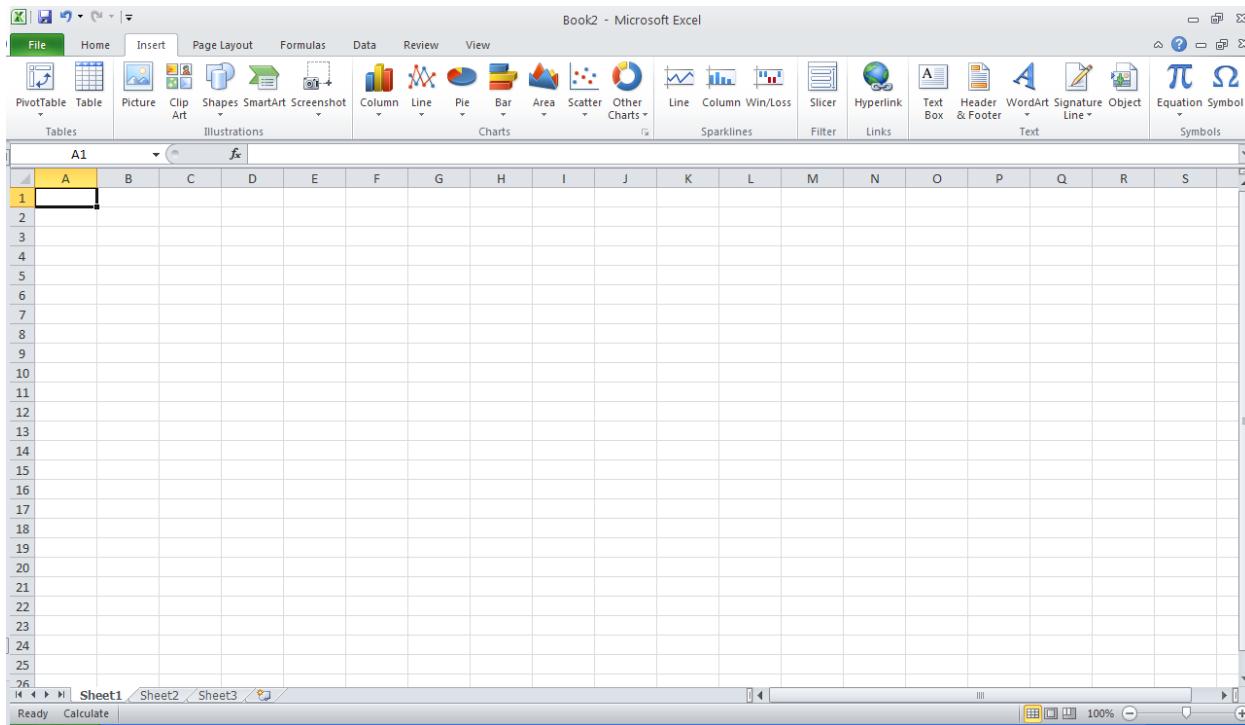
- (a) Make a histogram letting Excel scale it.
 - (b) Make a histogram using five classes. Use the method of part (b) of Problem 1.
4. Histograms are not effective displays for some data. Consider the following data:

1	2	3	6	7	9	8	4	12	10
1	9	1	12	12	11	13	4	6	206

Enter the data and make a histogram letting Excel do the scaling. Now drop the high value, 206, from the data set. Do you get more refined information from the histogram by eliminating the high and unusual data value?

BAR GRAPHS, CIRCLE GRAPHS, AND TIME-SERIES GRAPHS (SECTION 2.2 OF UNDERSTANDING BASIC STATISTICS)

Excel produces a wide variety of charts. To access these charts, use the Insert Ribbon and select the button with a picture of the desired chart on it:



Bar Graphs

You have the option of making a vertical bar graph (called a column graph in Excel) or a horizontal bar graph (called a bar graph in Excel).

Before making a chart, you must enter the necessary data in a worksheet, in rows or columns with appropriate row and column headers.

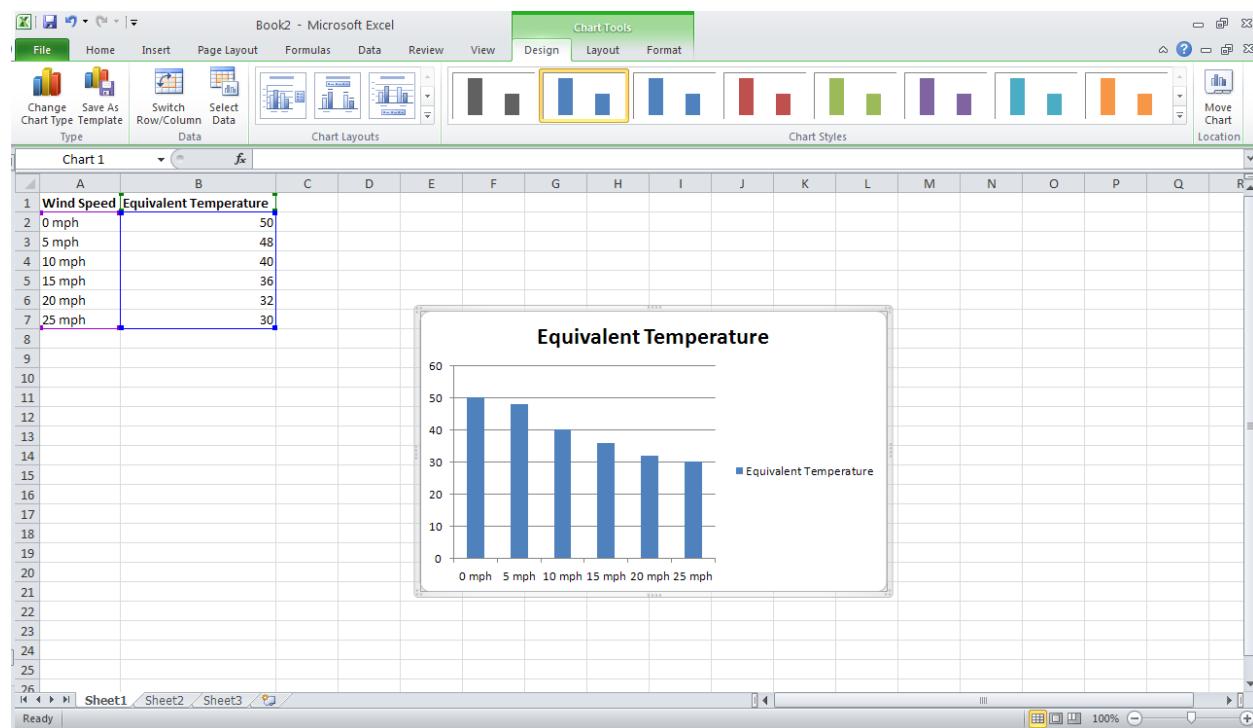
Example

If you are out hiking, and the air temperature is 50°F with no wind, a light jacket will keep you comfortable. However, if a wind comes up, you will feel cold, even though the temperature has not changed.

This is called wind chill. In the following spreadsheet, wind speeds and equivalent temperatures as a result of wind chill are given for a calm-air temperature of 50°F.

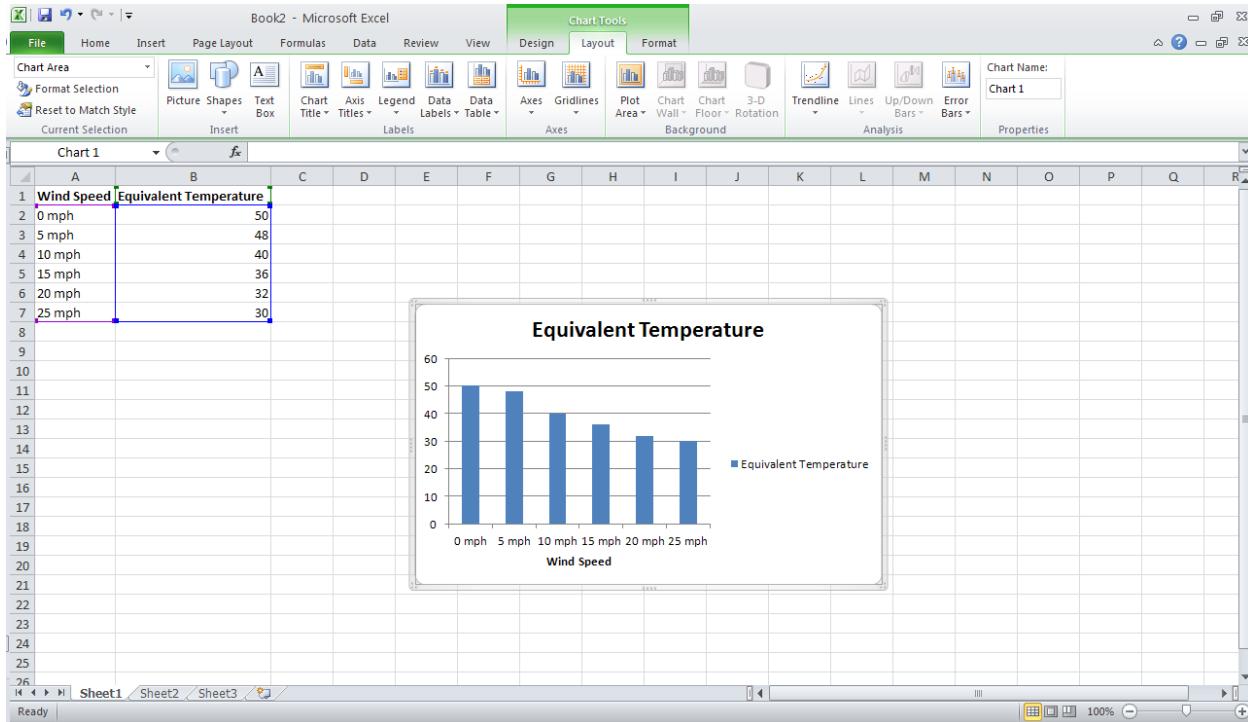
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Wind Speed	Equivalent Temperature																
2	0 mph	50																
3	5 mph	48																
4	10 mph	40																
5	15 mph	36																
6	20 mph	32																
7	25 mph	30																
8																		
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25																		
26																		

Notice that the Columns A and B are widened, and the labels are typed in bold. Also, each wind speed is followed by a label. This will cause Excel to treat the wind speeds as row headers, rather than as numerical values. Now, after making sure that a cell in or touching the data blocks is selected, open the Insert Ribbon, choose Column, 2-D Clustered Column. The row headers, i.e. the wind speeds, give us the labels on the horizontal axis, while the values in Column B, the equivalent temperatures, appear as bar heights.



You may modify any area of the chart (title, bars, axes, etc). For example, to add a title to the x-axis, click Layout under Chart Tools. Click **Axis Titles>Primary Horizontal Axis Title>Title Below Axis**. Then click the title that appears to modify it.

Notice that there are several other options, click on the various options and menus to explore the options available.

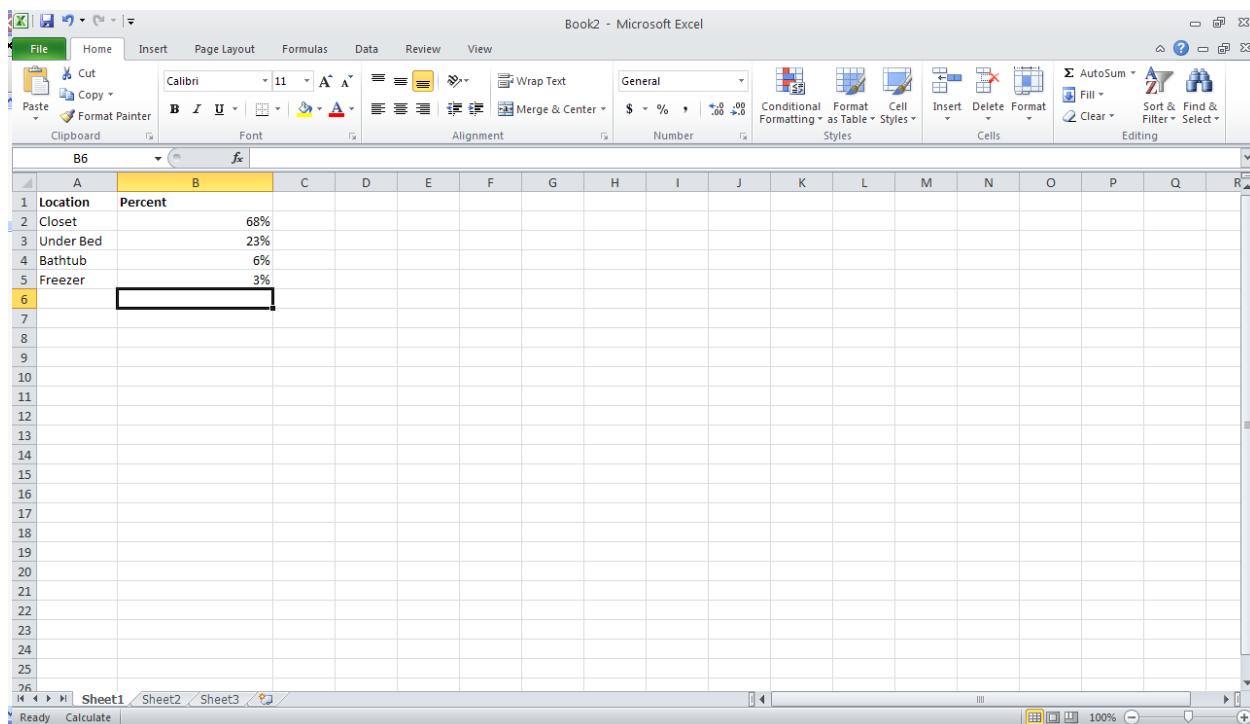


Circle Graphs

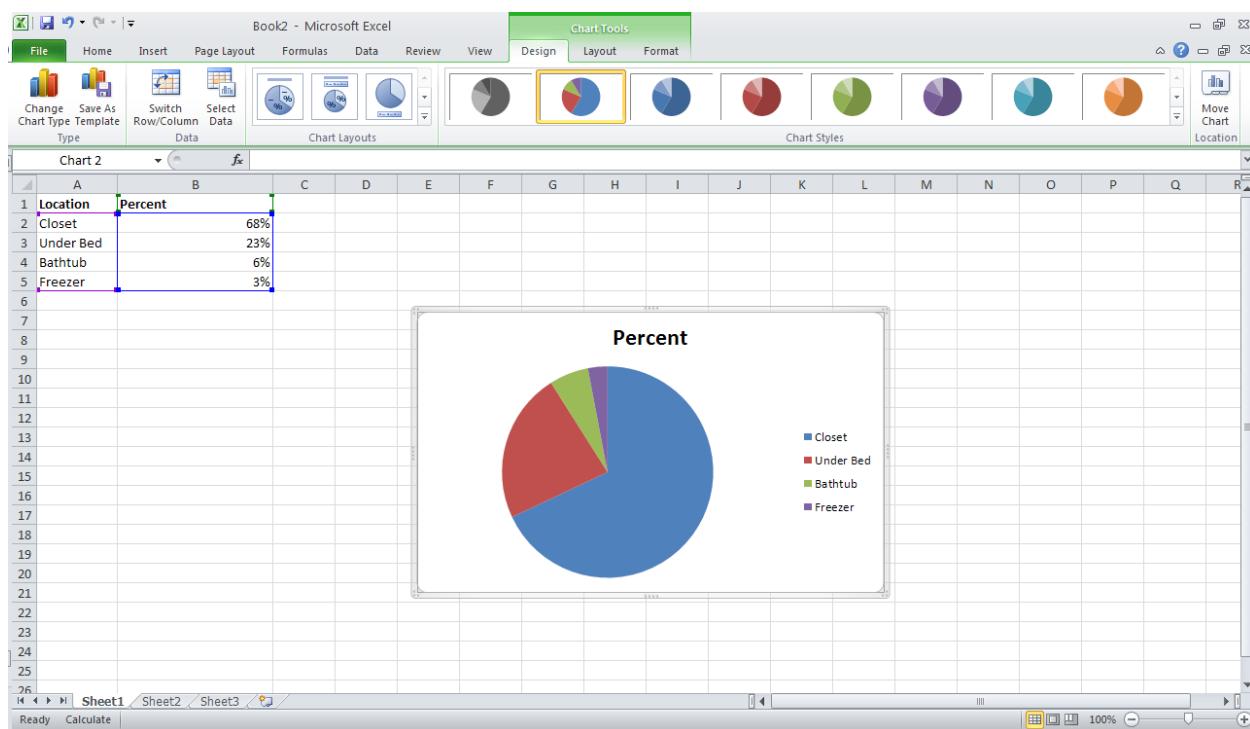
Another option available is Pie Chart. Again, enter the data in the worksheet first.

Example

Where do we hide the mess when company comes? According to USA Today, a survey showed that 68% of the respondents hide the mess in the closet, 23% put things under the bed, 6% put things in the bathtub, and 3% put things in the freezer. Make a circle graph for these data. We will put labels in Column A and the percents in Column B.



Select the pie chart on the Insert Ribbon.



Time-Series Graphs

You can make time charts by selecting Line Charts.

LAB ACTIVITIES FOR BAR GRAPHS, CIRCLE GRAPHS, AND TIME-SERIES GRAPHS

1. According to a survey of chief information officers at large companies, the technology skills most in demand are: Networking, 33%; Internet/intranet development, 21%; Applications development, 18%; Help desk/user support, 8%; Operations, 6%; Project management, 6%, Systems analysis, 5%; Other, 3%.
 - (a) Make a bar graph displaying this data.
 - (b) Make a circle graph displaying this data.
2. In a survey in which respondents could name more than one choice, on-line Internet users were asked where they obtained news about current events. The results are: Search engine/directory sites, 49%; Cable news site, 41%; On-line service; 40%; Broadcast news site, 40%; Local newspapers, 30%; National newspaper site; 24%; Other, 13%; National newsmagazine site, 12%; Haven't accessed news on-line, 11%.
 - (a) Make a horizontal bar graph displaying this information.
 - (b) Is this information appropriate for a circle graph display? Why or why not?
3. What percentage of its income does the average household spend on food, and how many workdays are devoted to earning the money spent on food in an average household? The American Farm Bureau Federation gave the following information, by year: In 1930, 25% of a household's budget went to food, and it took 91 workdays to earn the money. In 1960, 17% of the budget was for food, and the money took 64 workdays to earn. In 1990, food was 12% of the budget, earned in 43 workdays. For the year 2000, it was projected that the food budget would be 11% of total income and that it would take 40 workdays to earn the money.
 - (a) Enter these data in an Excel worksheet so you can create graphs.
 - (b) Make bar charts for both the percent of budget for food, by year, and for the workdays required.
 - (c) Use Excel to make a "double" bar graph that shows side-by-side bars, by year, for the percent of budget and for the number of days of work. (You may need to change the format of the first column of numbers to something other than percent.)
 - (d) Are these data suitable for a time plot? If so, use the Line graph option in Excel to create a time plot that shows both the percent of budget and the number of workdays needed to provide household food.

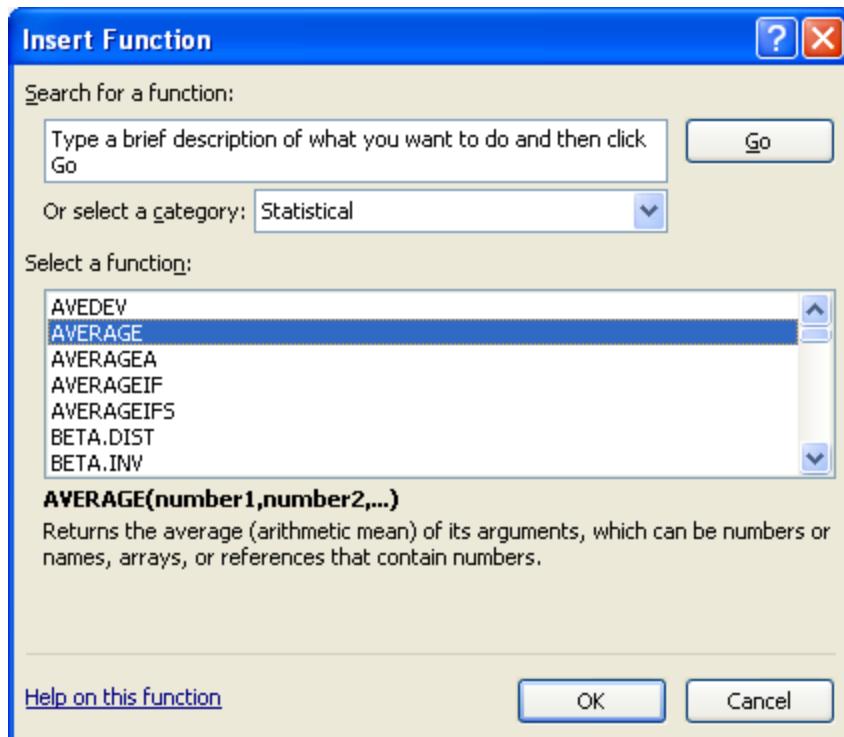
CHAPTER 3: AVERAGES AND VARIATION

CENTRAL TENDENCY AND VARIATION OF UNGROUPED DATA (SECTIONS 3.1 AND 3.2 OF *UNDERSTANDING BASIC STATISTICS*)

Sections 3.1 and 3.2 of *Understanding Basic Statistics* describe some of the measures used to summarize the character of a data set. Excel supports these descriptive measures.

On the toolbar, click the Formulas Ribbon and click the Insert Function button.

In the dialog box that appears, select Statistical in the dropdown box, and in the “Select a function:” box select the measure of interest. To find the arithmetic mean of a set of numbers, for instance, we use the function AVERAGE.



Notice that the bottom of the dialog box contains a brief explanation of how the selected function works. Of the descriptive measures discussed in Sections 3.1 and 3.2 of the text, Excel supports the following:

AVERAGE(data range)

Returns the arithmetic mean \bar{x} or μ of the data values in the designated cells.

COUNT(data range)

Returns the number of data values in the designated cells.

MEDIAN(data range)

Returns the median of the data values in the designated cells.

MODE(data range)

Returns the mode of the data values in the designated cells.

STDEV(data range)

Returns the sample standard deviation of the data values in the designated cells.

STDEVP(data range)

Returns the population standard deviation of the data values in the designated cells.

TRIMMEAN(data range, percent as a decimal)

Returns a trimmed mean based on the *total* percentage of data removed from both the bottom and top of the ordered data values. If you want a 5% trimmed mean, implying that 5% of the bottom data and 5% of the top data will be removed, then enter 0.10 for the percent in Excel.

Formatting the Worksheet to Display the Summary Statistics

It is a good idea to create a column in which you type the name of each descriptive measure you use, next to the column where the corresponding computations are performed.

Example

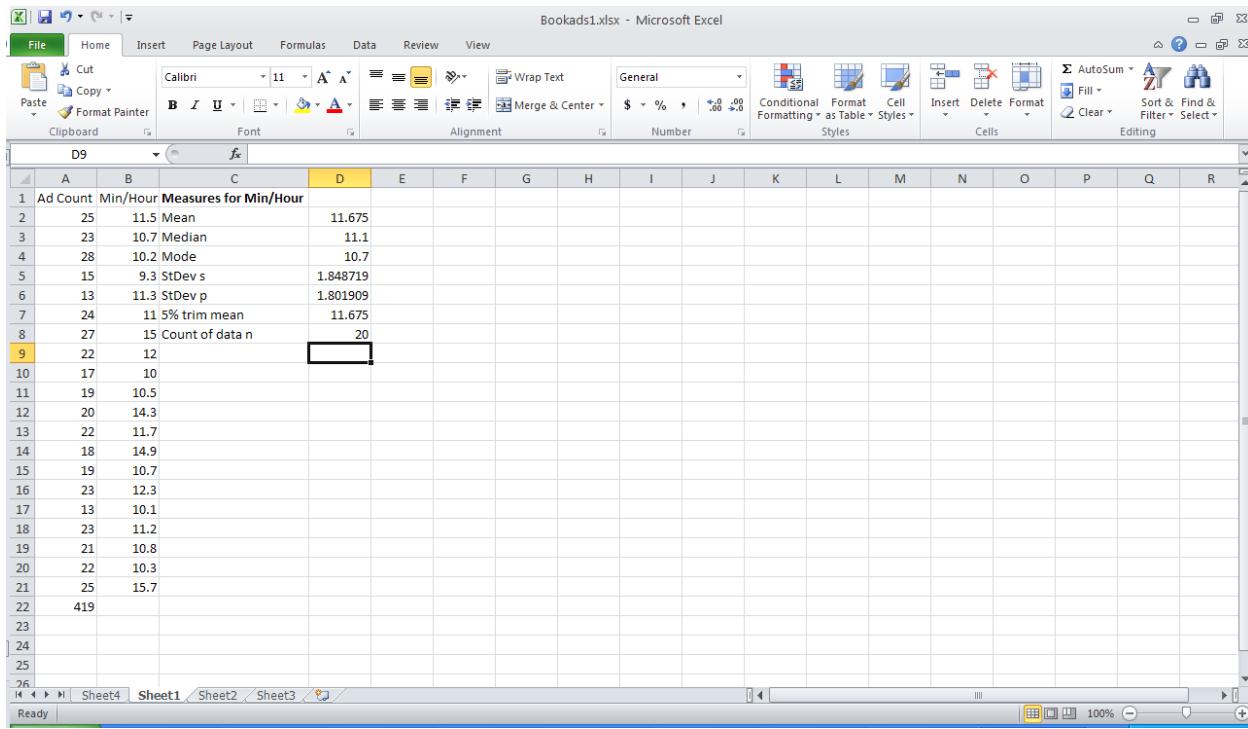
Let's again use the data about ads during primetime TV. We will retrieve Book1ads and find summary statistics for Column B, the time taken up with ads. And we will use Column C as our column of names for the descriptive statistics measures. Notice that we widened the column to accommodate the names. We label Column C to remind us that the summary statistics apply to the number of minutes per hour that ads consume.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
2	25	11.5 Mean	11.675														
3	23	10.7 Median															
4	28	10.2 Mode															
5	15	9.3 StDev s															
6	13	11.3 StDev p															
7	24	11.5% trim mean															
8	27	15 Count of data n															
9	22	12															
10	17	10															
11	19	10.5															
12	20	14.3															
13	22	11.7															
14	18	14.9															
15	19	10.7															
16	23	12.3															
17	13	10.1															
18	23	11.2															
19	21	10.8															
20	22	10.3															
21	25	15.7															
22	419																
23																	
24																	
25																	
26																	
27																	

Notice that Cell D2 is highlighted, and that the formula bar shows the command = AVERAGE(B2:B21). The value in Cell D2 is the mean of the data in the Cells B2 through B21.

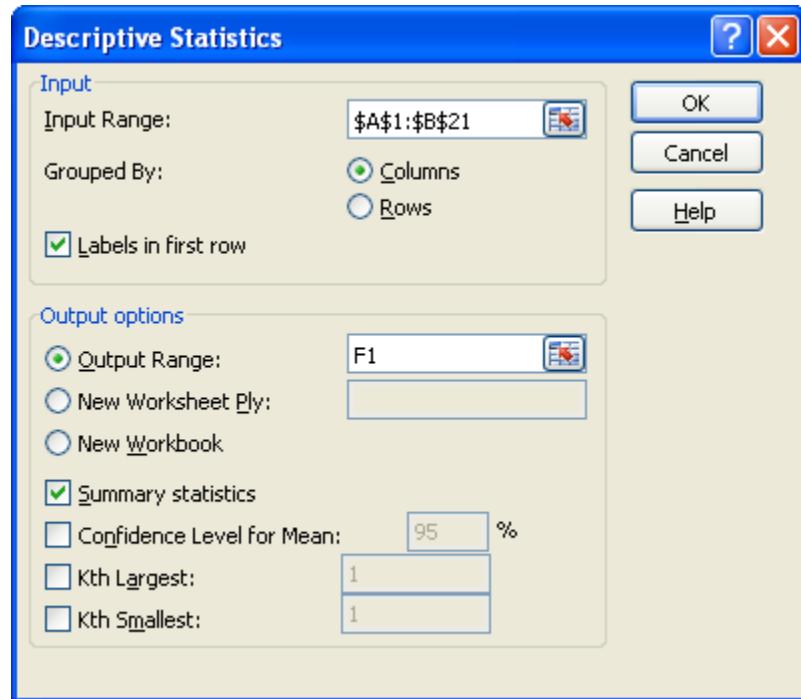
To compute the other measures, we enter the appropriate formulas in Column D and identify the measures used in Column C, as shown. Notice that you can type the commands directly in the formula bar (don't forget to put =

before the command), or you can use the Insert Function button and retrieve the function from the category Statistical.



Don't forget that you can control the number of digits displayed after the decimal by using the buttons on the standard toolbar to increase or decrease the number of decimal places.

Another way to obtain a table of some descriptive statistics is to use the menu choices **Data> Data Analysis>Descriptive Statistics**. A dialog box appears. If you check Summary statistics, an output table containing the mean, median, mode, and other measures appears.



For the Ad count and Min/Hr data the results are as follows:

Screenshot of Microsoft Excel showing the results of the Descriptive Statistics analysis on the 'Ad Count' and 'Min/Hr' data.

The Data ribbon tab is selected, and the Data Analysis button is visible in the Analysis group.

The results are displayed in the range D1:G21:

	A	B	C	D	E	F	G
1	Ad Count	Min/Hr		Ad Count	Min/Hr		
2	25	11.5		Mean	20.95	Mean	11.675
3	23	10.7		Standard E	0.944444	Standard I	0.413386
4	28	10.2		Median	22	Median	11.1
5	15	9.3		Mode	23	Mode	10.7
6	13	11.3		Standard I	4.22368	Standard I	1.848719
7	24	11		Sample V	17.83947	Sample V	3.417763
8	27	15		Kurtosis	-0.34256	Kurtosis	0.166619
9	22	12		Skewness	-0.43164	Skewness	1.124017
10	17	10		Range	15	Range	6.4
11	19	10.5		Minimum	13	Minimum	9.3
12	20	14.3		Maximum	28	Maximum	15.7
13	22	11.7		Sum	419	Sum	233.5
14	18	14.9		Count	20	Count	20
15	19	10.7					
16	23	12.3					
17	13	10.1					
18	23	11.2					
19	21	10.8					
20	22	10.3					
21	25	15.7					
22							
23							
24							
25							
26							

At the bottom of the screen, the status bar displays: Average: 34.94341904 Count: 54 Sum: 908.5288951 100%.

LAB ACTIVITIES FOR CENTRAL TENDENCY AND VARIATION OF UNGROUPED DATA

- Twenty randomly sampled people were asked to dial thirty telephone numbers each. The incidence of numbers misdialed by these people is as follows:

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

Enter the data and use the appropriate commands to find the mean, median, mode, sample standard deviation, population standard deviation, 10% trimmed mean, and data count.

- Consider the test scores of thirty students in a political science class.

85	73	43	86	73	59	73	84	100	62
75	87	70	84	97	62	76	89	90	83
70	65	77	90	94	80	68	91	67	79

- Use the appropriate commands to find the mean, median, mode, sample standard deviation, 10% trimmed mean, and data count.
- Suppose that Greg, a student in a political science course, missed a several classes because of illness. Suppose he took the final exam anyway and made a score of 30 instead of 85 as listed in the data set. Change the 85 (first entry in the data set) to 30 and use the appropriate commands to find the new mean, median, mode, sample standard deviation, 10% trimmed mean, and data count. Compare the new mean, median and standard deviation with the ones in part (a). Which average was most affected: median or mean? What about the standard deviation?

- Consider the following ten data values:

4	7	3	15	9	12	10	2	9	10
---	---	---	----	---	----	----	---	---	----

- Use the appropriate commands to find the sample standard deviation and the population standard deviation. Compare the two values.
- Now consider these fifty data values in the same general range:

7	9	10	6	11	15	17	9	8	2
2	8	11	15	14	12	13	7	6	9
3	9	8	17	8	12	14	4	3	9
2	15	7	8	7	13	15	2	5	6
2	14	9	7	3	15	12	10	9	10

Again, use the appropriate commands to find the sample standard deviation and the population standard deviation. Compare the two values.

- Compare the results of parts (a) and (b). As the sample size increases, does it appear that the difference between the population and sample standard deviations decreases? Why would you expect this result from the formulas?

4. In this problem we will explore the effects of changing data values by multiplying each data value by a constant, or by adding the same constant to each data value.

- (a) Clear your workbook or begin a new one. Then enter the following data into Column A, with the column label “Original” in Cell A1.

1 8 3 5 7 2 10 9 4 6 3

- (b) Now label Column B as $A * 10$. Select Cell B2. In the formula bar, type $=A2*10$ and press Enter. Select Cell B2 again and move the cursor to the lower right corner of Cell B2. A small black + should appear. Click-drag the + down the column so that Column B contains all the data of Column A, but with each value in Column A multiplied by 10.
- (c) Now suppose we add 30 to each data value in Column A and put the new data in Column C. First label Column E as $A + 30$. Then select Cell C2. In the formula bar type $=A2+30$ and press Enter. Then select Cell C2 again and position the cursor in the lower right corner. The cursor should change shape to a small black +. Click-drag down Column C to generate all the entries of Column A increased by 30.
- (d) Predict how you think the mean and the standard deviation of Columns B and C will be similar to or different from those values for column A. Use the >Data>Data Analysis>Descriptive Statistics dialog box to find the mean and standard deviation for all three columns. Note: use all three columns as input columns in the dialogue box. Compare the actual results to your predictions. What do you predict will happen to these descriptive statistics values if you multiply each data value of Column A by 50? If you add 50 to each data value in Column A?

BOX-AND-WHISKER PLOTS (SECTION 3.3 OF *UNDERSTANDING BASIC STATISTICS*)

Excel does not have any commands or dialog boxes that produce box-and-whisker plots directly. Macros can be written to accomplish the task. However, Excel does have commands to produce the five-number summary, and you can then draw a box-and-whisker plot by hand.

The commands for the five-number summary can be found in the dialogue box obtained by pressing the Insert Function (or function wizard) key on the tool bar.

MIN(data range) returns the minimum data value from the designated cells.

QUARTILE(data range, 1) returns the first quartile for the data in the designated cells.

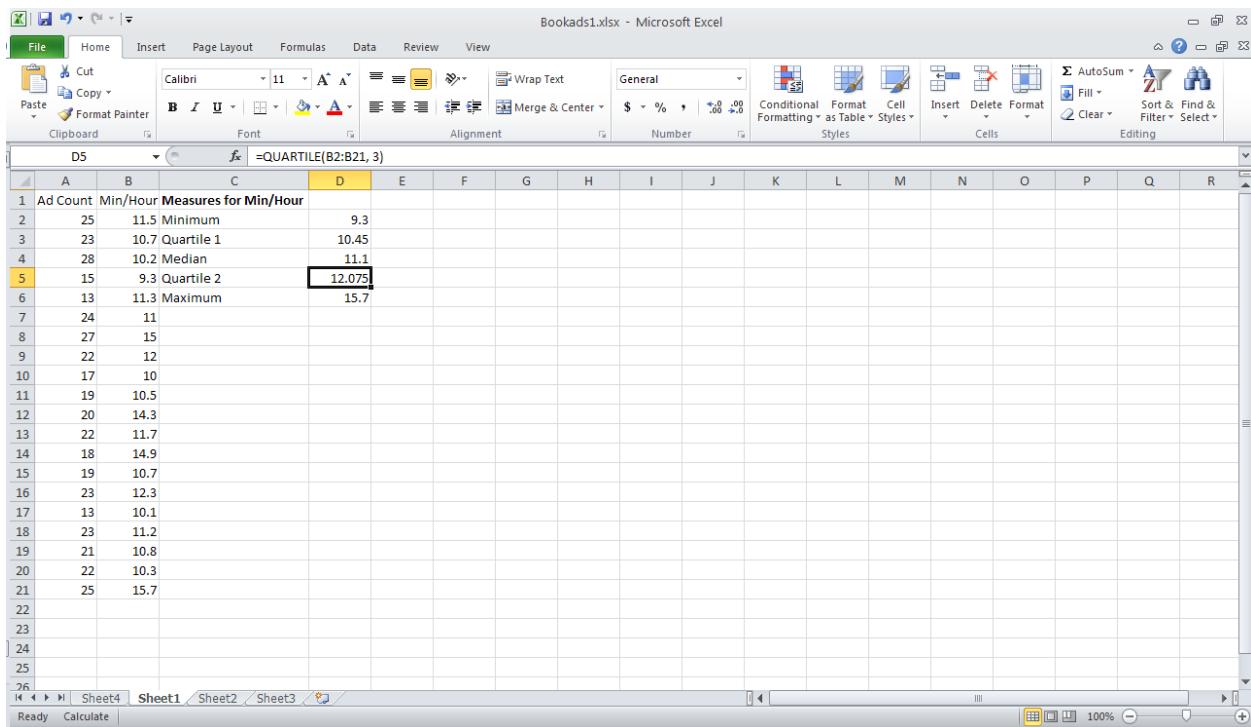
MEDIAN(data range) returns the median of the data in the designated cells.

QUARTILE(data range, 3) returns the third quartile for the data in the designated cells.

MAX(data range) returns the maximum data value from the designated cells.

Example

Generate the five-number summary for the number of minutes of ads per hour on commercial TV, using the data in Book1ads.



In computing quartiles, Excel uses a slightly different process from the one adopted in *Understanding Basic Statistics*. However, the results will generally be nearly the same.

CHAPTER 4: REGRESSION AND CORRELATION

LINEAR REGRESSION - TWO VARIABLES (SECTIONS 4.1 and 4.2 OF *UNDERSTANDING BASIC STATISTICS*)

Chapter 4 of *Understanding Basic Statistics* introduces linear regression. The formula for the correlation coefficient r is given in Section 4.1. Formulas to find the equation of the least squares line, $y = a + bx$, are given in Section 4.2. This section also contains the formula for the coefficient of determination, r^2 .

Excel supports several functions related to linear regression. To use these, first enter the paired data values in two columns. Put the explanatory variable in a column labeled with x , or an appropriate descriptive name, and put the response variable in a column labeled with y , or an appropriate descriptive name.

The functions and corresponding syntax are

LINEST(y range, x range)

which returns the slope b and y -intercept a of the least-squares line, in that order. Although this command can be found under the Insert Function button menu, it is best to type it in because it is an array formula. (The full LINEST function involves two more, optional parameters, but we will ignore these.) To use LINEST,

1. Activate two cells, the first to hold the slope b , the second for the intercept a .
2. In the formula bar, type =LINEST(y range,x range) with the appropriate cell ranges in place of x range and y range.
3. Instead of pressing Enter, press **Ctrl+Shift+Enter**. This key combination activates the array formula features so that you get the outputs for both b and a . Otherwise, you will get only the slope b of the least squares line.

The other functions are employed in the usual way, by activating a cell and then either typing the command directly in the formula bar, followed by Enter, or by using the Insert Function dialog box.

SLOPE(y range, x range) returns the slope b of the least-squares line.

INTERCEPT(y range, x range) returns the intercept a of the least-squares line.

CORREL(y range, x range) returns the correlation coefficient r .

FORECAST(x value, y range, x range) returns the predicted y value for the specified x value, using extrapolation from the given pairs of x and y values. Note that you need to use a new FORECAST command for each different x value.

We will now use Excel to generate a scatter diagram and then add the results of the least squares regression.

Example

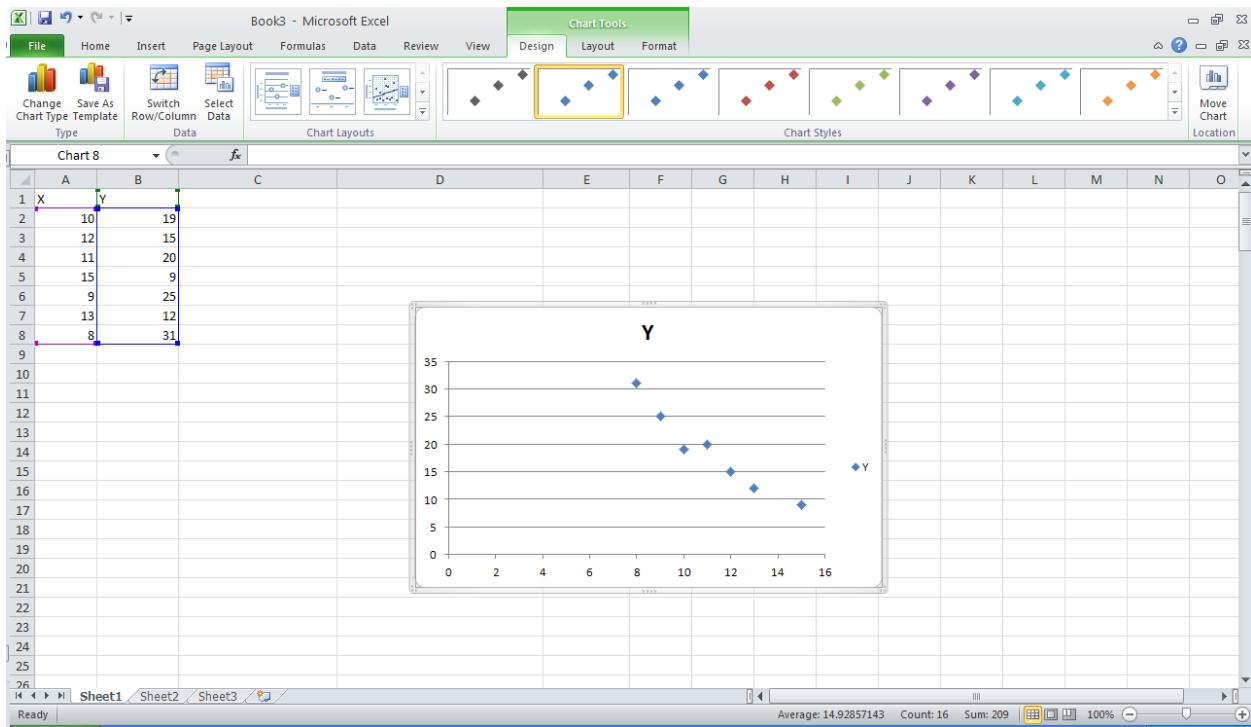
In retailing, merchandise loss due to shoplifting, damage, and other causes is called shrinkage. The managers at H.R. Merchandise think that there is a relationship between shrinkage and the number of clerks on duty. To explore this relationship, a random sample of seven weeks was selected. During each week, the staffing level of sales clerks was held constant and the dollar value (in hundreds of dollars) of the shrinkage was recorded.

X	10	12	11	15	9	13	8	Staffing level
Y	19	15	20	9	25	12	31	(in hundreds)

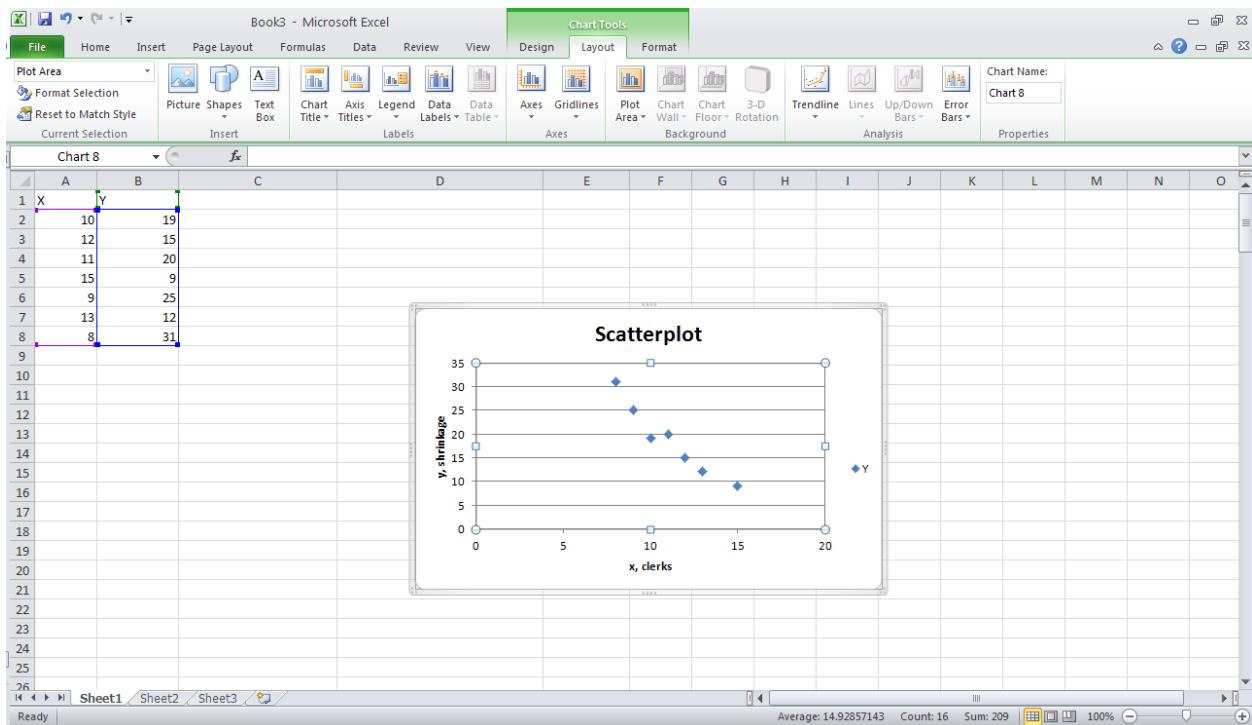
Open a worksheet. Place the X values in Column A with a corresponding label and the Y values in Column B.

Create a Scatter Diagram

Click on the Insert Ribbon and select Scatter. Select the data. Choose the first subtype, which shows only points.

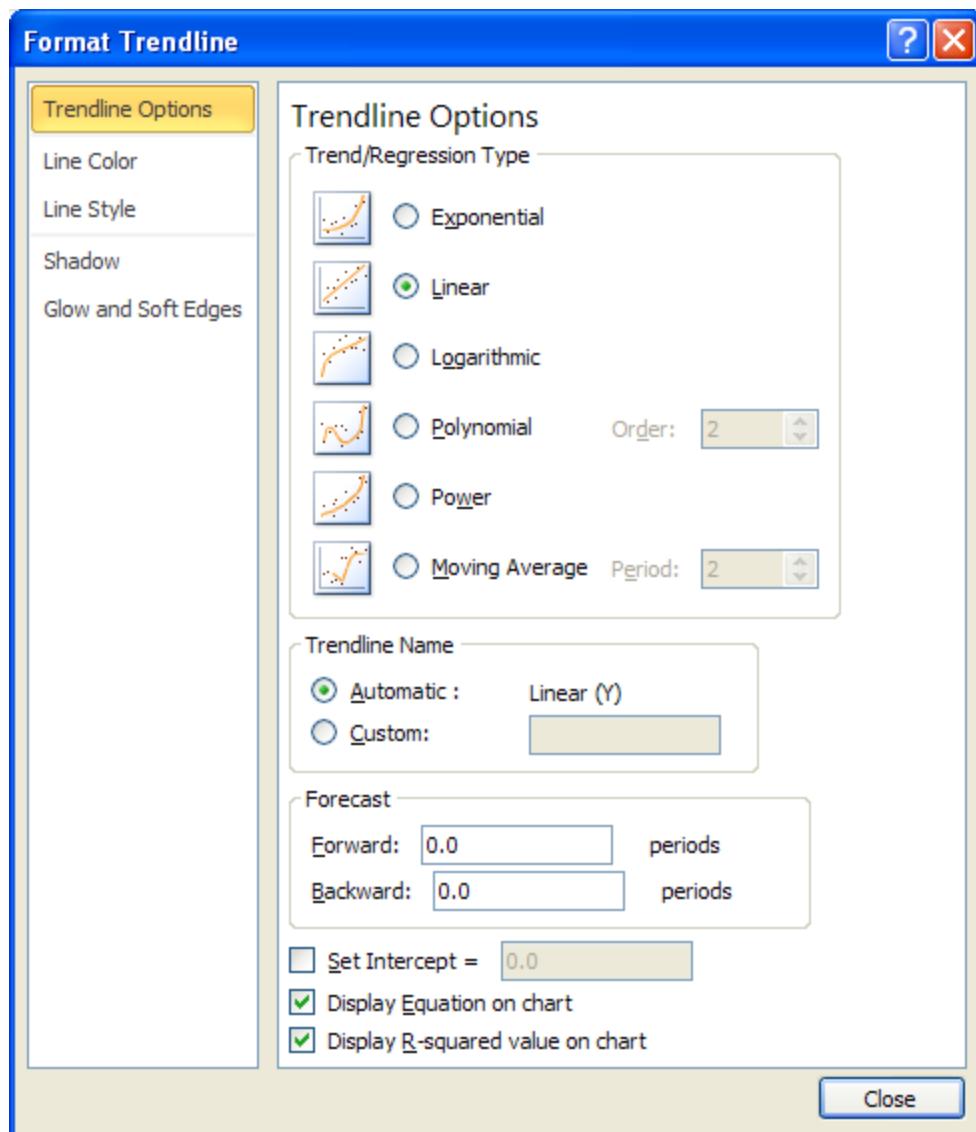


Change the title and axis labels.

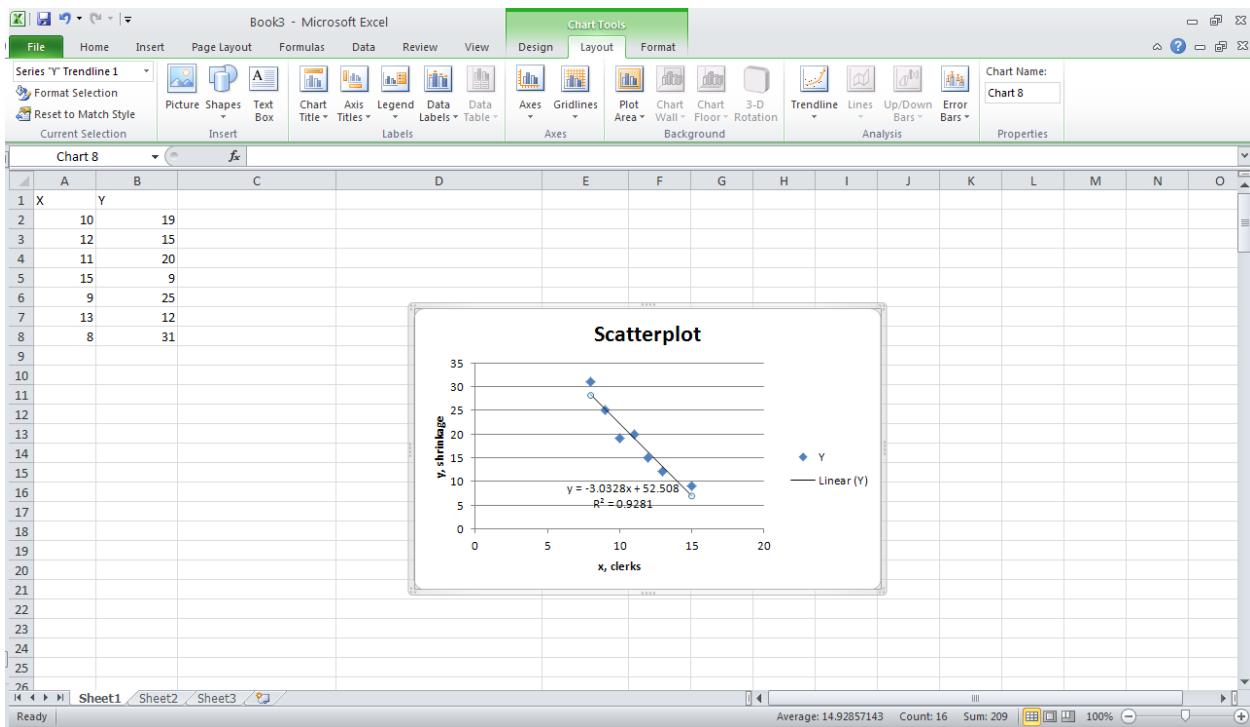


Add least-squares results to the plot

The least-squares line can be added to the plot, along with its equation and the value of r^2 . Right-click on one of the data points shown in the scatter diagram. A drop-down menu will appear. Select Add Trendline to call up a dialog box.



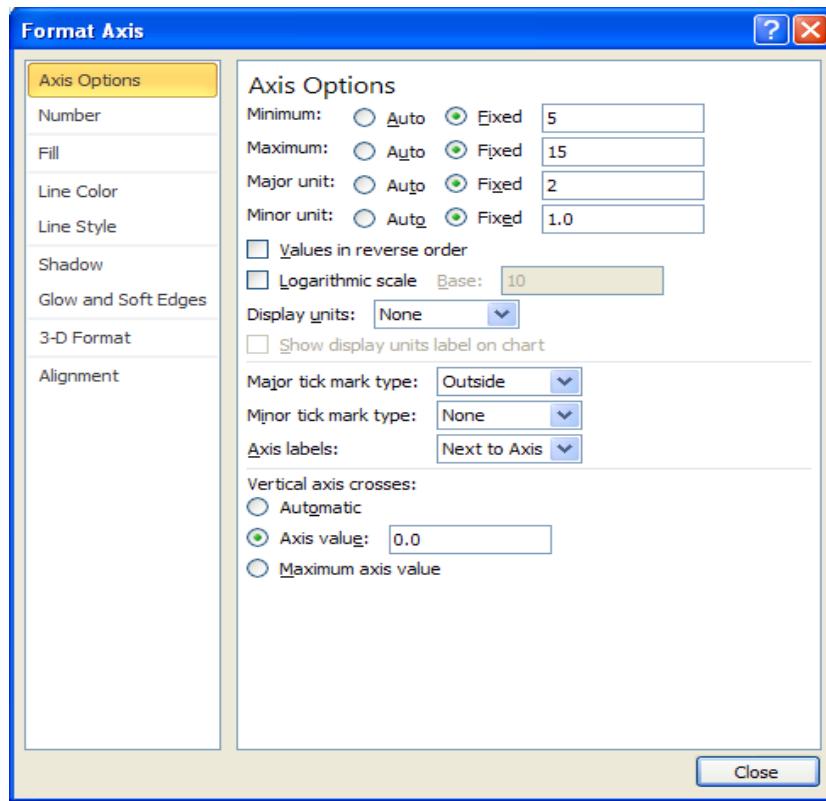
Be sure Linear is selected as the Type. Check Display equation on chart and Display R-squared on chart, and then click Close. Now our scatter diagram shows the graph of the least squares-line and the equation. You can move the equation out of the way of the graph by clicking on it and dragging the resulting box to a convenient location.



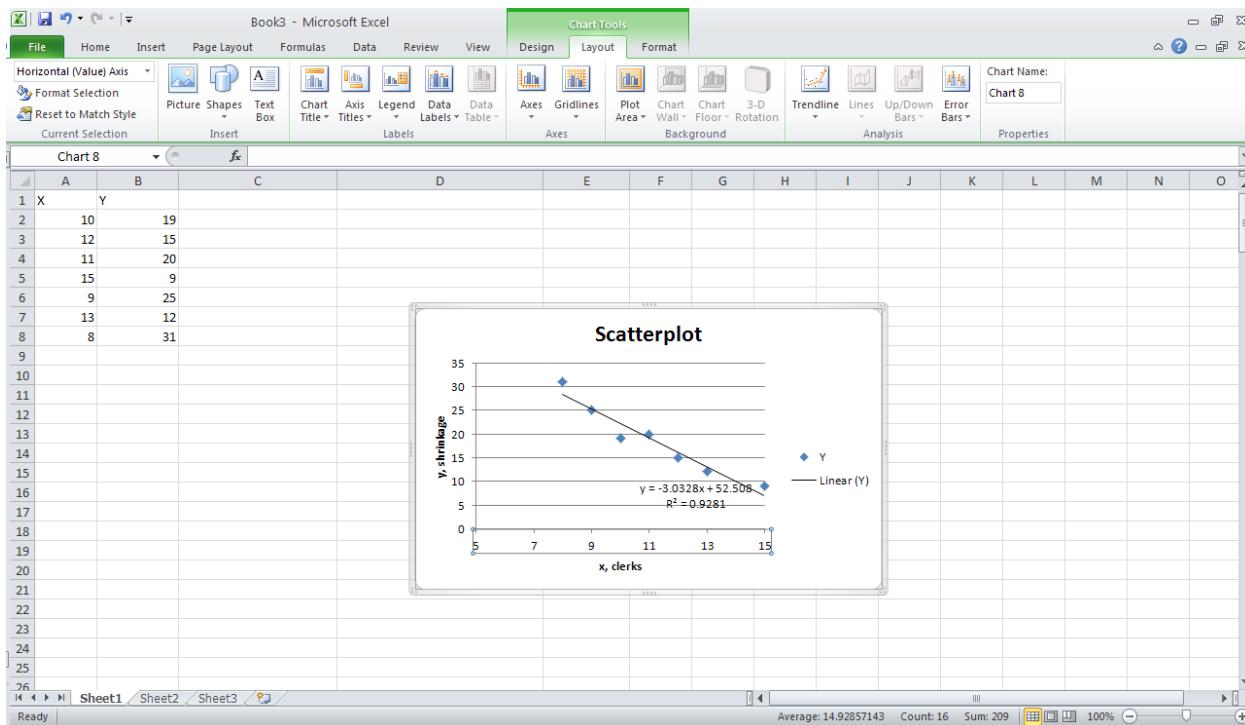
Scale the Axes

Sometimes all the points of a scatter diagram are in a corner, and we want to rescale the axes to reflect the data range. To do so,

1. Right-click on the X-axis, select Format Axes.
2. Change the minimum and maximum values for X. You may retain 0 as the value for Value (Y) axis crosses at.

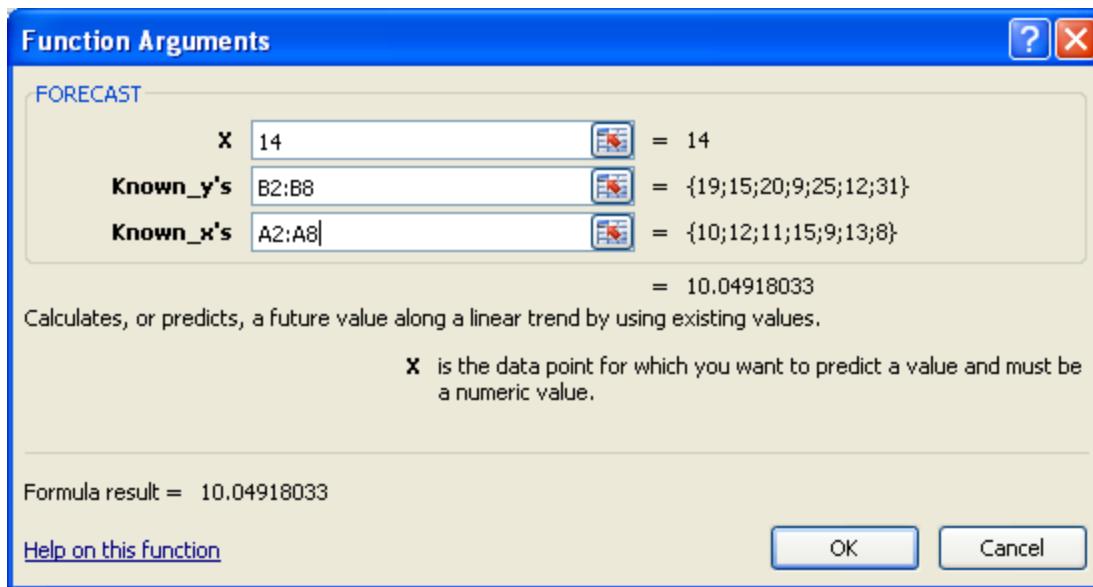


Go through a similar procedure to rescale the Y -axis. The result of our changes appears as shown at the top of the next page.

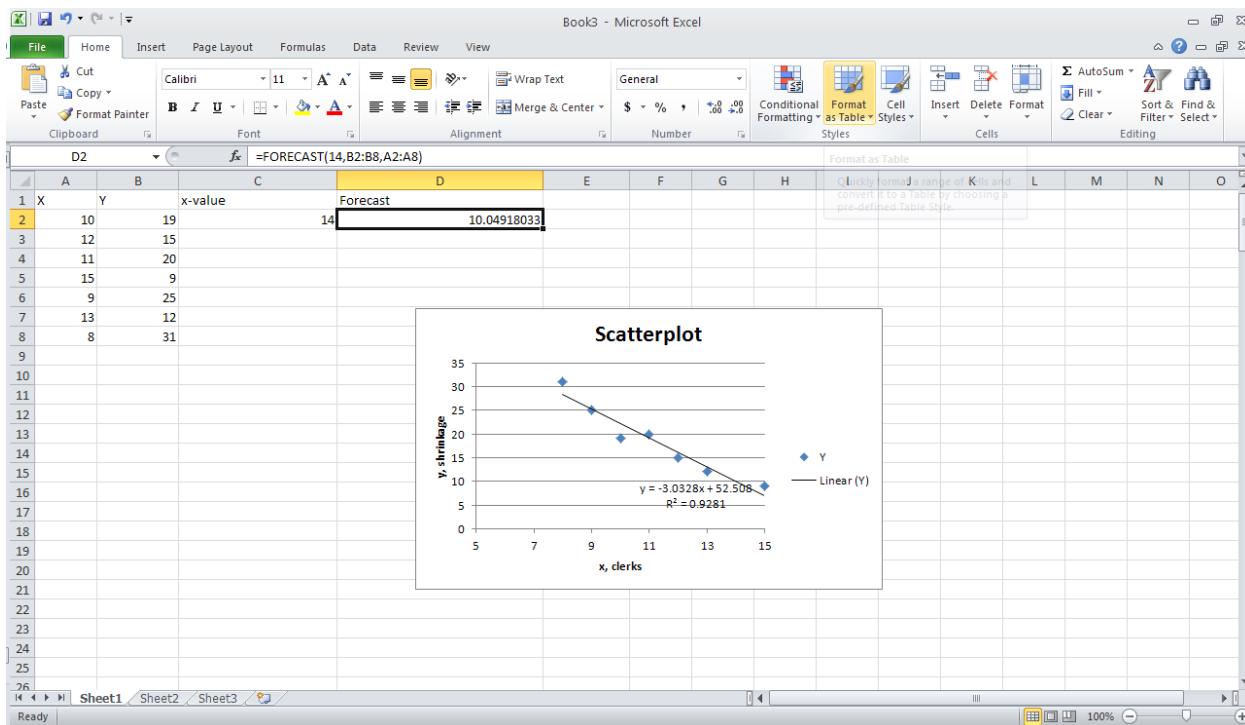


Forecast a value

Let's predict the shrinkage when fourteen clerks are available, using FORECAST. Click Insert Function on the tool bar, then select Statistical in the drop down box and then Forecast. Fill in the dialog box as shown.



The predicted Y value is about 10.05. Since the unit for Y is hundreds of dollars, this represents a predicted shrinkage of \$1005 when fourteen clerks are on duty.



LAB ACTIVITIES FOR TWO-VARIABLE LINEAR REGRESSION

1. Open or retrieve the worksheet Slr01.xls from the student website. This worksheet contains the following data, with the list price in Column C1 and the best price in Column C2. The best price is the best price negotiated by a team from the magazine.

LIST PRICE VERSUS BEST PRICE FOR A NEW GMC PICKUP TRUCK

In the following data pairs (X, Y),

X = List Price (in \$1000) for a GMC Pickup Truck

Y = Best Price (in \$1000) for a GMC Pickup Truck

Source: Consumers Digest, February 1994

(12.400, 11.200)	(14.300, 12.500)	(14.500, 12.700)
(14.900, 13.100)	(16.100, 14.100)	(16.900, 14.800)
(16.500, 14.400)	(15.400, 13.400)	(17.000, 14.900)
(17.900, 15.600)	(18.800, 16.400)	(20.300, 17.700)
(22.400, 19.600)	(19.400, 16.900)	(15.500, 14.000)
(16.700, 14.600)	(17.300, 15.100)	(18.400, 16.100)
(19.200, 16.800)	(17.400, 15.200)	(19.500, 17.000)
(19.700, 17.200)	(21.200, 18.600)	

- (a) Use Excel to create a scatter plot for the data

- (b) Right-click on a data point and use the Add Trendline option to show the least-squares line on the scatter diagram, along with its equation and the value of r^2 .
 - (c) Use the least-squares model to predict the best price for a truck with a list price of \$20,000. Note: Enter this value as 20, since X is assumed to be in thousands of dollars. (Use FORECAST.)
2. Other Excel worksheets appropriate to use for simple linear regression are:
- Cricket Chirps Versus Temperature: Slr02.xls
 Source: *The Song of Insects* by Dr. G.W. Pierce, Harvard Press

The chirps per second for the striped grouped cricket are stored in C1; the corresponding temperature in degrees Fahrenheit is stored in C2.

Diameter of Sand Granules Versus Slope on a Natural Occurring Ocean Beach: Slr03.xls
 Source *Physical Geography* by A.M. King, Oxford press

The median diameter (MM) of granules of sand is stored in C1; the corresponding gradient of beach slope in degrees is stored in C2.

National Unemployment Rate Male Versus Female: Slr04.xls
 Source: *Statistical Abstract of the United States*

The national unemployment rate for adult males is stored in C1; the corresponding unemployment rate for adult females for the same period of time is stored in C2.

Select these worksheets and repeat Parts (a)-(c) of Problem 1, using Column A as the explanatory variable and Column B as the response variable.

3. A psychologist studying the correlation between interruptions and job stress rated a group of jobs for interruption level. She selected a random sample of twelve people holding jobs from among those rated, and analyzed the people's stress level. The results follow, with X being interruption level of the job on a scale of 1 (fewest interruptions) to 20 and Y the stress level on a scale of 1 (lowest stress) to 50.

Person	1	2	3	4	5	6	7	8	9	10	11	12
X	9	15	12	18	20	9	5	3	17	12	17	6
Y	20	37	45	42	35	40	20	10	15	39	32	25

- (a) Enter the X values into Column A and the Y values into Column B.
 - (b) Follow parts (a) through (c) of Problem 1 using the X values as the explanatory data values and the Y values as response data values.
 - (c) Redo Part (b). This time change the X values to the response data values and the Y values to the explanatory data values (i.e. exchange headers for the X and Y columns) How does the scatter diagram compare? How does the least-squares equation compare? How does the correlation coefficient compare? How does the standard error of estimate compare? Does it seem to make a difference which variable is the response variable and which is the explanatory variable?
4. The researcher in Problem 3 was able to add to her data. Another eleven randomly sampled people had their jobs rated for interruption level and were then evaluated for stress level.

Person	13	14	15	16	17	18	19	20	21	22	23
--------	----	----	----	----	----	----	----	----	----	----	----

X	4	15	19	13	10	9	3	11	12	15	4
Y	20	35	42	37	40	23	15	32	28	38	12

Add this data to the data in problem 3, and repeat Parts (a) and (b). Be sure the label column A as the X values and column B as the Y values.

CHAPTER 5: ELEMENTARY PROBABILITY THEORY

SIMULATIONS

Excel has several random number generators. Recall from Chapter 1 that `RANDBETWEEN(Bottom,Top)` puts out a random integer between (and including) the bottom and top numbers. Again, the Analysis ToolPak needs to be included as an Add-In to make `RANDBETWEEN` available. To find the `RANDBETWEEN` function, click the Insert Function or Function Wizard button on the tool bar. Then select All in the category drop down box and scroll down in until you find `RANDBETWEEN`. You can also type the command directly in the formula bar, but again, remember to type = first.

We can use the random number generator to simulate experiments such as tossing coins or rolling dice.

Example

Simulate the experiment of tossing a fair coin 200 times. Look at the percent of heads and the percent of tails. How do these compare with the expected 50% for each?

Assign the outcome heads to digit 1 and tails to digit 2. We will draw a random sample of size 200 from the distributions of integers from a minimum of 1 to a maximum of 2. When using a random number generator, you are best off setting recalculation to manual. To do this, go to **File>Options** and then click on the tab labeled Formulas. Select Manual calculation, then press OK.

Now put the label Coin Toss in Cell A1, and enter =`RANDBETWEEN(1,2)` in Cell A2. Then press Enter. Reselect Cell A2, move the cursor to the lower right corner until the + symbol appears, and drag down through Cell A201. Since calculation is set to manual, press Shift-F9 to apply the random integer generation command to each of the selected cells. Column A should now have 200 entries.

The screenshot shows a Microsoft Excel spreadsheet titled "Book3 - Microsoft Excel". The ribbon menu is visible at the top. The "Home" tab is selected, showing various toolbar icons for cutting, pasting, and formatting. The formula bar displays the text "Coin Toss". The main worksheet area contains a single column of data labeled "Coin Toss" in cell A1. The data consists of 200 rows of values, where row 1 contains "Coin Toss" and rows 2 through 201 contain either the value 1 or 2. The cells are formatted as general numbers. The bottom of the screen shows the standard Excel navigation tools and status bar indicating "Ready Calculate" and "100%".

Count the number of heads and the number of tails

Next we want to count the number of 1's and 2's in column A. We will set up a table in Columns C and D to display the counts. Label Cell C1 as Outcome. Type Heads in Cell C2 and Tails in Cell C3. Then Label Cell D1 as Frequency.

We will use the COUNTIF command to count the 1's and 2's. The syntax for the COUNTIF command is

COUNTIF(data range,condition)

Recall that we assigned the number 1 to the outcome heads and the number 2 to the outcome tails. Select Cell D2, and enter

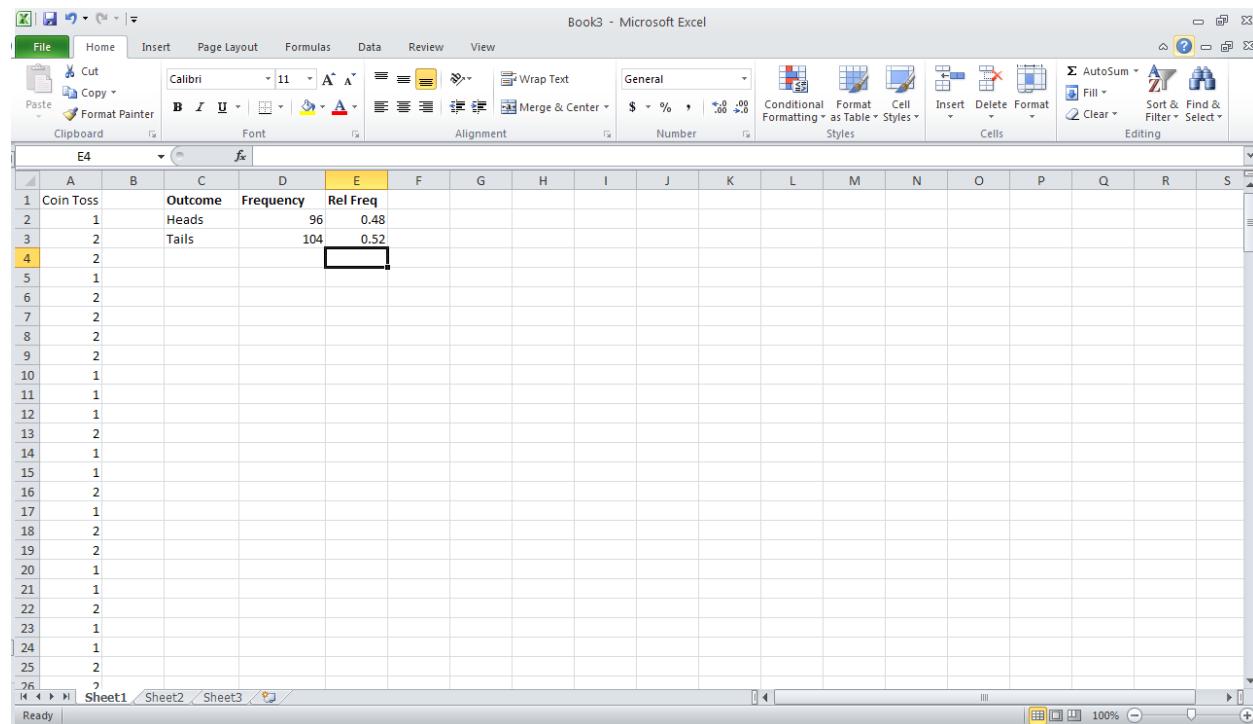
= COUNTIF(A1:A201,1)

This will return the number of 1's, or heads, in the designated cell range. Next select Cell D3, and enter =COUNTIF(A1:A200,2). This will return the number of 2's, or tails, in the same designated cell range.

Compute the relative frequency of each outcome

Let's use column E to display the probability of each outcome. Label Cell E1 as Rel Freq. Select Cell E2. In the formula bar, type =D2/200 and press Enter. Then select Cell E3 and enter =D3/200. The display should be similar to the one shown.

Notice that the percentages of heads and of tails are each close to 50%. This is what the Law of Large Numbers predict. Of course, each time you repeat the simulation, you will generally get slightly different results.



The screenshot shows a Microsoft Excel spreadsheet titled "Book3 - Microsoft Excel". The ribbon menu is visible at the top. The active cell is E4. The data table is as follows:

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Coin Toss	Outcome	Frequency	Rel Freq														
2	1	Heads	96	0.48														
3	2	Tails	104	0.52														
4	2																	
5	1																	
6	2																	
7	2																	
8	2																	
9	2																	
10	1																	
11	1																	
12	1																	
13	2																	
14	1																	
15	1																	
16	2																	
17	1																	
18	2																	
19	2																	
20	1																	
21	1																	
22	2																	
23	1																	
24	1																	
25	2																	
26	2																	

LAB ACTIVITIES FOR SIMULATIONS

1. Use the RANDBETWEEN command to simulate 50 tosses of a fair coin. Make a table showing the frequency of the outcomes and the relative frequency. Compare the results with the theoretical expected percents (50% heads, 50% tails). Repeat the process for 500 trials. Are these outcomes closer to the results predicted by theory?
2. Use RANDBETWEEN to simulate 50 rolls of a fair die. Use the number 1 for the bottom value and 6 for the top. Make a table showing the frequency of each outcome and the relative frequency. Compare the results with the theoretical expected percents (16.7% for each outcome). Repeat the process for 500 tosses. Are these outcomes closer to the results predicted by theory?

CHAPTER 6: THE BINOMIAL PROBABILITY DISTRIBUTION AND RELATED TOPICS

THE BINOMIAL PROBABILITY DISTRIBUTION (SECTIONS 6.2 AND 6.3 OF *UNDERSTANDING BASIC STATISTICS*)

The binomial probability distribution is discussed in Chapter 6 of *Understanding Basic Statistics*. It is a discrete probability distribution controlled by the number of trials, n , and the probability of success on a single trial, p .

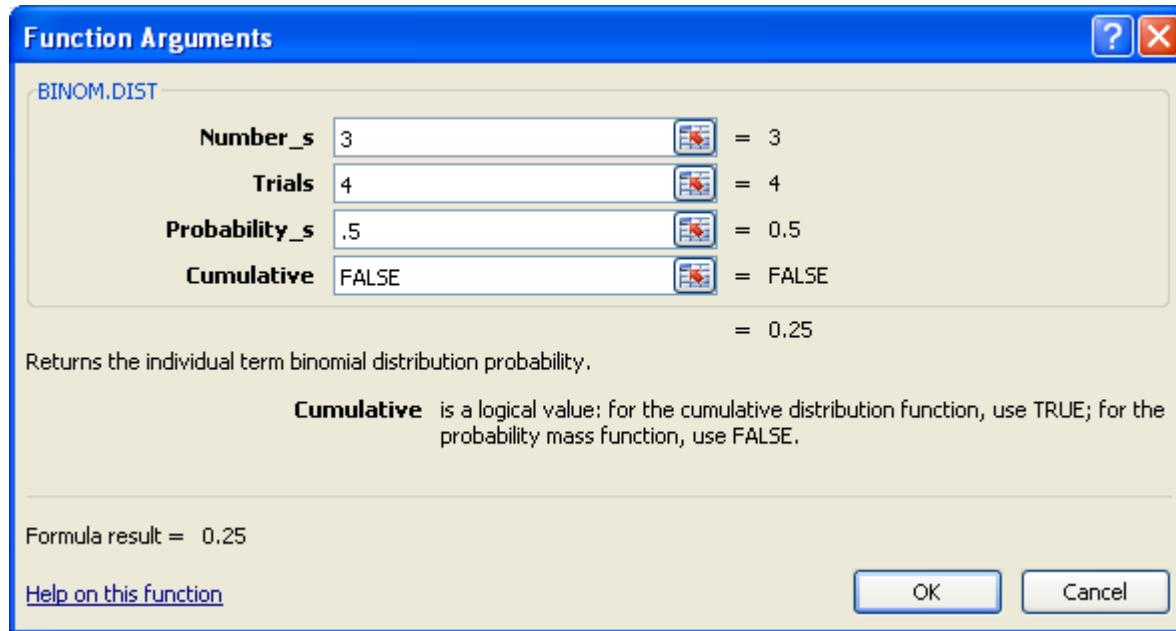
The Excel function that generates binomial probabilities is

BINOM.DIST(r,n,p,cumulative)

where r represents the number of successes. Using TRUE for cumulative returns the cumulative probability of obtaining no more than r successes in n trials, and using FALSE returns the probability of obtaining exactly r successes in n trials.

You can type the command directly in the formula bar (don't forget the preceding equal sign), or you can call up the dialog box by pressing the Insert Function (Function Wizard) button on the menu bar, then selecting Statistical in the drop down box and BINOM.DIST.

To compute the probability of exactly three successes out of four trials where the probability of success on a single trial is 0.50, we would enter the following information into the dialog box. When we press Enter, the formula result 0.25 will appear in the active cell.



Example

A surgeon regularly performs a certain difficult operation. The probability of success for any one such operation is $p = 0.73$. Ten similar operations are scheduled. Find the probability of success for 0 through 10 successes out of these operations.

First let's put information regarding the number of trials and probability of success on a single trial into the worksheet. We type $n = 10$ in Cell A1 and $p = 0.73$ in Cell B1.

Next, we will put the possible values for the number of successes, r , in Cells A3 through A13 with the label **r** in Cell A2. We can also duplicate A2 through A13 in D2 through D13 for easier reading of the finished table. Now place the label **P(r)** in Cell B2 and the label **P(X ≤ r)** in Cell C2. We will have Excel generate the probabilities of the individual number of successes r in Cells B3 through B13 and the corresponding cumulative probabilities in Cells C3 through C13.

Generate P(r) values and adjust format

Select Cell B3 as the active cell. In the formula bar enter

=BINOM.DIST(A3,10,0.73,false)

and press Enter. Then select Cell B3 again, and move the cursor to the lower right corner of the cell. When the small black + appears, drag through Cell B13. This process generates the probabilities for each value of r in Cells A3 through A13.

The probabilities are expressed in scientific notation, where the value after the E indicates that we are to multiply the decimal value by the given power of 10. To reformat the probabilities, select them all and press the comma button on the formatting tool bar. Then press the button to move the decimal point until you see four digits after it.

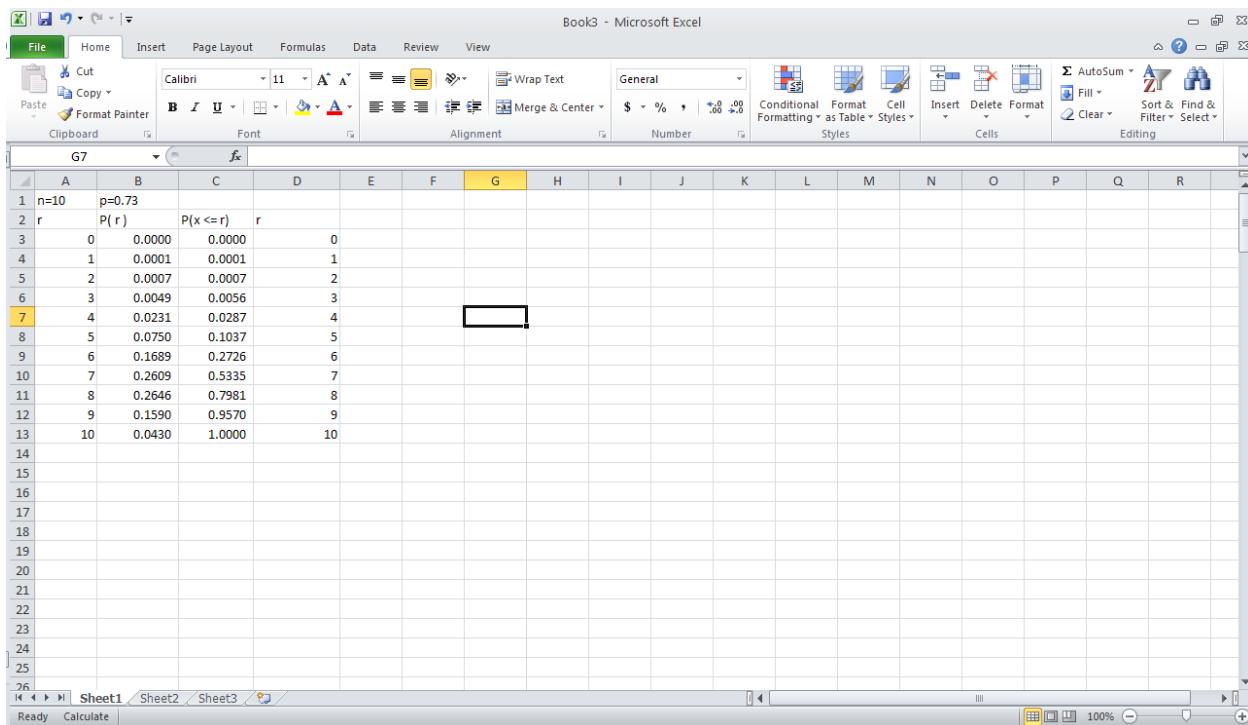


Generate Cumulative Probabilities P(X ≤ r) and adjust format

Select Cell C3 as the active cell. In the formula bar enter

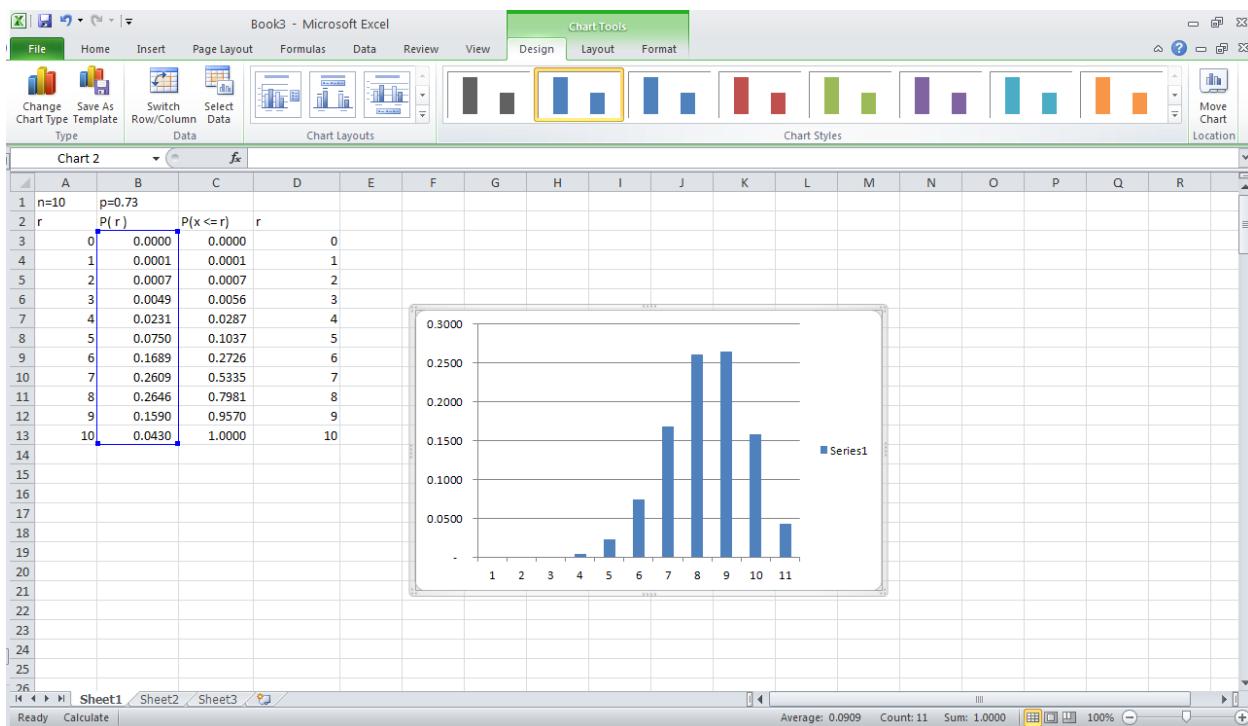
=BINOM.DIST(A3,10,0.73,true)

and press Enter. Then select Cell C3 again, move the cursor to the lower right corner of the cell, and drag down through Cell C13. This generates the cumulative probabilities for each value of r in Cells A3 through A13. Again, reformat the probabilities to show four decimal places.

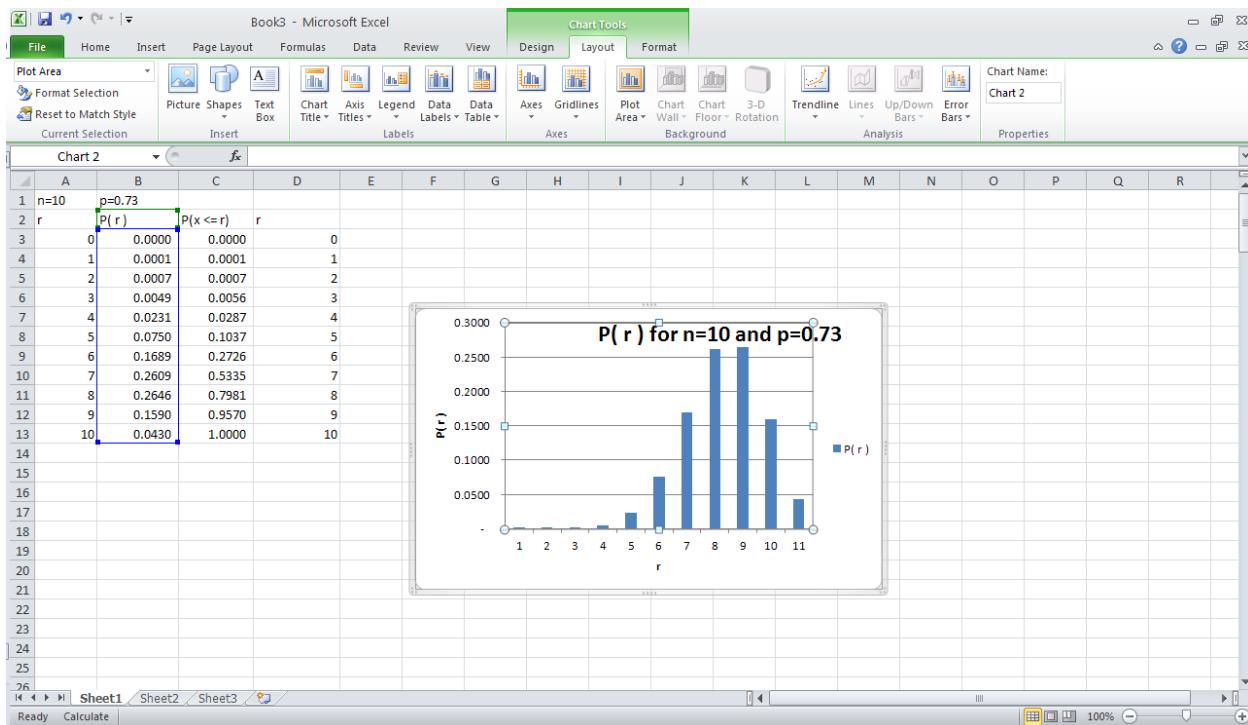


Next, let's create a bar graph showing the probability distribution.

Select cells B2 through B13. Open the Insert Ribbon. Select Column and the first sub-type.



Add a title and labels for each axis.



LAB ACTIVITIES FOR BINOMIAL PROBABILITY DISTRIBUTIONS

1. You toss a coin n times. Call heads success. If the coin is fair, the probability of success p is 0.5. Use BINOM.DIST command with False for cumulative to find each of the following probabilities.
 - (a) Find the probability of getting exactly five heads out of eight tosses.
 - (b) Find the probability of getting exactly twenty heads out of 100 tosses.
 - (c) Find the probability of getting exactly forty heads out of 100 tosses.
 2. You toss a coin n times. Call heads success. If the coin is fair, the probability of success p is 0.5. Use BINOM.DIST command with True for cumulative to find each of the following probabilities
 - (a) Find the probability of getting at least five heads out of eight tosses.
 - (b) Find the probability of getting at least twenty heads out of 100 tosses.
 - (c) Find the probability of getting at least forty heads out of 100 tosses.
- Hint: Keep in mind how BINOM.DIST works. Which should be larger, the value in (b) or the value in (c)?
3. A bank examiner's record shows that the probability of an error in a statement for a checking account at Trust Us Bank is 0.03. The bank statements are sent monthly. What is the probability that exactly two of the next twelve monthly statements for our account will be in error? Now use the BINOM.DIST with True for cumulative to find the probability that at least two of the next twelve statements contain errors. Use this result with subtraction to find the probability that more than two of the next twelve statements contain errors. You can activate a cell and use the formula bar to do the required subtraction.
 4. Some tables for the binomial distribution give values only up to 0.5 for the probability of success p . There is a symmetry between values of p greater than 0.5 and values of p less than 0.5.
 - (a) Consider the binomial distribution with $n = 10$ and $p = .75$. Since there are anywhere from 0 to 10 successes possible, put the numbers 0 through 10 in Cells A2 through A12. Use Cell A1 for the label r . Use BINOM.DIST with cumulative False option to generate the probabilities for $r = 0$ through 10. Store the results in Cells B2 through B12. Use Cell B1 for the label **$p = 0.75$** .

- (b) Now consider the binomial distribution with $n = 10$ and $p = .25$. Use BINOM.DIST with cumulative False option to generate the probabilities for $r = 0$ through 10. Store the results in Cells C2 through C12. Use Cell C1 for the label **p = 0.25**.
- (c) Now compare the entries in Columns B and C. How does $P(r = 4 \text{ successes with } p = .75)$ compare to $P(r = 6 \text{ successes with } p = .25)$?

5.

- (a) Consider a binomial distribution with fifteen trials and probability of success on a single trial $p = 0.25$. Create a worksheet showing values of r and corresponding binomial probabilities. Generate a bar graph of the distribution.
- (b) Consider a binomial distribution with fifteen trials and probability of success on a single trial $p = 0.75$. Create a worksheet showing values of r and the corresponding binomial probabilities. Generate a bar graph.
- (c) Compare the graphs of parts (a) and (b). How are they skewed? Is one symmetric with the other?

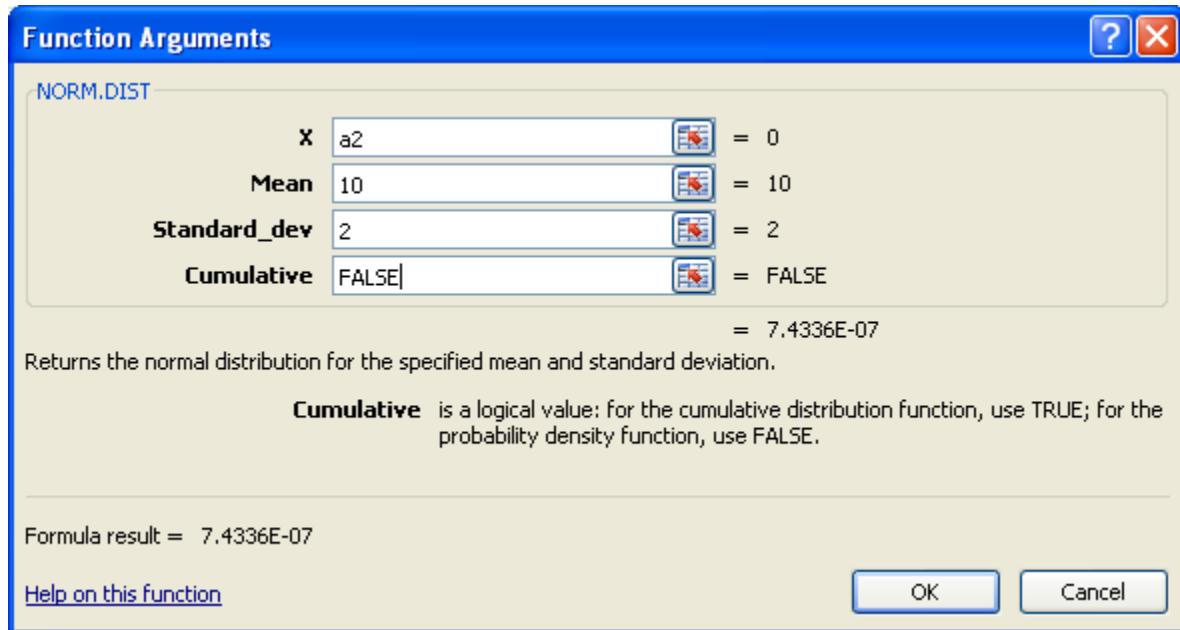
CHAPTER 7: NORMAL CURVES AND SAMPLING DISTRIBUTIONS

GRAPHS OF NORMAL PROBABILITY DISTRIBUTIONS (SECTION 7.1 OF UNDERSTANDING BASIC STATISTICS)

A normal distribution is a continuous probability distribution governed by the parameters μ (the mean) and σ (the standard deviation), as discussed in Section 7.1 of *Understanding Basic Statistics*. The Excel command that generates values for a normal distribution is

NORM.DIST(x,mean,standard deviation,cumulative)

When we set the value of cumulative to FALSE, the command gives the values of the normal probability density function for the corresponding x value. You can type the command directly into the formula bar, or find it by using the Insert Function button on the standard toolbar, selecting Statistical in the drop box and scrolling to NORMDIST in the dialog box below. We filled in the entries that we will use in the next example.



Example

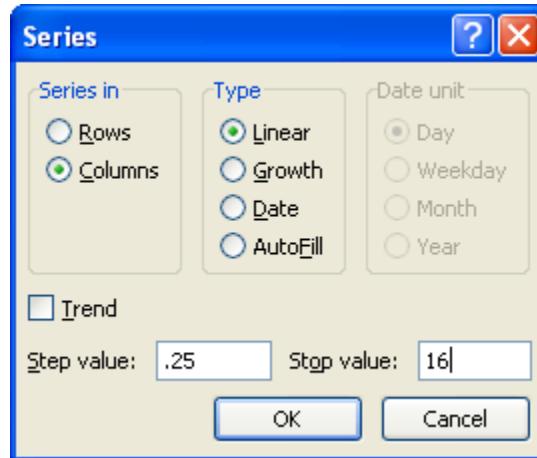
Graph the normal distribution with mean $\mu=10$ and standard deviation $\sigma=2$.

Since most of the normal curve occurs over the values $\mu-3\sigma$, $\mu+3\sigma$, we will start the graph at $10 - 3(2) = 4$ and end it at $10 + 3(2) = 16$. We will let Excel set the scale on the vertical axis automatically.

Generate the column of x values

To graph a normal distribution, we must have a column of x values and a column of corresponding y values. We begin by generating a column of x values ranging 4 to 16, with an increment of 0.25. To do this, select Cell A2 and

enter the number 4. Select Cell A2 again and use the >Home>Fill>Series to open the dialog box shown next. Set the options in the dialog box as shown and then press OK.



You will see that Column A now contains the numbers 4, 4.25, 4.50, ... all the way up to 16.

Generate the column of y values

Select Cell B2, and enter

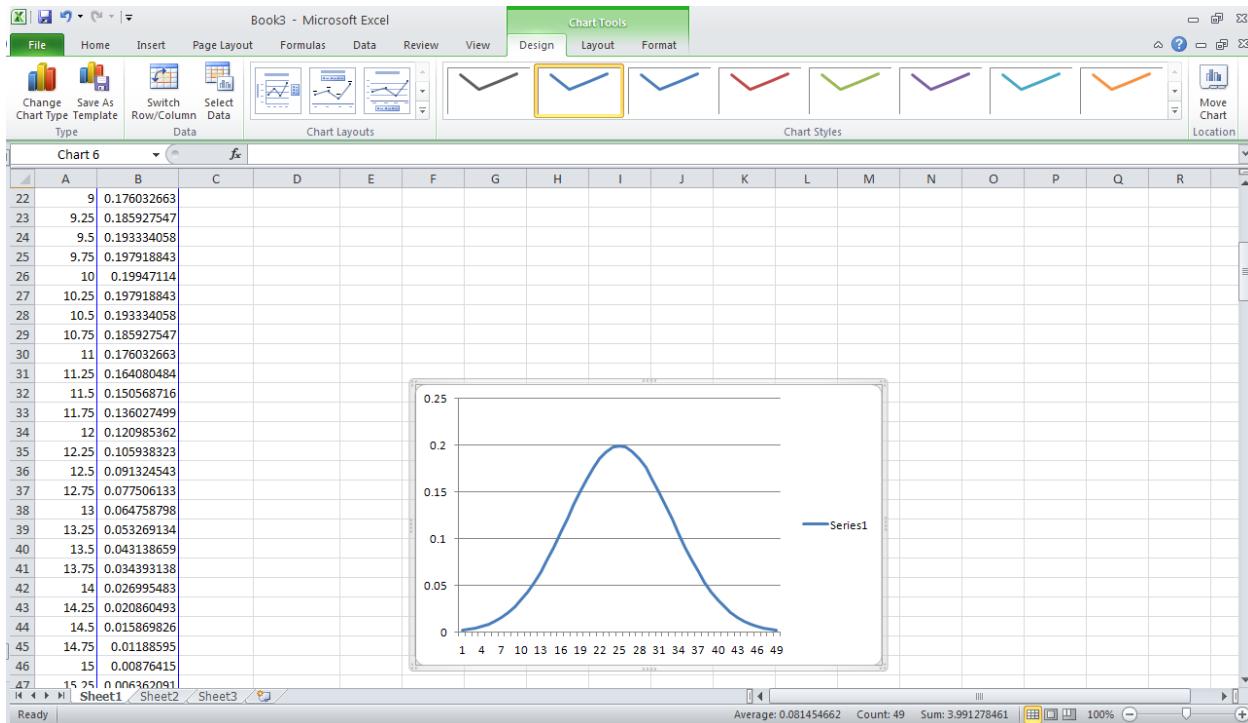
=NORM.DIST(A2,10,2,False)

Press Enter. Select Cell B2 again and move the cursor to the lower right corner of the cell. When the cursor changes to a small black +, hold down the left mouse button and drag down the column until each Column-A entry has a corresponding Column-B entry. Release the left mouse button. All the y values should now appear.

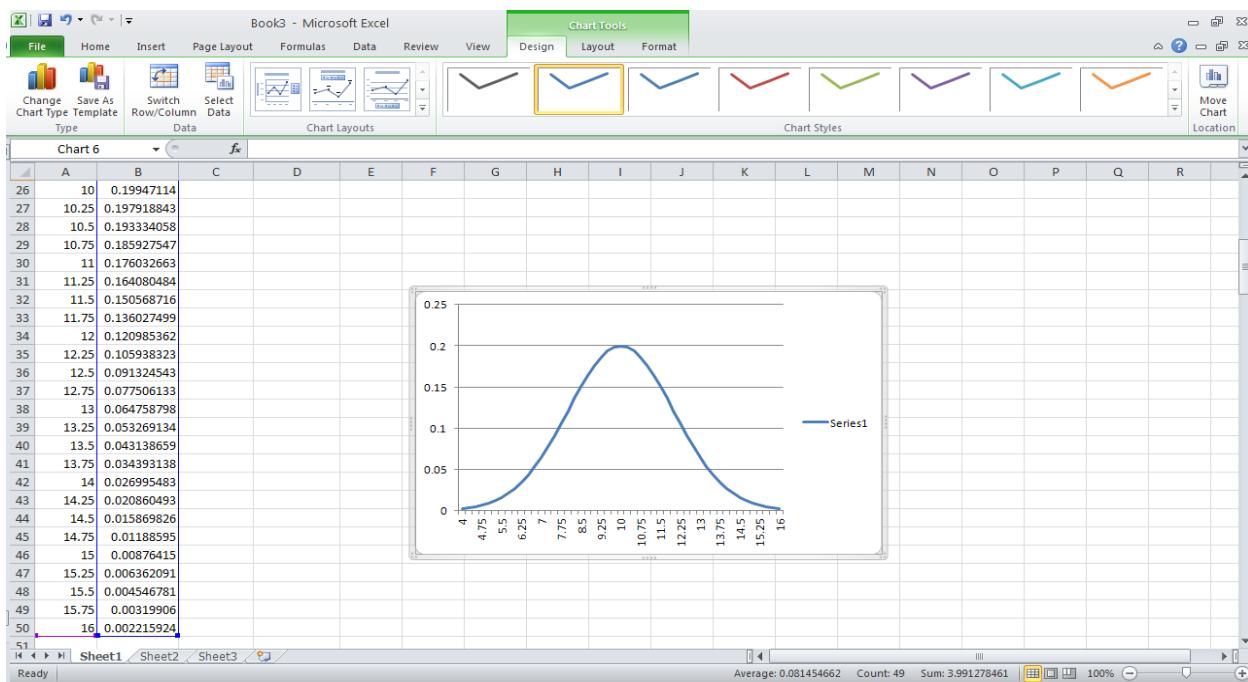
x	y
4	0.002215924
4.25	0.00319906
4.5	0.004546781
4.75	0.006362091
5	0.00876415
5.25	0.01188595
5.5	0.015869826
5.75	0.020860493
6	0.026995483
6.25	0.034393138
6.5	0.043138659
6.75	0.053269134
7	0.064758798
7.25	0.077506133
7.5	0.091324543
7.75	0.105938323
8	0.120985362
8.25	0.136027499
8.5	0.150568716
8.75	0.164080484
9	0.176032663
9.25	0.185927547
9.5	0.193334058
9.75	0.197918843
10	0.19947114

Create the graph of a normal distribution

We will use a Line Graph to create the graph of a normal distribution. Select the data in column B. On the Insert Ribbon, select Line Graph and choose the first chart sub-type.



Right-click on the chart area and choose Select Data. Under Horizontal (Category) Axis Labels, click Edit. Select the cells in Column A, starting with Cell A2. Click OK twice.

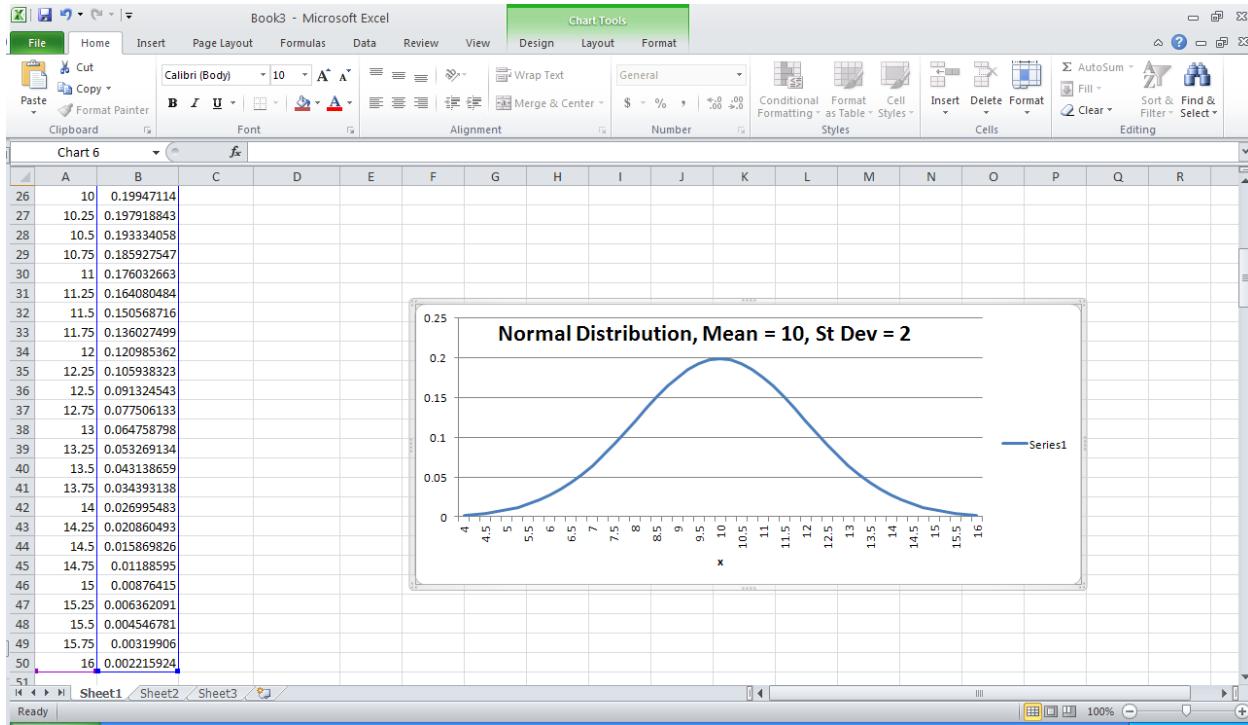


Next, add a title and variable label to the x-axis. In the Chart Title, type

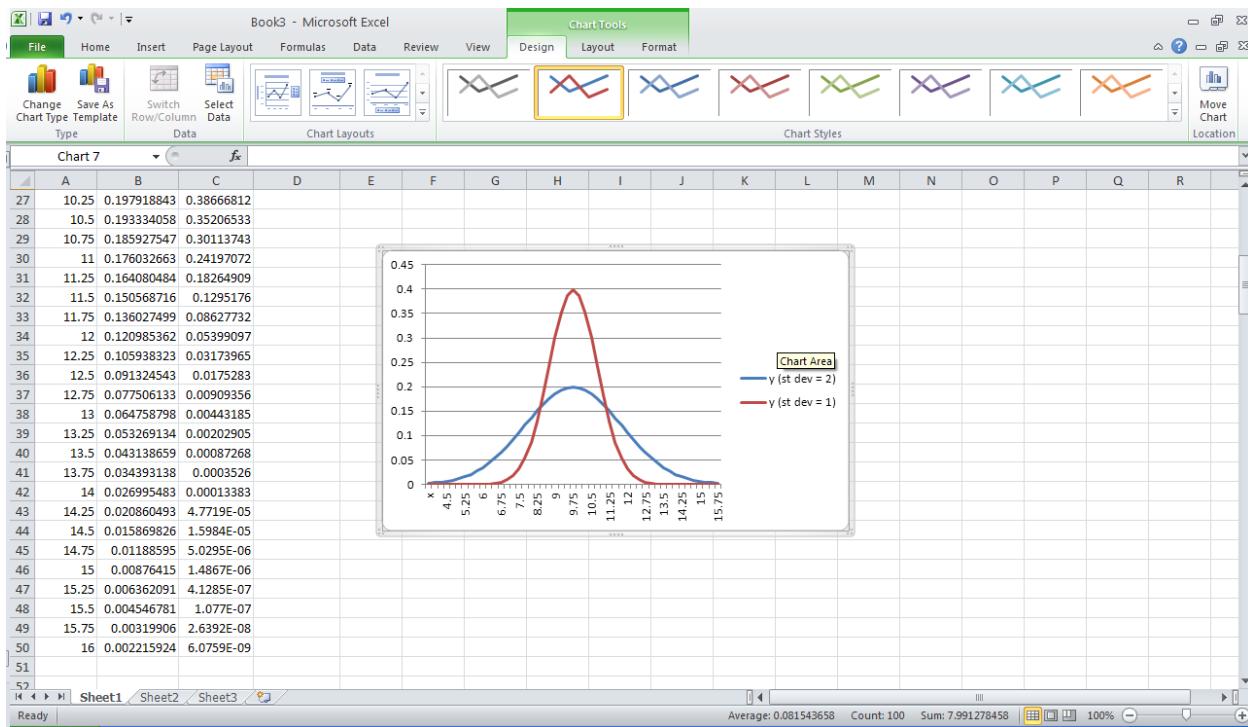
Normal Distribution, Mean = 10, St Dev=2

For Category (X) axis, type x.

Now your worksheet will contain the graph of the described normal distribution. Move the graph and size it to your liking. Notice that as you make the graph wider or taller, the labels shown on the x-axis might change.



We can also graph two (or more) normal distributions on the same graph. In the next display we generated y values for a normal distribution with mean 10 and standard deviation 1 in Column C. Then, we select both Column B and C before selecting the chart type.



STANDARD SCORES AND NORMAL PROBABILITIES

Excel has several built-in functions relating to normal distributions.

STANDARDIZE(x,mean,standard deviation) returns the z score for the given x value from a distribution with the specified mean and standard deviation.

NORM.DIST(x1,mean,standard deviation,cumulative); when cumulative is TRUE, this returns probability that a random value x selected from this distribution is $\leq x_1$, i.e. it returns $P(x \leq x_1)$. This is the same as the area to the left of the specified x_1 value under the described normal distribution. When cumulative is FALSE, it returns the height of the normal probability density function evaluated at x_1 . We used this function to graph a normal distribution.

NORM.INV(probability,mean,standard deviation) returns the inverse of the normal cumulative distribution. In other words, when a probability is entered, the command returns the value from the normal distribution with specified mean and standard deviation so that the area to the left of that value is equal to the designated probability.

NORM.S.DIST(z1) returns the probability that a randomly selected z score is less or equal the specified value of z_1 , i.e. it returns $P(z \leq z_1)$. This is the same as the area to the left of the specified z_1 value under the standard normal distribution. This command is equivalent to NORM.DIST($x_1, 0, 1, \text{true}$).

NORM.S.INV(probability) returns the value such that the area to its left under the standard normal distribution is equal to the specified probability. This command is equivalent to NORM.INV(probability,0,1).

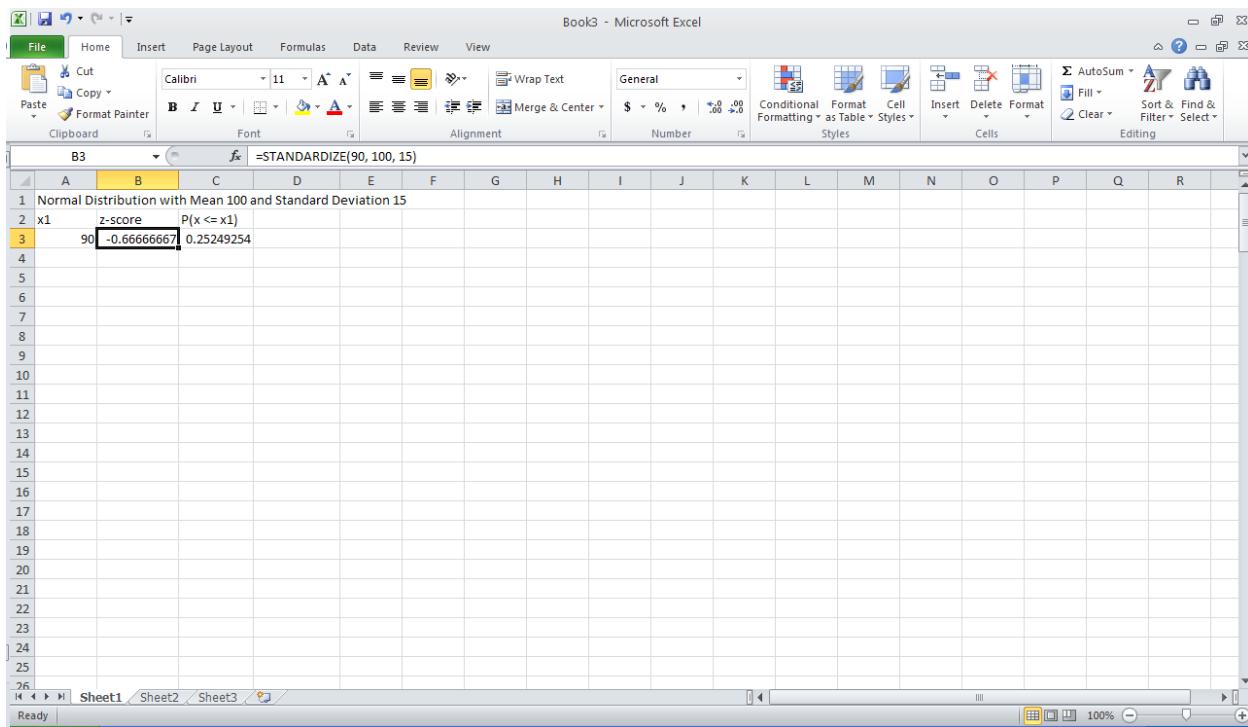
Each of these commands can be typed directly into the formula bar for an active cell or accessed by using the Insert Function button.

Examples

- (a) Consider a normal distribution with mean 100 and standard deviation 15. Find the z score corresponding to $x = 90$ and find the area to the left of 90 under the distribution.

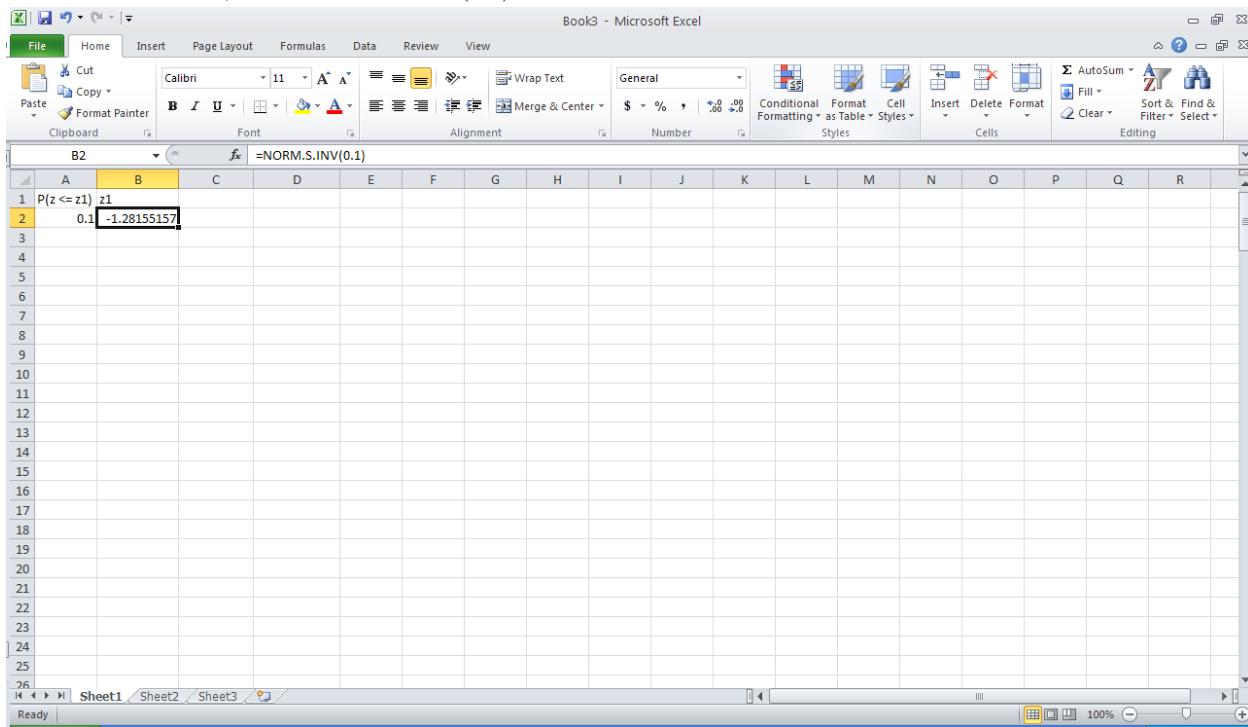
First we place some headers and labels on the worksheet. Then,

1. in Cell B3, enter =STANDARDIZE(90,100,15)
2. in Cell C3, enter =NORMDIST(90,100,15,true)



- (b) Find the z score so that 10% of the area under the standard normal distribution is to the left of z.

Again, we put some labels on the worksheet. Then, since we are working with a standard normal distribution, we use NORMSINV(0.1).

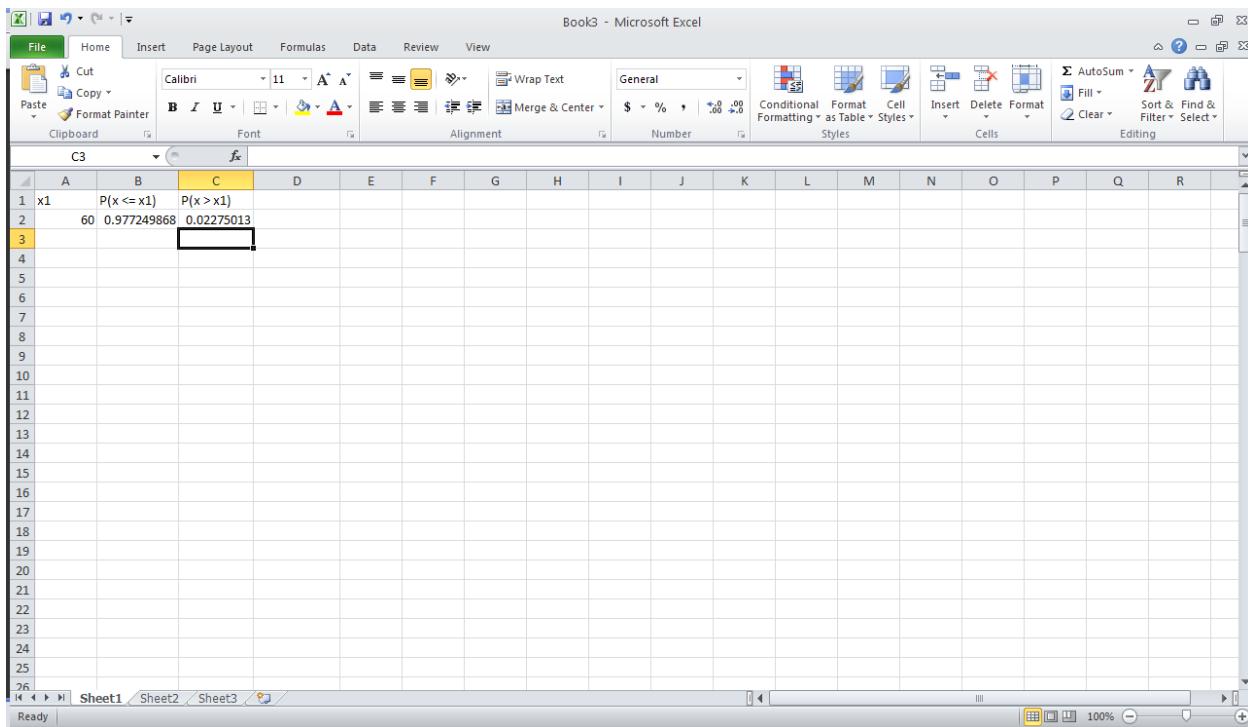


To find areas under normal curves between two values, we do simple arithmetic with the cumulative areas provided by Excel. For instance, to find the area under a standard normal distribution between -2 and 3, we would use `NORM.DIST(3, 0, 1, true)` to find the cumulative area to the left of 3 and then subtract the cumulative area to the left of -2, found using `NORM.DIST(-2, 0, 1, true)`.

The screenshot shows a Microsoft Excel spreadsheet titled "Book3 - Microsoft Excel". The ribbon is visible at the top with tabs for File, Home, Insert, Page Layout, Formulas, Data, Review, and View. The Home tab is selected. The formula bar shows the formula `=A2-B2`. The main table has three columns: A, B, and C. Column A contains `P(z <= 3)`, column B contains `P(z <= -2)`, and column C contains the formula `P(-2 <= z <= 3)`. The value in cell A1 is 0.99865, in B1 is 0.022750132, and in C1 is 0.97589997. The formula bar also shows the formula `=A2-B2`.

	A	B	C
1	$P(z \leq 3)$	$P(z \leq -2)$	$P(-2 \leq z \leq 3)$
2	0.99865	0.022750132	0.97589997
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
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26			

To find areas under normal curves to the right of a specified value, we subtract the cumulative area to the left of the value from 1. For instance, consider the normal distribution with mean 50 and standard deviation 5. Below is a worksheet in which the area to the right of 60 is found.



LAB ACTIVITIES FOR NORMAL DISTRIBUTIONS

1. (a) Use Excel to sketch a graph of the standard normal distribution with a mean of 0 and a standard deviation of 1. Generate x values in column A ranging from -3 to 3 in increments of 0.5. Use NORM.DIST to generate the y values in column B.
 (b) Use Excel to sketch a graph of a normal distribution with a mean of 10 and a standard deviation of 1. Generate x values in Column A ranging from 7 to 13 in increments of 0.5. Use NORM.DIST to generate the y values in column B. Compare the graphs of parts (a) and (b). Do the height and spread of the graphs appear to be the same? What is different? Why would you expect this difference.
 (c) Sketch a graph of a normal distribution with a mean of 0 and a standard deviation of 2. Generate x values in Column A ranging from -6 to 6 in increments of 0.5. Use NORM.DIST to generate the y values in Column B. Compare that graph to that of part (a). Do the height and spread of the graphs appear to be the same? What is different? Why would you expect this difference? Note, to really compare the graphs, it is best to graph them using the same scales. Redo the graph of part (a) using x from -6 to 6. Then redo the graph in this part using the same x values as in part (a) and y values ranging from 0 to the high value in part (a).
2. Use NORM.DIST or NORM.S.DIST plus arithmetic to find the specified area.
 - (a) Find the area to the left of 2 on a standard normal distribution.
 - (b) Find the area to the left of -1 on a standard normal distribution.
 - (c) Find the area between -1 and 2 on a standard normal distribution.
 - (d) Find the area to the right of 2 on a standard normal distribution.
 - (e) Find the area to the left of 40 on a normal distribution with $\mu = 50$ and $\sigma = 8$.
 - (f) Find the area to the left of 55 on a normal distribution with $\mu = 50$ and $\sigma = 8$.
 - (g) Find the area between 40 and 55 on a normal distribution with $\mu = 50$ and $\sigma = 8$.
 - (h) Find the area to the right of 55 on a normal distribution with $\mu = 50$ and $\sigma = 8$.
3. Use NORM.INV or NORM.S.INV to find the specified x or z value.

- (a) Find the z value so that 5% of the area under the standard normal curve falls to the left of z .
- (b) Find the z value so that 15% of the area under the standard normal curve falls to the left of z .
- (c) Consider a normal distribution with mean 10 and standard deviation 2. Find the x value so that 5% of the area under the normal curve falls to the left of x .
- (d) Consider a normal distribution with mean 10 and standard deviation 2. Find the x value so that 15% of the area under the normal curve falls to the left of x .

INTRODUCTION TO SAMPLING DISTRIBUTIONS (SECTION 7.4 OF *UNDERSTANDING BASIC STATISTICS*)

Excel has no commands that directly support the demonstration of sampling distributions.

CHAPTER 8: ESTIMATION

CONFIDENCE INTERVALS FOR THE MEAN - WHEN σ IS KNOWN (SECTION 8.1 OF *UNDERSTANDING BASIC STATISTICS*)

Excel's function for computing confidence intervals for a population mean assumes a normal distribution, regardless of sample size. Therefore, as stated in the text, if the population distribution is not a normal distribution, then a large sample should be used. The command syntax is

CONFIDENCE.NORM(alpha, standard deviation, sample size)

where alpha equals 1 minus the confidence level. In other words, an alpha of 0.05 indicates a 95% confidence interval. To generate a 99% confidence interval, use alpha = 0.01. The standard deviation is the population standard deviation σ .

Recall from the discussion in *Understanding Basic Statistics* that a confidence interval for the population mean has the form

$$\bar{x} - E \leq \mu \leq \bar{x} + E$$

Excel uses the formula

$$E = z_c \frac{\sigma}{\sqrt{n}}$$

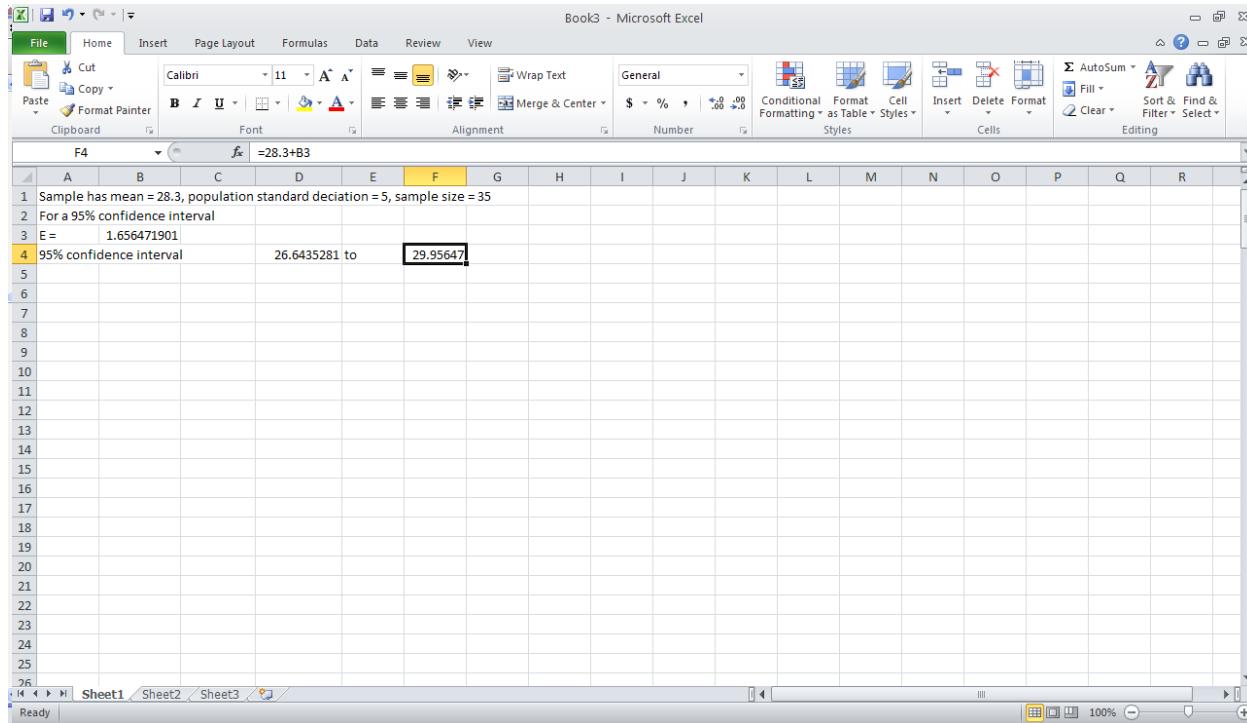
where z_c is the critical value for the chosen confidence level. For $c = 95\%$, $z_c=1.96$.

CONFIDENCE.NORM returns the value of E . To find the lower boundary of the confidence interval, you must subtract E from the sample mean \bar{x} of your data; to find the upper boundary, you add E to the sample mean.

Example

Lucy decided to try to estimate the average number of miles she drives each day. For a three-month period, she selected a random sample of 35 days and kept a record of the distance driven on each of those sample days. The sample mean was 28.3 miles; assume that the standard deviation was $\sigma = 5$ miles. Find a 95% confidence interval for the population mean of miles Lucy drove per day in the three-month period.

For a 95% confidence level, alpha is 0.05. In our Excel worksheet, after putting in some information and labels, we enter =CONFIDENCE.NORM(0.05,5,35) in Cell B3 to represent E . In Cell D4, we type =28.3-B3 to compute the lower value of the confidence interval, and we place the upper value of the confidence interval in Cell F4 using =28.3+B3.



CONFIDENCE INTERVALS FOR THE MEAN – WHEN σ IS UNKNOWN (SECTION 8.2 OF UNDERSTANDING BASIC STATISTICS)

When the population standard deviation σ is unknown, the sample standard deviation s is used to replace σ , and the confidence intervals are computed using Student's t distribution.

The confidence interval is computed as

$$\bar{x} - E \text{ to } \bar{x} + E$$

where $E = t_c \frac{s}{\sqrt{n}}$.

Excel has two commands for Student's t distribution under the statistical options of Insert Function.

T.DIST(x, degrees of freedom, tails) returns the area in the tail of Student's t distribution beyond the specified value of x , for the specified number of degrees of freedom and one tail.

T.DIST.2T(x, degrees of freedom, tails) returns the area in the tail of Student's t distribution beyond the specified value of x , for the specified number of degrees of freedom and two tails.

T.INV(probability, degrees of freedom) returns the t_c value such that the area in the left tail beyond the t_c value equals the specified probability for the specified degrees of freedom.

T.INV.2T(probability, degrees of freedom) returns the t_c value such that the area in the area in the two tails beyond the t_c value equals the specified probability for the specified degrees of freedom.

We can use the T.INV.2T command to find the t_c value to use in the confidence interval. For instance, if we have a sample of size 10 with mean $\bar{x} = 6$ and $s = 1.2$, then the t_c value we use in the computation of a 95% confidence

interval is 2.262. Notice that for a 95% confidence interval, 5% of the area is in the two tails. The number of degrees of freedom is $10 - 1 = 9$.

The screenshot shows a Microsoft Excel spreadsheet titled "Book3 - Microsoft Excel". The ribbon menu is visible at the top. The "Home" tab is selected, showing the "Font" and "Number" groups. The formula bar displays the formula `=T.INV.2T(0.05, 9)`. Cell A1 contains the result `2.262157`. The rest of the worksheet is blank with rows 2 through 25 visible.

We can also find the E value in the Describe Statistics dialog box found by selecting **>Data>Data Analysis>Descriptive Statistics**. If you have data entered into a worksheet, you can use these menu selections to automatically compute the sample mean \bar{x} and the sample standard deviation s for the data, as well as the value of E for the confidence interval on the basis of Student's t distribution no matter what the sample size is.

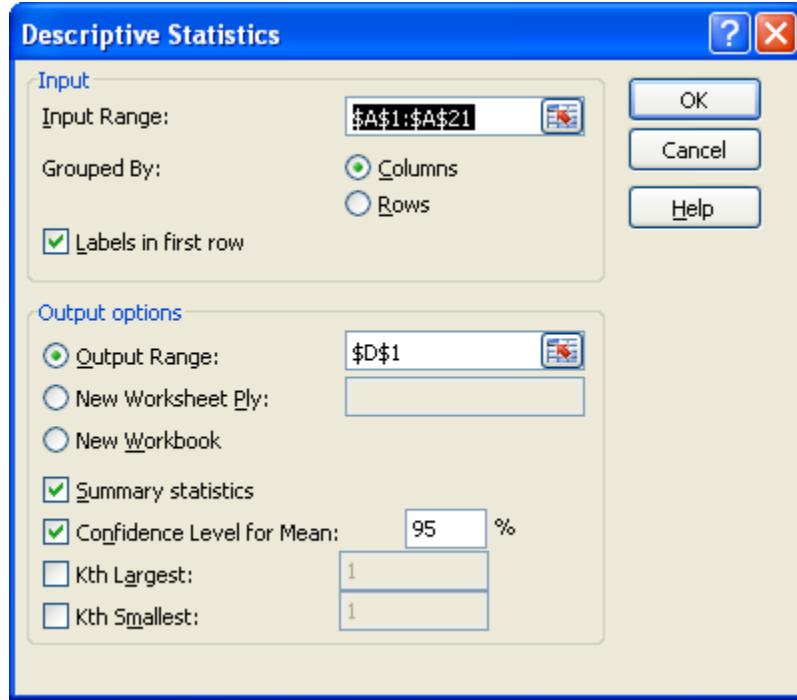
Example

The manager of First National Bank wishes to know the average waiting times for student loan application action. A random sample of 20 applications showed the waiting times (in days) to be

3	7	8	24	6	9	12	25	18	17
4	32	15	16	21	14	12	5	18	16

Find a 95% confidence interval for the population mean of waiting times.

Enter the data in Column A. Use the menu selection **>Data>Data Analysis>Descriptive Statistics** to access the following dialog box. Since the weights are in Column A, we select the cells containing the range and use these for the input range. We place the upper left corner of the output in Cell C1 and check that we want summary statistics and a 95% confidence interval.



Next we widen cells in Column D and E to accommodate the output. Notice that the sample mean is in Cell E3 and that the value of E for a 95% confidence interval (again, based on Student's t distribution, not the standard normal distribution) is in Cell E16. We put the confidence interval in Cells F2 to H2 by entering $=D3-D16$ in Cell F2 and $=D3+D16$ in Cell H2. The display should be similar to the one shown below.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	Days			Days	Mean	14.1											
2	3				Standard Error	1.722757887											
3	7				Median	14.5											
4	8				Mode	12											
5	24				Standard Deviation	7.704407488											
6	6				Sample Variance	59.35789474											
7	9				Kurtosis	-0.041378791											
8	12				Skewness	0.520150075											
9	25				Range	29											
10	18				Minimum	3											
11	17				Maximum	32											
12	4				Sum	282											
13	32				Count	20											
14	15				Confidence Level(95.0%)	3.605773697											
15	16																
16	21																
17	14																
18	12																
19	5																
20	18																
21	16																
22																	
23																	
24																	
25																	
26																	

LAB ACTIVITIES FOR CONFIDENCE INTERVALS FOR THE MEAN

1. Retrieve the worksheet Sv03.xls. This contains the heights (in feet) of 65 randomly selected pro basketball players. Use the Descriptive Statistics dialog box to get summary statistics for the data and to create a 90% confidence interval.
2. Retrieve the worksheet Sv01.xls from the Excel data disk. This worksheet contains the number of shares of Disney Stock (in hundreds of shares) sold for a random sample of sixty trading days in 1993 and 1994. Use the Descriptive Statistics dialog box to get summary statistics for the data and to create the following confidence intervals.
 - (a) Find a 99% confidence interval for the population mean volume.
 - (b) Find a 95% confidence interval for the population mean volume.
 - (c) Find a 90% confidence interval for the population mean volume.
 - (d) Find an 85% confidence interval for the population mean volume.
 - (e) What do you notice about the lengths of the intervals as the confidence level decreases?
3. There are many types of errors that will cause a computer program to terminate or give incorrect results. One type of error is punctuation. For instance, if a comma is inserted in the wrong place, the program might not run. A study of programs written by students in a beginning programming course showed that 75 out of 300 errors selected at random were punctuation errors. Find a 99% confidence interval for the proportion of errors made by beginning programming students that are punctuation errors. Next find a 90% confidence interval. Use the CONFIDENCE command to find the interval. Is this interval longer or shorter?

CHAPTER 9: HYPOTHESIS TESTING

TESTING A SINGLE POPULATION MEAN - WHEN σ IS KNOWN (SECTION 9.2 OF *UNDERSTANDING BASIC STATISTICS*)

Chapter 9 of *Understanding Basic Statistics* introduces tests of hypotheses. Testing involving a single mean is found in Section 9.2. Hypothesis tests in this section test the value of the population mean, μ , against some specified value, denoted by k .

When population standard deviation σ is known, one-sample z -tests are appropriate for testing the null hypothesis $H_0: \mu = k$ against one of the three alternative hypotheses $H_1: \mu > k$, $H_1: \mu < k$, or $H_1: \mu \neq k$ when (1) the data in the sample are known to be from a normal distribution (in which case any sample size will do) or when (2) the data distribution is unknown or the data are believed to be from a non-normal distribution, but the sample size, n , is large ($n \geq 30$).

In Excel, the **Z.TEST** function finds the P value for an upper- or right-tailed test, used to decide between the hypotheses $H_0: \mu = k$ and $H_1: \mu > k$. The null hypothesis says that value of the population mean μ is k . A right-tailed test is used when the sample mean \bar{x} is greater than k , suggesting that μ may in fact be greater than k , as the alternative hypothesis states.

The syntax is

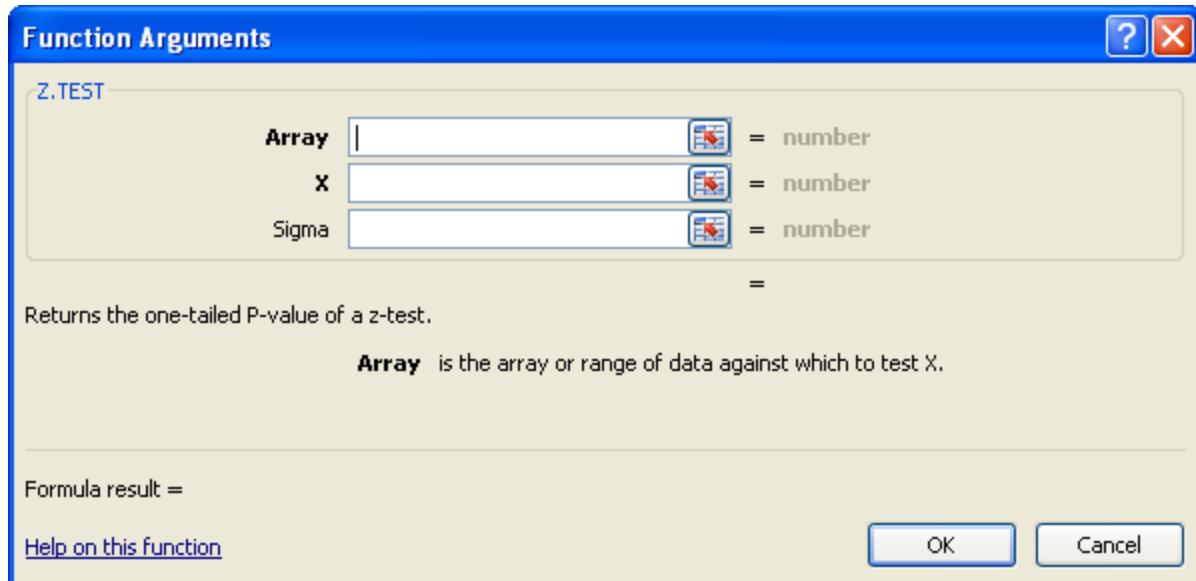
Z.TEST(array, x, sigma)

The array is the list of sample values; what Excel calls x is k , and sigma is the known value of σ , the population standard deviation. If the syntax used is Z.TEST(array, x), i.e. if there is no sigma value given, then Excel calculates the sample standard deviation, s , from the sample data in array and uses that in place of σ .

The P value returned by Z.TEST is the probability, given that the null hypothesis is true, of getting results at least as extreme as those observed in the sample. More precisely, Z.TEST gives the probability of obtaining a sample mean greater than or equal to the observed sample mean, \bar{x} . When this probability is small, it means that the data in the observed sample would be surprising if H_0 were true. This is a reason to reject H_0 .

Z.TEST can also be used to apply a left-tailed test ($H_0: \mu = k$ versus $H_1: \mu < k$) or a two-tailed test ($H_0: \mu = k$ versus $H_1: \mu \neq k$). To apply a left-tailed test, for the case where the sample mean \bar{x} is less than k , simply apply a right-tailed test and then subtract the result from 1. (When $\bar{x} < k$, the area found by Z.TEST in the upper “tail” will be greater than 0.5, and 1 minus that area will be the area in the lower tail.) To apply a two-tailed test, either double the P value from a right-tailed test (when $\bar{x} > k$) or double the P value from a left-tailed test (when $\bar{x} < k$).

To call up the Z.TEST dialog box, click the Insert Function button on the tool bar, select Statistical in the drop box, and scroll to Z.TEST. The dialog box should be similar to the one shown on the top of the next page.



Enter the cell range containing the sample values in the Array blank, and in the blank for X, enter the mean given by the null hypothesis. In the Sigma blank, enter the value of the population standard deviation σ if it is known. Again, sigma is optional; if this box is left blank, Excel will compute the sample standard deviation for the data in the specified Array and use s instead of σ in the computation for z . Recall that if we are dealing with large samples, s and σ are fairly close, so this approximation produces reliable results. Finally, when you click on OK, the P value of the right-tailed test of x is computed.

You can also type the command directly into the formula bar using **Z.TEST(data range, X, sigma)**.

Once the P value is computed, the user can then compare it with α , the level of significance of the test. If P value $\leq \alpha$, we reject the null hypothesis. If P value $> \alpha$, we do not reject the null hypothesis

Example

Z.TEST requires the use of large samples (size 30 or greater) when the population distribution is unknown. Let us consider the following data, which contains heights in feet of 32 randomly selected professional basketball players.

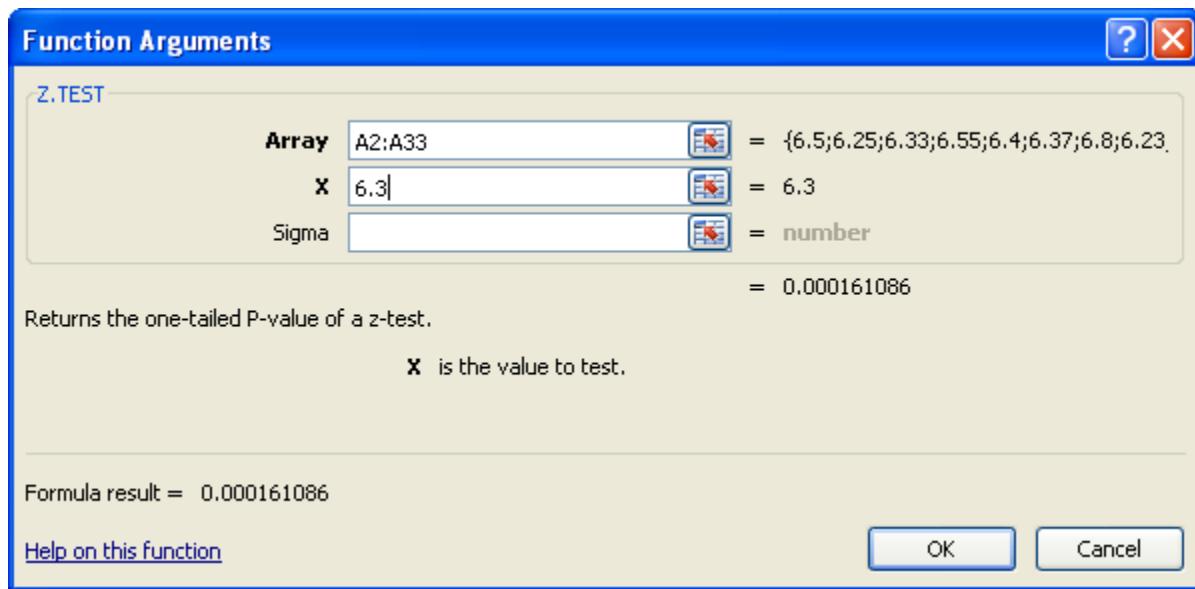
6.5	6.25	6.33	6.55	6.4	6.37	6.8	6.23
7.1	5.9	6.45	6.7	6.55	6.4	6.38	6.2
6.72	6.9	6.5	6.44	6.8	5.9	6.0	6.9
6.3	7.2	6.3	6.82	6.32	6.44	6.56	6.71

Assume that twenty years ago, the average height of professional basketball players was 6.3 feet (that translates to 6 feet, 3.6 inches). Let's use the above data to consider whether the current population mean height of professional basketball players is greater than it was twenty years ago. The null hypothesis will be that their average height is the same. Given our alternative hypothesis ("greater than"), we will apply a right-tailed test.

Enter the data in Column A. Cell A1 contains the label Heights. Enter the data in cells A2:A33.

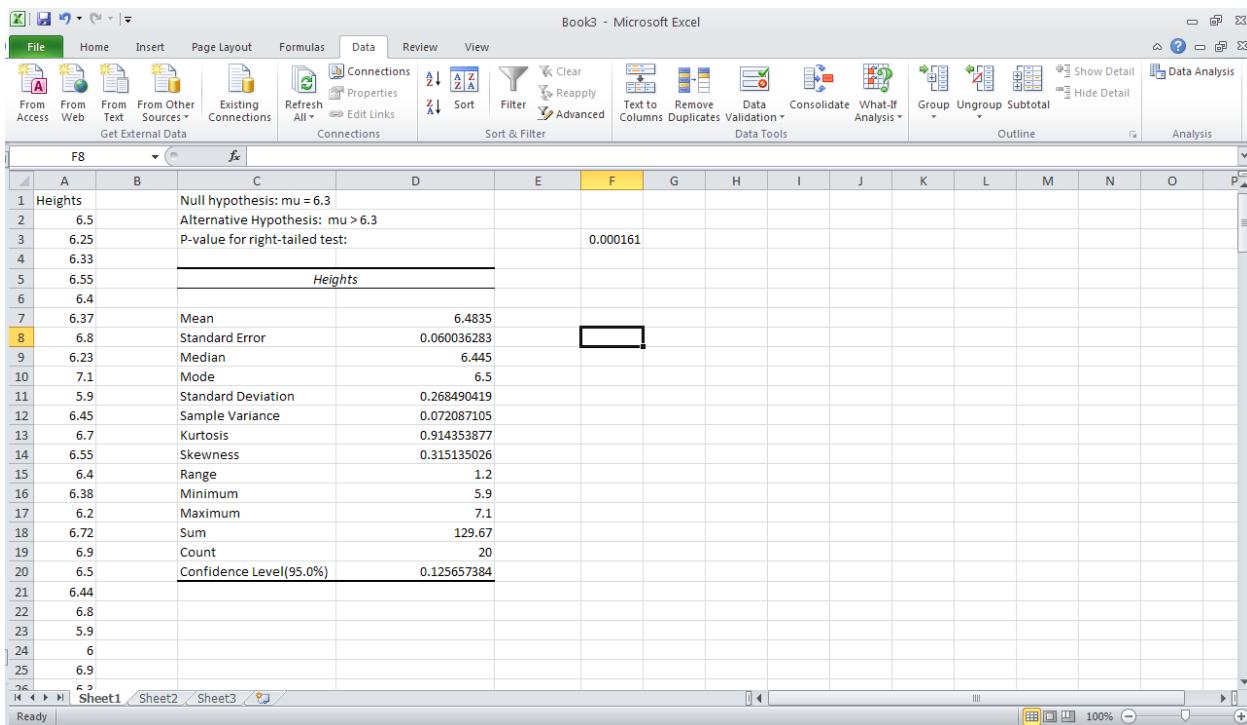
After typing in some labeling information, we want to display the P value provided by Z.TEST in Cell F3. Activate Cell F3 and, in the Insert Function dialog box, select Statistical in the drop box and Z.TEST. The dialog box should be similar to the one shown at the top of the next page.

We will use the cell range A2:A33 for the Array and 6.3 as the value of X. The population standard deviation is not given in this case. To demonstrate the use of Z.TEST, let's use the value of s , the sample standard deviation for the value of σ , and let Excel compute s from the sample data. Notice that with the space for Sigma left blank, the dialog box tells us that the P value is about 0.00016. We interpret this as the probability that 32 data values could come out with a mean greater than or equal to that of the sample, given that they were taken from a normal distribution with a mean of 6.3.



So the P value is about 0.00016. Since this is less than even the very restrictive $\alpha = 0.01$, we reject the null hypothesis and conclude that the population mean height of professional basketball players now is greater than it was twenty years ago.

For completeness, we also used the >Data>Data Analysis>Descriptive Statistics menu choice and dialog box to generate the descriptive statistics for our data. We selected output range beginning in cell C5, and then widened the columns to fit the display.



LAB ACTIVITIES FOR TESTING A SINGLE POPULATION MEAN

1. Open or retrieve the worksheet Sv04.xls from the student website. The data in Column A of this worksheet represent the miles per gallon gasoline consumption (highway) for a random sample of 55 makes and models of passenger cars (source: Environmental Protection Agency).

30	27	22	25	24	25	24	15
35	35	33	52	49	10	27	18
20	23	24	25	30	24	24	24
18	20	25	27	24	32	29	27
24	27	26	25	24	28	33	30
13	13	21	28	37	35	32	33
29	31	28	28	25	29	31	

Test the hypothesis that the population mean mile per gallon gasoline consumption for such cars is greater than 25 mpg.

- (a) Do we know σ for the mpg consumption? If not, use the value of s for the value of σ (sometimes this is done in practice when sample size is large.) Can we use the normal distribution for the hypothesis test?
- (b) State the null and alternate hypothesis and type them on your worksheet.
- (c) Use Z.TEST with Sigma omitted.
- (d) Look at the P value in the output. Compare it to α . Do we reject the null hypothesis or not? Does it depend on the level of significance?
- (e) Use the Descriptive Statistics dialog box to generate the summary statistics for the data, and place the results on the worksheet.

CHAPTER 10: INFERENCES ABOUT DIFFERENCES

TESTS INVOLVING PAIRED DIFFERENCES - DEPENDENT SAMPLES (SECTION 10.1 OF *UNDERSTANDING BASIC STATISTICS*)

The test for difference of means of dependent samples is presented in Section 10.1 of *Understanding Basic Statistics*. Dependent samples arise from before-and-after studies, some studies of data taken from the same subjects, and some studies on identical twins.

In Excel there are two functions that produce the P value for a one- or two-tailed test of paired differences. The first command is **T.TEST**, found using Insert Function with Statistical in the drop down box and T.TEST. You can also activate a cell and type the command in the formula bar. This command returns only the P value for the test. The syntax is

T.TEST(data range of sample 1, data range of sample 2, tails, type)

If tails = 1, then T.TEST returns the P value for a one-tailed test, and if tails = 2, then T.TEST returns the two-tailed value. For the parameter called type, there are three choices:

Type	Test performed using Student's t distribution
1	Paired difference test
2	Difference of means test for two samples with equal variances
3	Difference of means test for two samples with unequal variances

The other Excel command, **>Data>Data Analysis>t-Test: Paired Two Sample for Means**, gives much more information than T.TEST. We will use this command in the next example.

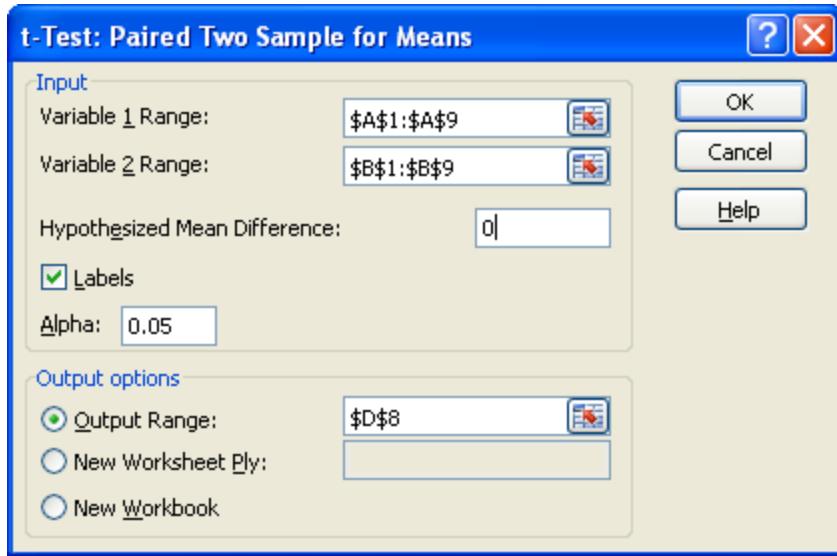
Example

Promoters of a state lottery decided to advertise the lottery heavily on television for one week during the middle of one of the lottery games. To see if the advertising improved ticket sales, they surveyed a random sample of 8 ticket outlets and recorded weekly sales for one week before the television campaign and for one week after the campaign. The results follow (in ticket sales) where row A gives sales prior to the campaign and row B gives sales afterward.

A	3201	4529	1425	1272	1784	1733	2563	3129
B	3762	4851	1202	1131	2172	1802	2492	3151

Test the claim that the television campaign increased lottery ticket sales at the 0.05 level of significance.

We enter the data in Columns A and B, with appropriate headers. Next, open the dialog box below, using **>Data>Data Analysis> t-Test: Paired Two Sample for Means**.



Notice that we use Column A cells for Variable 1 Range, Column B cells for Variable 2 range, and we check the Labels box. The null hypothesis is $H_0: \mu = 0$, so we enter 0 as the value for the Hypothesized Mean difference. We select Cell D8 as the upper left cell for the Output Range, and we widen the output columns to fit the display.

	A	B
1	3201	3762
2	4529	4851
3	1425	1202
4	1272	1131
5	1784	2172
6	1733	1802
7	2563	2492
8	3129	3151
9		
10		
11		Paired Difference Test
12		Null Hypothesis: Mean of differences = 0
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

Notice that we get $P = 0.1386$ for a one-tailed test. Since this value is larger than the level of significance, we do not reject the null hypothesis. The same output gives the P value for a two-tailed test as well. In addition, we see the sample t value of -1.17846, together with the critical values for a one- or two-tailed test using $\alpha= 0.05$.

LAB ACTIVITIES FOR TESTS INVOLVING PAIRED DIFFERENCES

1. Open or retrieve the worksheet Tvcds01.xls from the student website. The data are pairs of values where the entries in Column A represents average salary (\$1000/yr) for male faculty members at an institution and those in Column B represent the average salary for female faculty members (\$1000/yr) at the same institution. A random sample of 22 U.S. colleges and universities was used (source: Academe, Bulletin of the American Association of University Professors).

(34.5, 33.9)	(30.5, 31.2)	(35.1, 35.0)	(35.7, 34.2)	(31.5, 32.4)
(34.4, 34.1)	(32.1, 32.7)	(30.7, 29.9)	(33.7, 31.2)	(35.3, 35.5)
(30.7, 30.2)	(34.2, 34.8)	(39.6, 38.7)	(30.5, 30.0)	(33.8, 33.8)
(31.7, 32.4)	(32.8, 31.7)	(38.5, 38.9)	(40.5, 41.5)	(25.3, 25.5)
(28.6, 28.0)	(35.8, 35.1)			

2. An audiologist is conducting a study on noise and stress. Twelve subjects selected at random were given a stress test in a room that was quiet. Then the same subjects were given another stress test, this time in a room with high-pitched background noise. The results of the stress tests were scores 1 through 20 with 20 indicating the greatest stress. The results follow, where A represents the score of the test administered in the quiet room and B represents the scores of the test administered in the room with the high-pitched background noise.

Subject	1	2	3	4	5	6	7	8	9	10	11	12
A	13	12	16	19	7	13	9	15	17	6	14	15
B	18	15	14	18	10	12	11	14	17	8	16	16

Test the hypothesis that the stress level was greater during exposure to high-pitched background noise. Look at the P value. Should you reject the null hypothesis at the 1% level of significance? At the 5% level?

TESTING OF DIFFERENCES OF MEANS (SECTION 10.2 OF *UNDERSTANDING BASIC STATISTICS*)

Tests of difference of means for independent samples are presented in Section 10.2 of *Understanding Basic Statistics*. We consider the $\bar{x}_1 - \bar{x}_2$ distribution. The null hypothesis is that there is no difference between means, so $H_0: \mu_1 = \mu_2$ or $H_0: \mu_1 - \mu_2 = 0$.

When σ_1 and σ_2 are known

When we are testing the difference of means with known σ_1 and σ_2 , the z -test based on normal distribution is used if either the population has a normal distribution or the sample size is large. The values of population variance, which is the square of population standard deviation, are actually needed in the Excel testing procedure dialog box. Some examples used in this section do not provide the values of population standard deviations. In order to demonstrate the use of the testing procedure, we use the sample variance values for the population variance values.

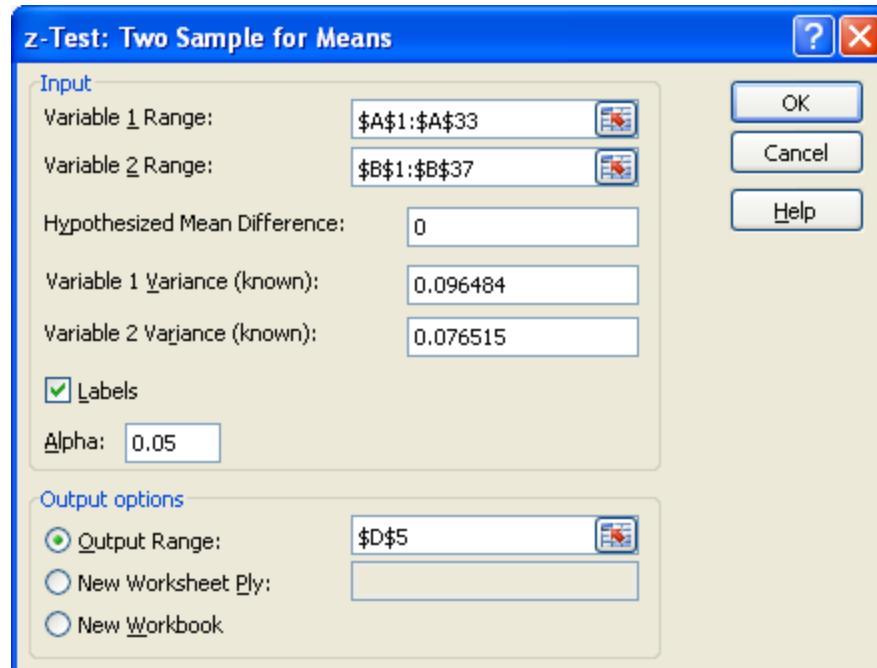
In an Excel worksheet, use Insert Function, and select Statistical in the drop down box, then VAR. We did this to get the variances shown in the next worksheet.

The menu selection >Data>Data Analysis> **z-Test Two Sample for Means** provides the sample z statistic, P values for a one- or two-tailed test, and critical z values for a one- or two-tailed test at the specified level of significance.

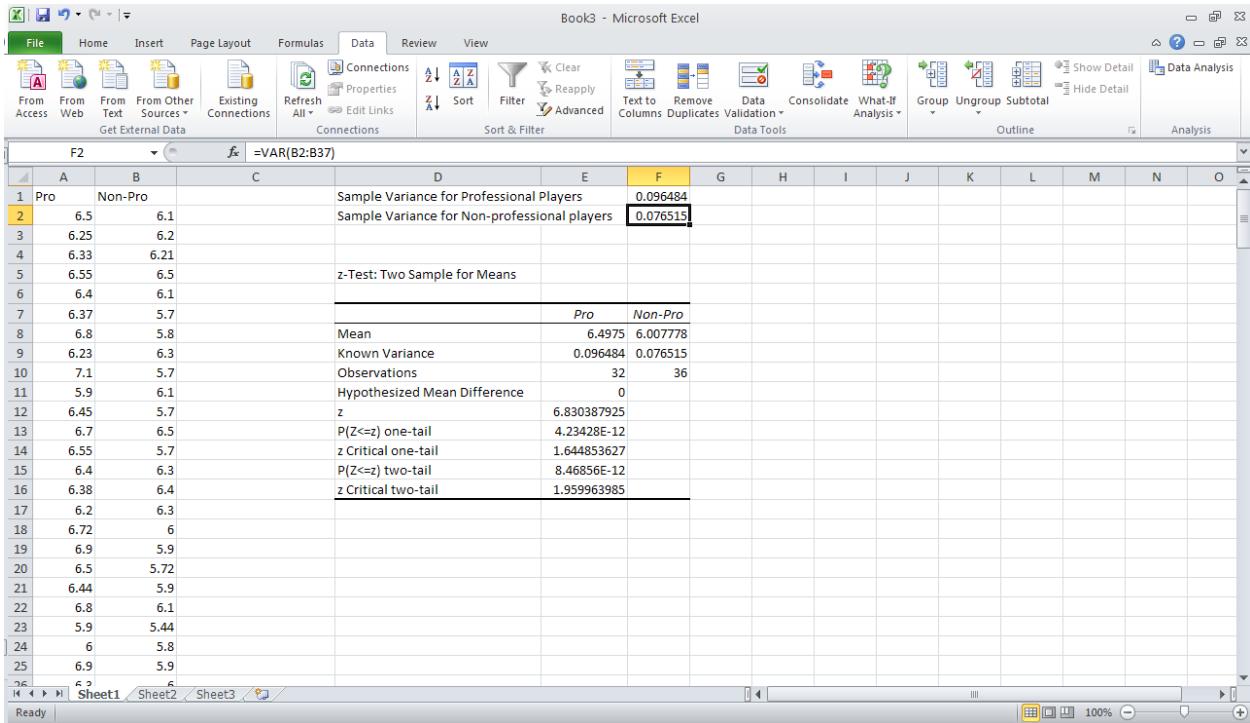
Example

The following data contains heights in feet of 36 randomly selected non-professional basketball players. Let us compare this data with the data given in the previous example, which contains the heights of 32 professional basketball players.

6.1	6.2	6.21	6.5	6.1	5.7	5.8	6.3	5.7
6.1	5.7	6.5	5.7	6.3	6.4	6.3	6	5.9
5.72	5.9	6.1	5.44	5.8	5.9	6.0	5.9	5.5
6.1	6.2	6.3	5.8	6.2	6.4	5.8	5.71	6.0



Click on OK. The result follows.



When σ_1 and σ_2 are unknown

To do a test of difference of sample means when σ_1 and σ_2 are unknown, t-tests are used if either the population has approximately a normal distribution or the sample size is large. If we assume that the samples come from populations with the same standard deviation, use **>Data>Data Analysis> t-Test: Two-Sample Assuming Equal Variances**. If we believe that population standard deviations are not equal, use **>Data>Data Analysis> t-Test: Two-Sample Assuming Unequal Variances**.

Example

Sellers of microwave French fry cookers claim that their process saves cooking time. The McDougle Fast Food Chain is considering the purchase of these new cookers, but wants to test the claim.

Six batches of French fries were cooked in the traditional way. The cooking times (in minutes) were

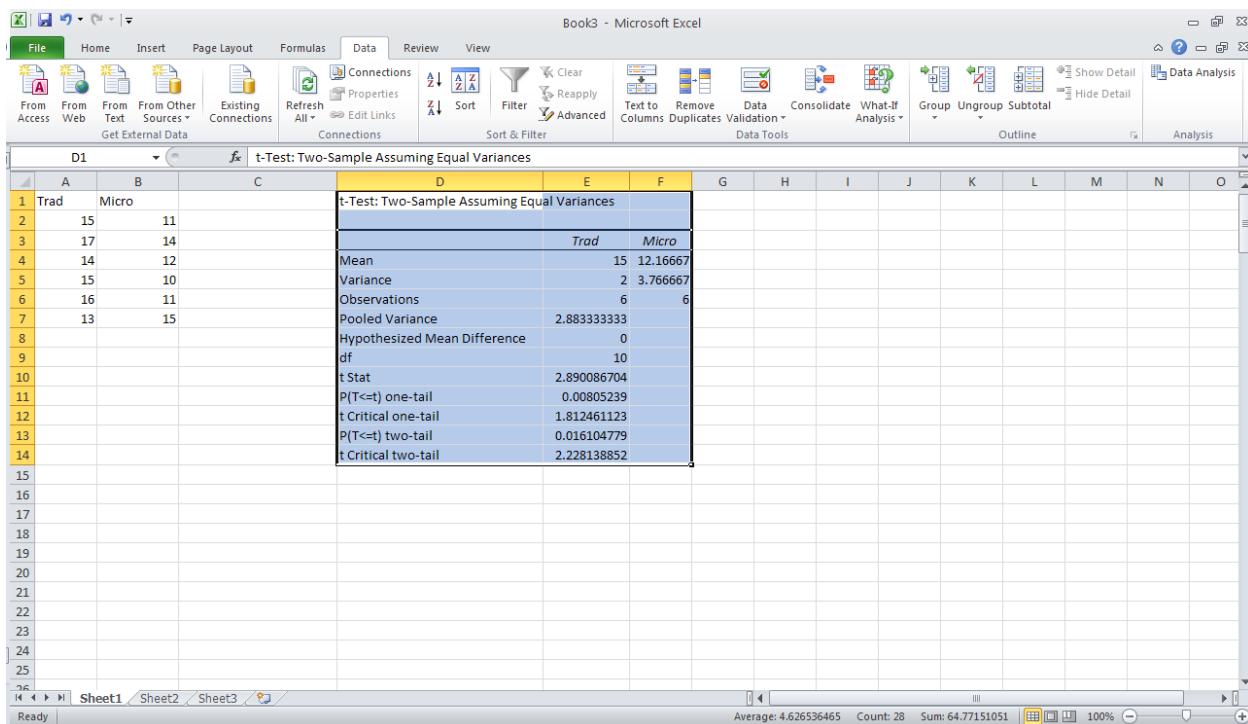
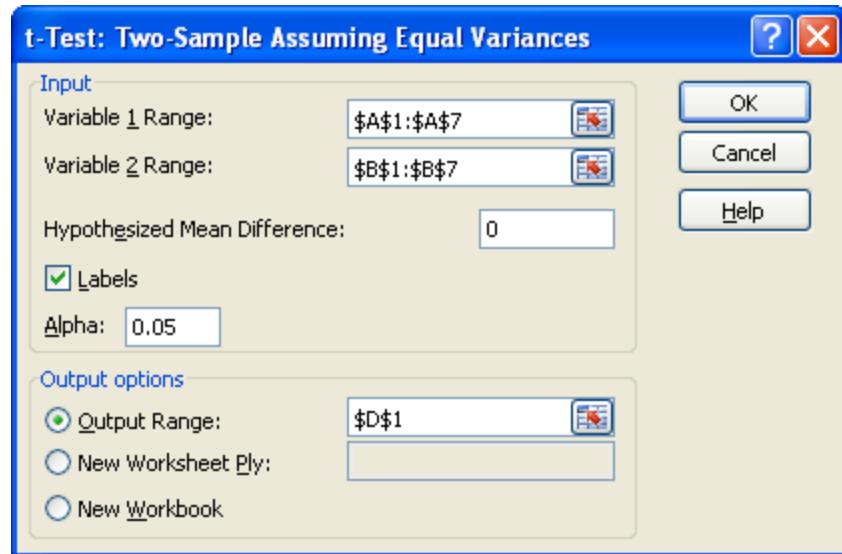
15 17 14 15 16 13

Six batches of French fries of the same weight were cooked using the new microwave cooker. These cooking times (in minutes) were

11 14 12 10 11 15

Let us assume that both populations are approximately normal with equal standard deviation. Test the claim that the microwave process takes less time. Use $\alpha = 0.05$.

We will enter the traditional data in Column A and the new data in Column B. Then we use **>Data>Data Analysis>t-Test: Two-Sample Assuming Equal Variances**. The hypothesized mean difference is zero.



We see that the p value for a one-tail test is 0.00805. Since this value is less than 0.05, we reject the null hypothesis and conclude that the new method takes less time on average.

LAB ACTIVITIES FOR TESTING DIFFERENCES OF MEANS

1. Calm Cough Medicine is testing a new ingredient to see if its addition will lengthen the effective cough relief time of a single dose. A random sample of fifteen doses of the standard medicine was tested, and the effective relief times (in minutes) were

42	35	40	32	30	26	51	39	33	28
37	22	36	33	41					

Then a random sample of twenty doses with the new ingredient was tested. The effective relief times (in minutes) were

43	51	35	49	32	29	42	38	45	74
31	31	46	36	33	45	30	32	41	25

Assume that the standard deviations of the relief times are equal for the two populations. Also assume that both populations are approximately normal. Test the claim that the effective relief time is longer when the new ingredient is added. Use $\alpha = 0.01$.

2. Retrieve the worksheet Tvis06.xls from the student website. The data represent numbers of cases of red fox rabies for a random sample of sixteen areas in each of two different regions of southern Germany.

Number of Cases in Region 1

10	2	2	5	3	4	3	3	4	0	2	6	4	8	7	4
----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Number of Cases in Region 2

1	1	2	1	3	9	2	2	4	5	4	2	2	0	0	2
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Test the hypothesis that the average number of cases in Region 1 is greater than the average number of cases in Region 2. Use a 1% level of significance. Assume that both populations are approximately normal and have equal standard deviations.

3. Retrieve the Excel worksheet Tvis02.xls from the data student website. The data represent the petal length (in centimeters) for a random sample of 35 *Iris Virginica* plants and for a random sample of 38 *Iris Setosa* plants (source: Anderson, E., Bulletin of American Iris Society).

Petal Length of *Iris Virginica*

5.1	5.8	6.3	6.1	5.1	5.5	5.3	5.5	6.9	5.0	4.9	6.0	4.8	6.1	5.6	5.1
5.6	4.8	5.4	5.1	5.1	5.9	5.2	5.7	5.4	4.5	6.1	5.3	5.5	6.7	5.7	4.9
4.8	5.8	5.1													

Petal Length of *Iris Setosa*

1.5	1.7	1.4	1.5	1.5	1.6	1.4	1.1	1.2	1.4	1.7	1.0	1.7	1.9	1.6	1.4
1.5	1.4	1.2	1.3	1.5	1.3	1.6	1.9	1.4	1.6	1.5	1.4	1.6	1.2	1.9	1.5
1.6	1.4	1.3	1.7	1.5	1.7										

Test the hypothesis that the average petal length for *Iris Setosa* is shorter than the average petal length for *Iris Virginica*. Assume that population standard deviations are unequal.

CHAPTER 11: ADDITIONAL TOPICS USING INFERENCE

CHI-SQUARE TEST OF INDEPENDENCE (SECTION 11.1 OF *UNDERSTANDING BASIC STATISTICS*)

Use of the chi-square distribution to test independence is discussed in Section 11.1 of *Understanding Basic Statistics*. In such tests we use hypotheses

- H_0 : The variables are independent
 H_1 : The variables are not independent

In Excel, the applicable command (accessed using the Insert Function button) is

CHISQ.TEST(set of observed values, set of expected values)

which returns the P value of the sample χ^2 value, where the sample χ^2 value is computed as

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Here, E stands for the expected count in a cell, and O stands for the observed count in that same cell. The sum is taken over all cells.

In our Excel worksheet, we first enter in the contingency table of observed values. If the table does not contain column sums or row sums, use the Sum button on the tool bar to generate the sums. We need to create the table of expected values, where the expected value E for a cell is

$$E = (\text{column total}) \left(\frac{\text{row total}}{\text{grand total}} \right)$$

By careful use of absolute and relative cell references, we can type the formula once and then copy it to different positions in the contingency table of expected values. Recall that an absolute cell reference has \$ symbols preceding the column and row designators.

Example

A computer programming aptitude test has been developed for high school seniors. The test designers claim that scores on the test are independent of the type of school the student attends: rural, suburban, urban. A study involving a random sample of students from these types of institutions yielded the following contingency table. Use the CHISQ.TEST command to compute the P value of the sample chi-square value. Then determine if type of school and test score are independent at the $\alpha = 0.05$ level of significance.

Score	School Type		
	Rural	Suburban	Urban
200-299	33	65	83
300-399	45	79	95
400-500	21	47	63

First we enter the table into a worksheet and use the sum button on the standard toolbar to generate the column, row, and grand total sums.

The screenshot shows a Microsoft Excel spreadsheet titled "Book3 - Microsoft Excel". The ribbon is visible at the top with tabs for File, Home, Insert, Page Layout, Formulas, Data, Review, and View. The "Formulas" tab is selected. The formula bar shows "fx". The main area contains a table with the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	Observed Values																	
2	Score	Rural	Suburban	Urban	Row Total													
3	200-299		33	65	83	181												
4	300-399		45	79	95	219												
5	400-500		21	47	63	131												
6	Col Total		99	191	241	531												
7																		
8																		
9																		
10																		
11																		
12																		
13																		
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24																		
25																		
26																		

The formula bar shows "fx". The status bar at the bottom right says "Ready" and "100%".

Next we create the contingency table of expected values, where the expected value for Cell B3 will go in Cell H3. Notice that in the formula

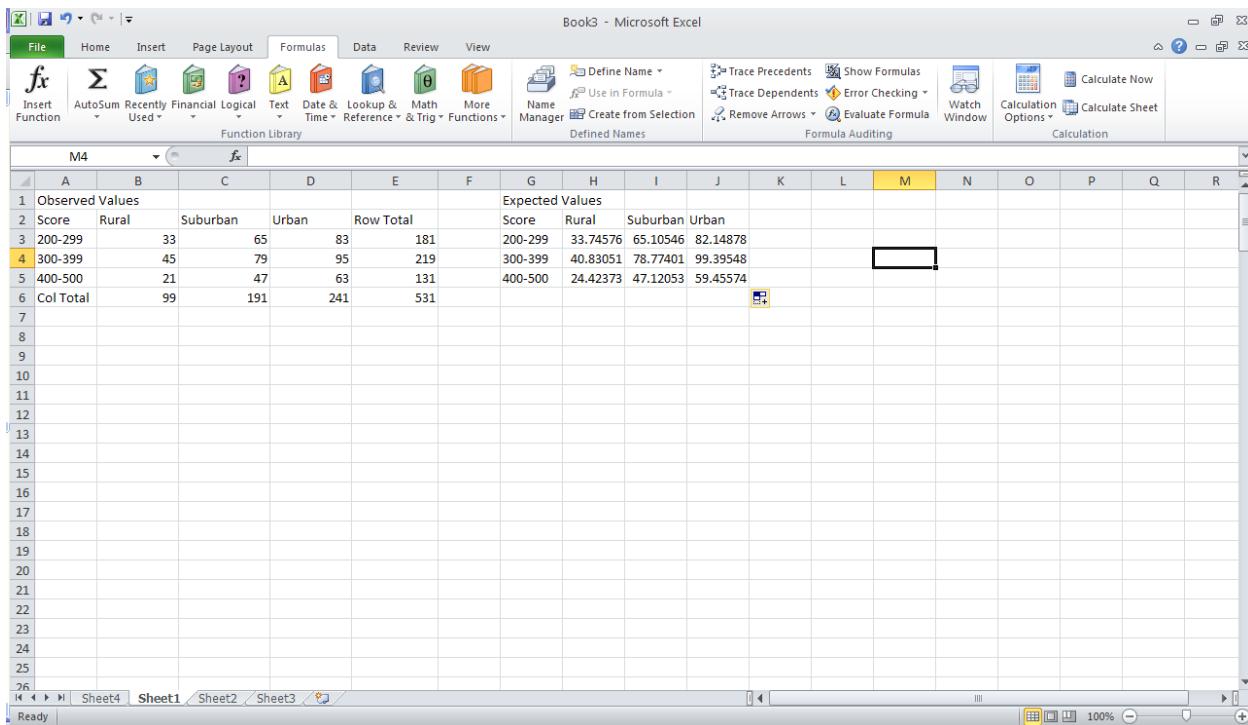
$$E = (\text{row total}) \left(\frac{\text{row total}}{\text{grand total}} \right)$$

The grand total stays the same for each expected value. The grand total is in Cell E6. Since we want this to be an absolute address used in each computation, we use the cell label \$E\$6. (Alternatively, we could just type in the grand total of 531 in the formula bar.) The column totals are all in Row 6, so when we refer to a column total, we will fix the row address by using \$6 and let the column names vary. The row totals are all in Column E, so we will fix the column address as \$E and let the row address vary when we use row totals. So the formula as entered in Cell H3 should be

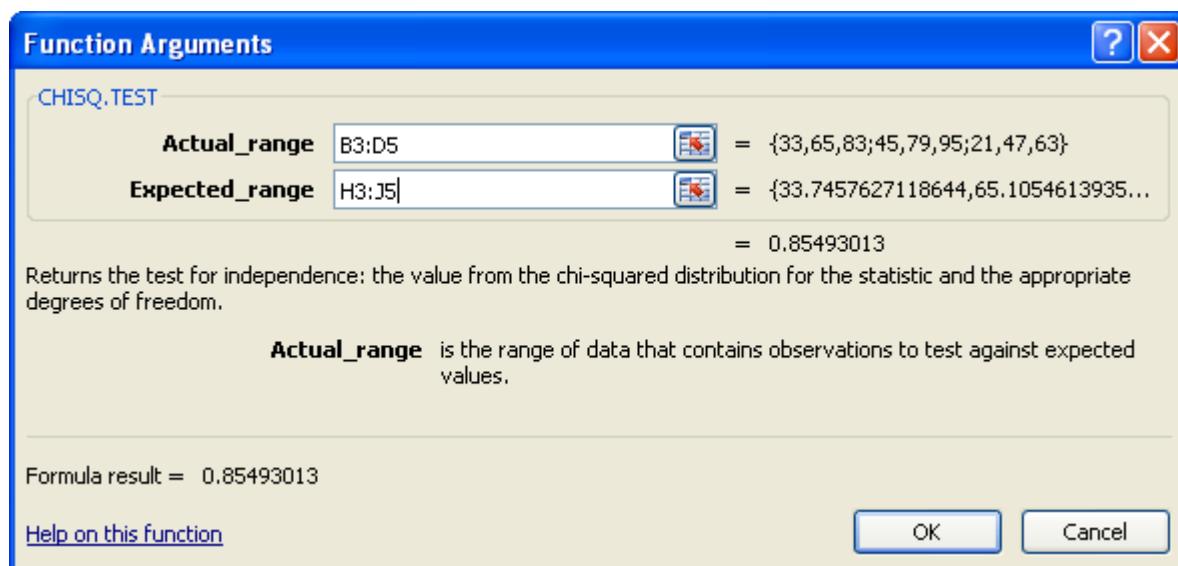
$$= B\$6*(E3/\$E\$6)$$

Now move the cursor to the lower right corner of Cell H3. When the small + appears, drag it to the lower right corner of cell J5. The calculations for all the cells will automatically be done.

We now have both the observed values and the expected values.



Now use the CHISQ.TEST command. After clicking the Insert Function button on the tool bar, select the CHISQ.TEST function and, in the dialog box that appears, enter the required ranges of values as shown.



The resulting P value is 0.8549. Place appropriate labels on the worksheet.

The screenshot shows a Microsoft Excel spreadsheet titled "Book3 - Microsoft Excel". The "Formulas" tab is active. The data is organized into two tables: "Observed Values" and "Expected Values". The "Observed Values" table has columns for Score (200-299, 300-399, 400-500) and Rural, Suburban, Urban locations. The "Expected Values" table has columns for Score (200-299, 300-399, 400-500) and Rural, Suburban, Urban locations. Cell D11 contains the formula =CHISQ.TEST(Observed!A1:D6, Expected!A1:D6). The value 0.85493013 is displayed in cell D11.

Since the P value is greater than $\alpha = 0.05$, we do not reject the null hypothesis. There is insufficient evidence to conclude that school type and test scores are not independent. Intuitively, we can confirm this by observing that the values we would expect, assuming independence (the values in the right table) are not very different from the values observed (the values in the left table).

LAB ACTIVITIES FOR CHI-SQUARE TEST OF INDEPENDENCE

In each activity, enter the contingency tables into a worksheet, then use the Sum button to generate the required row and column sums. Create a table of expected values. Finally, use CHISQ.TEST to find the P value of the sample statistic and draw the appropriate conclusion.

1. We Care Auto Insurance had its staff of actuaries conduct a study to see if vehicle type and loss claim are independent. A random sample of auto claims over the first six months gives the information in this contingency table.

		Total Loss Claims per Year per Vehicle			
Type of Vehicle		\$0-999	\$1000-2999	\$3000-5900	\$6000+
Sports Car		20	10	16	8
Truck		161	25	33	9
Family Sedan		40	68	17	7
Compact		52	73	48	12

Test the claim that car type and loss claim are independent. Use $\alpha = 0.05$.

2. An educational specialist is interested in comparing three methods of instruction:

SL - standard lecture with discussion

TV - video taped lectures with no discussion

IM - individualized method with reading assignments and tutoring, but no lectures

The specialist conducted a study of these three methods to see if they were independent. A course was taught using each of the three methods, and a standard final exam given at the end. Students were put into the different method sections at random. The course type and test results are shown in the contingency table below.

Course Type	Final Exam Score				
	<60	60-69	70-79	80-89	90-100
SL	10	4	70	31	25
TV	8	3	62	27	23
IM	7	2	58	25	22

Test the claim that the instruction method and final exam test scores are independent, using $\alpha = 0.01$.

Note: If you have raw data entered in columns, you can use the Pivot Wizard to construct a contingency table. See the Excel help menu or other manuals for details.

INFERENCE FOR REGRESSION (SECTION 11.4 OF *UNDERSTANDING BASIC STATISTICS*)

Example

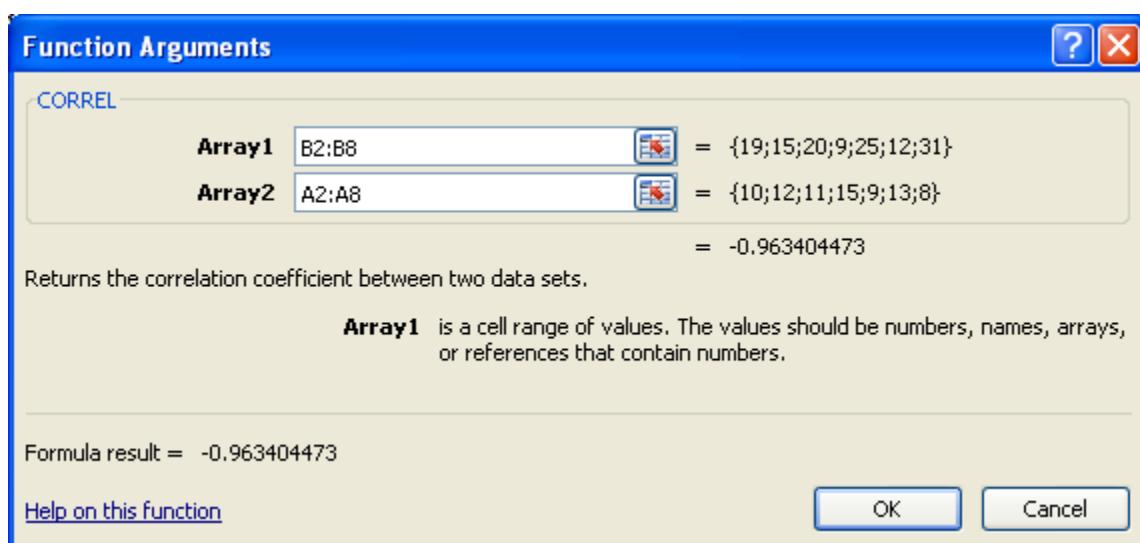
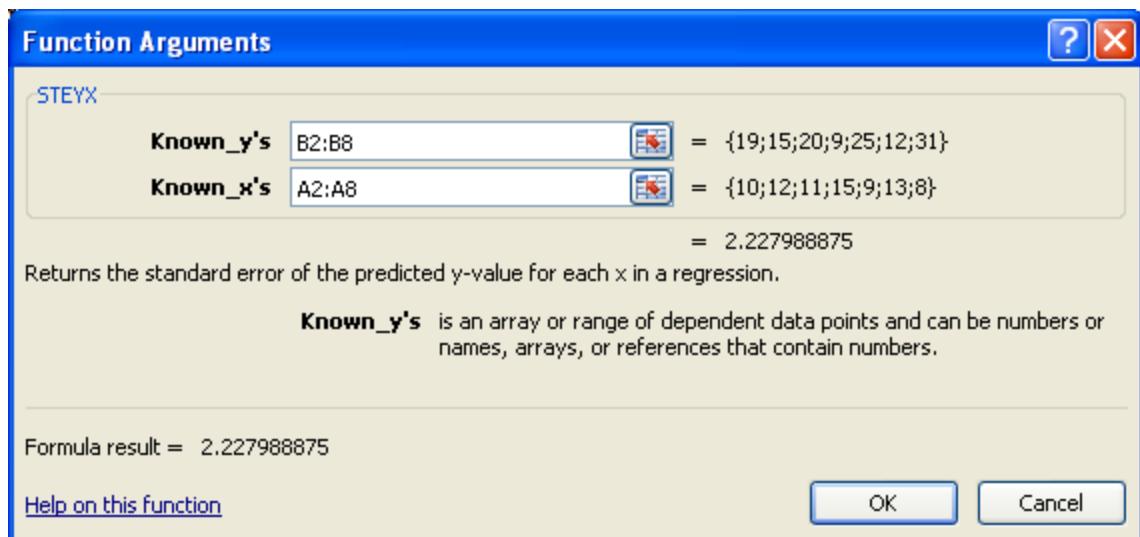
In retailing, merchandise loss due to shoplifting, damage, and other causes is called shrinkage. The managers at H.R. Merchandise think that there is a relationship between shrinkage and the number of clerks on duty. To explore this relationship, a random sample of seven weeks was selected. During each week, the staffing level of sales clerks was held constant and the dollar value (in hundreds of dollars) of the shrinkage was recorded.

<u>X</u>	10	12	11	15	9	13	8	Staffing level
<u>Y</u>	19	15	20	9	25	12	31	(in hundreds)

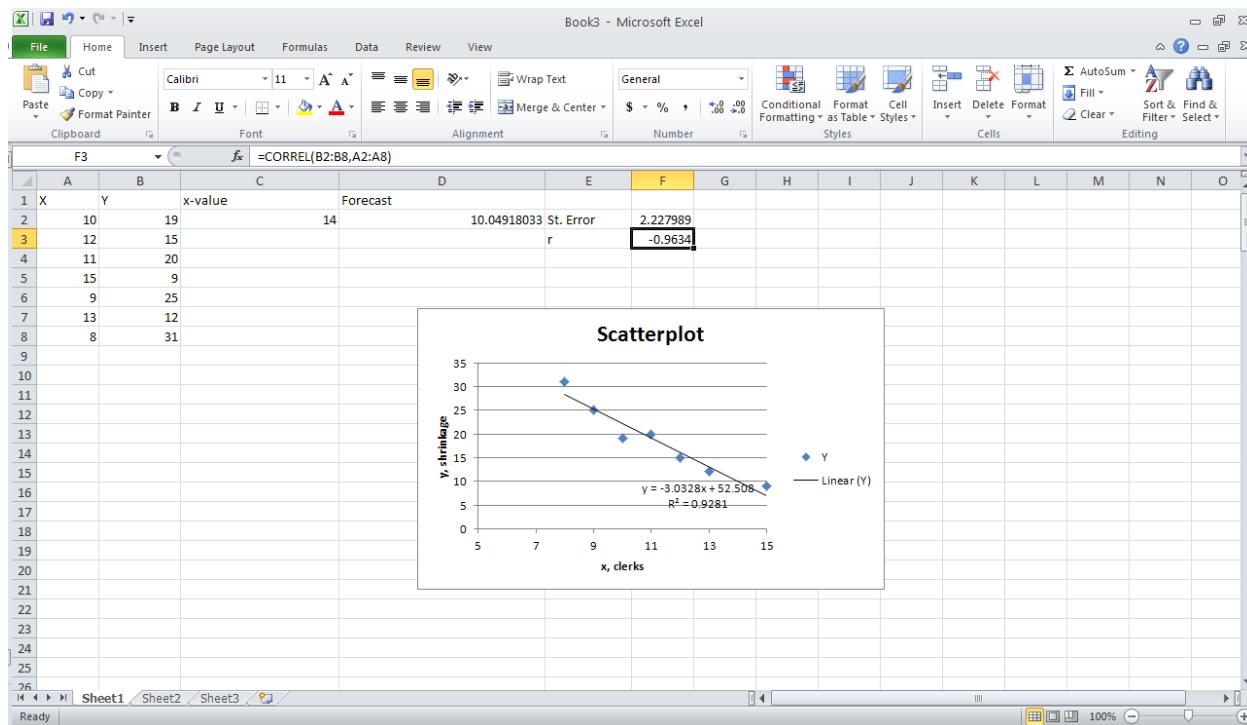
Open a worksheet. Place the X values in Column A with a corresponding label and the Y values in Column B.

Find the standard error of estimate and the value of r

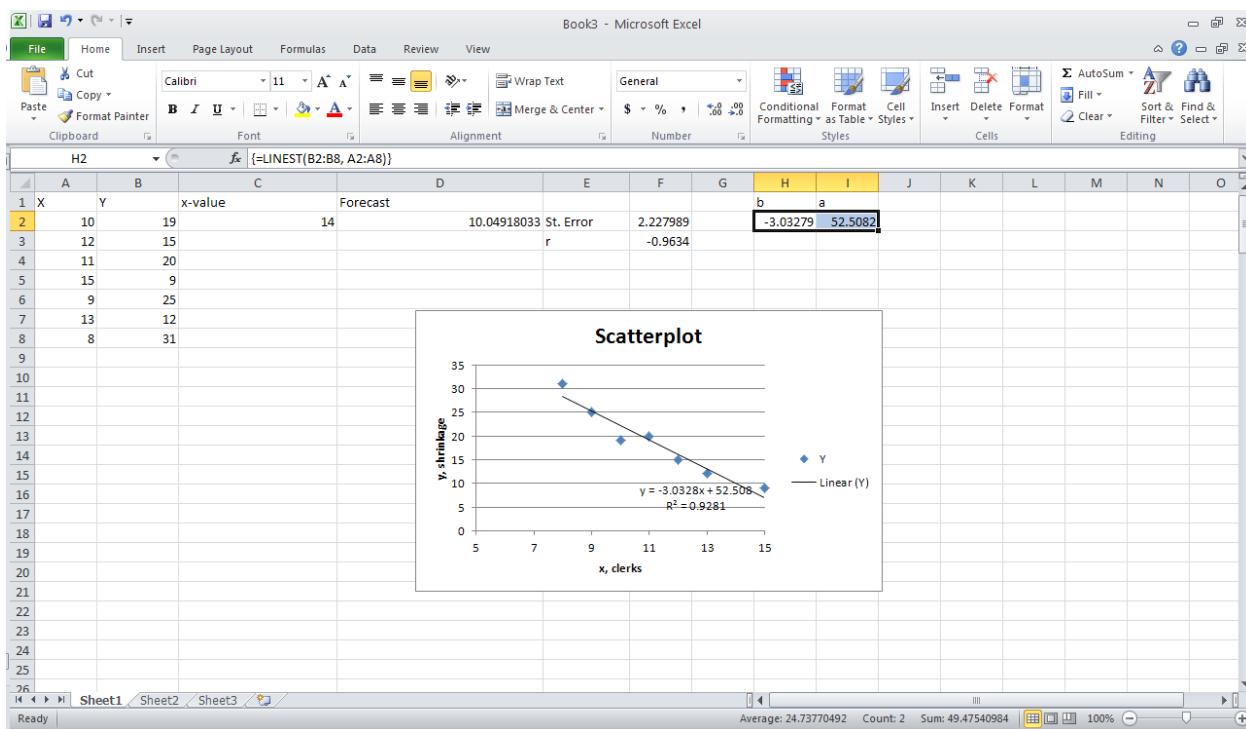
We use Insert Function, Statistical and select STEYX and CORREL to find the standard error and the correlation coefficient.



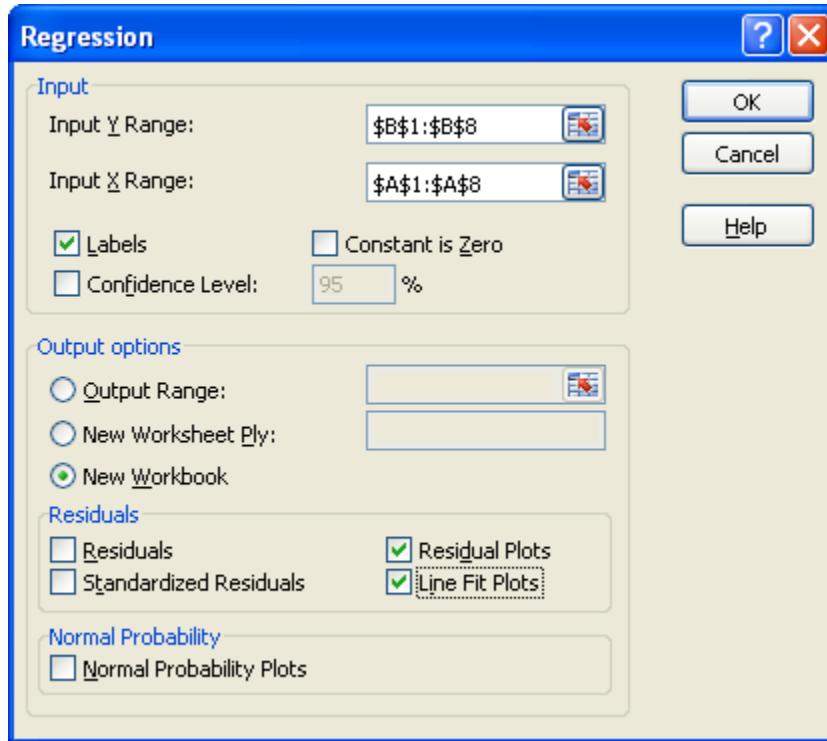
This worksheet shows the results.



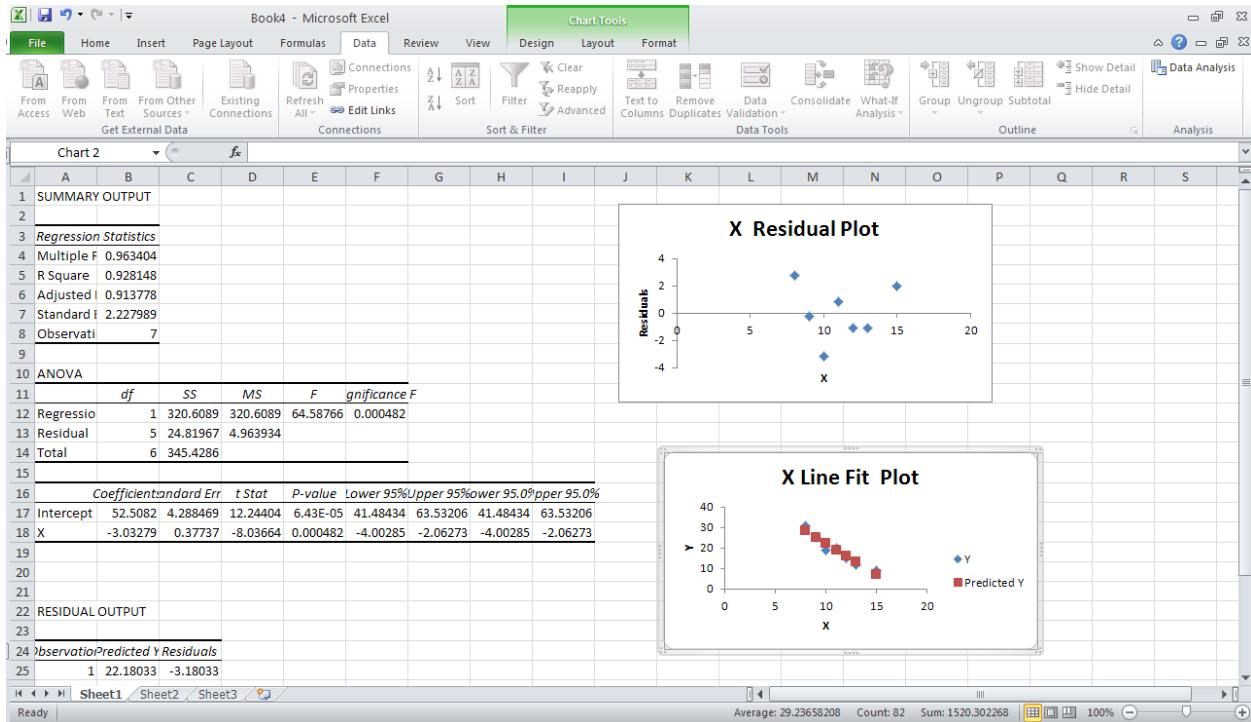
If we want to obtain the values of b and a in the least-squares line without using a graph, we can use LINEST(y range, x range). Activate *two* cells on the worksheet. Type =LINEST(B2:B8,A2:A8) in the formula bar, and press **Ctrl+Shift+Enter** to generate the values of both b and a .



To run inference for regression, we use >Data>Data Analysis>Regression.



We checked Residuals Plot and Line Fit Plot. Notice that the output goes to a new worksheet.



The output shows the value of the t-statistic for the inference test for the slope along with its p-value. Scrolling down would show the rest of the residual output.

LAB ACTIVITIES FOR TWO-VARIABLE LINEAR REGRESSION

5. Open or retrieve the worksheet Slr01.xls from the student website. This worksheet contains the following data, with the list price in Column C1 and the best price in Column C2. The best price is the best price negotiated by a team from the magazine.

LIST PRICE VERSUS BEST PRICE FOR A NEW GMC PICKUP TRUCK

In the following data pairs (X, Y),

X = List Price (in \$1000) for a GMC Pickup Truck

Y = Best Price (in \$1000) for a GMC Pickup Truck

Source: Consumers Digest, February 1994

(12.400, 11.200)	(14.300, 12.500)	(14.500, 12.700)
(14.900, 13.100)	(16.100, 14.100)	(16.900, 14.800)
(16.500, 14.400)	(15.400, 13.400)	(17.000, 14.900)
(17.900, 15.600)	(18.800, 16.400)	(20.300, 17.700)
(22.400, 19.600)	(19.400, 16.900)	(15.500, 14.000)
(16.700, 14.600)	(17.300, 15.100)	(18.400, 16.100)
(19.200, 16.800)	(17.400, 15.200)	(19.500, 17.000)
(19.700, 17.200)	(21.200, 18.600)	

- (d) Use Excel to create a scatter plot for the data
- (e) Right-click on a data point and use the Add Trendline option to show the least-squares line on the scatter diagram, along with its equation and the value of r^2 .
- (f) What is the value of the standard error of estimate? (Use STEYX.)
- (g) What is the value of the correlation coefficient r ? (Use CORREL.)
- (h) Use the least-squares model to predict the best price for a truck with a list price of \$20,000. Note: Enter this value as 20, since X is assumed to be in thousands of dollars. (Use FORECAST.)
6. Other Excel worksheets appropriate to use for simple linear regression are:

Cricket Chirps Versus Temperature: Slr02.xls

Source: *The Song of Insects* by Dr. G.W. Pierce, Harvard Press

The chirps per second for the striped grouped cricket are stored in C1; the corresponding temperature in degrees Fahrenheit is stored in C2.

Diameter of Sand Granules Versus Slope on a Natural Occurring Ocean Beach: Slr03.xls

Source *Physical Geography* by A.M. King, Oxford press

The median diameter (MM) of granules of sand is stored in C1; the corresponding gradient of beach slope in degrees is stored in C2.

National Unemployment Rate Male Versus Female: Slr04.xls

Source: *Statistical Abstract of the United States*

The national unemployment rate for adult males is stored in C1; the corresponding unemployment rate for adult females for the same period of time is stored in C2.

Select these worksheets and repeat Parts (a)-(d) of Problem 1, using Column A as the explanatory variable and Column B as the response variable.

7. A psychologist studying the correlation between interruptions and job stress rated a group of jobs for interruption level. She selected a random sample of twelve people holding jobs from among those rated, and analyzed the people's stress level. The results follow, with X being interruption level of the job on a scale of 1 (fewest interruptions) to 20 and Y the stress level on a scale of 1 (lowest stress) to 50.

Person	1	2	3	4	5	6	7	8	9	10	11	12
X	9	15	12	18	20	9	5	3	17	12	17	6
Y	20	37	45	42	35	40	20	10	15	39	32	25

- (d) Enter the X values into Column A and the Y values into Column B.
 - (e) Follow parts (a) through (d) of Problem 1 using the X values as the explanatory data values and the Y values as response data values.
 - (f) Redo Part (b). This time change the X values to the response data values and the Y values to the explanatory data values (i.e. exchange headers for the X and Y columns) How does the scatter diagram compare? How does the least-squares equation compare? How does the correlation coefficient compare? How does the standard error of estimate compare? Does it seem to make a difference which variable is the response variable and which is the explanatory variable?
8. The researcher in Problem 3 was able to add to her data. Another eleven randomly sampled people had their jobs rated for interruption level and were then evaluated for stress level.

Person	13	14	15	16	17	18	19	20	21	22	23
X	4	15	19	13	10	9	3	11	12	15	4
Y	20	35	42	37	40	23	15	32	28	38	12

Add this data to the data in problem 3, and repeat Parts (a) and (b). Be sure the label column A as the X values and column B as the Y values. Compare the new standard error of estimate with the old one. Does more data tend to reduce the value of standard error of estimate? What about the value of r ?

TABLE OF EXCEL FUNCTIONS

DESCRIPTIVE STATISTICS

These functions can be entered by using the Insert Function button on the standard toolbar, or by directly typing the function into the formula bar.

- =**AVERAGE**(cells containing data) returns the arithmetic mean of data.
- =**COUNT**(cells containing data) returns the number of data items.
- =**COUNTIF**(cells containing data,criteria) returns the number of data items satisfying the criteria.
- =**MAX**(cells containing data) returns the maximum value in the data.
- =**MEDIAN**(cells containing data) returns the median value of the data.
- =**MIN**(cells containing data) returns the minimum value in the data.
- =**MODE**(cells containing data) returns the mode of the data.
- =**QUARTILE**(cells containing data,quartile) returns the indicated quartile of the data.
- =**STDEV**(cells containing data) returns the sample standard deviation of the data.
- =**STDEVP**(cells containing data) returns the population standard deviation of the data.
- =**TRIMMEAN**(cells containing data,percent) returns the mean of the data trimmed by the total indicated percent, half from the bottom and half from the top.
- =**VAR**(cells containing data) returns the sample variance of the data.
- =**VARP**(cells containing data) returns the population variance of the data.

Dialog boxes found using the menu selections >**Data>Data Analysis>Descriptive Statistics** dialog box with Summary Statistics checked returns the mean standard error of mean, median, mode, standard deviation, variance, kurtosis, skewness, range, minimum, maximum, sum, and count of the data. Checking the confidence level box returns the error E for a confidence interval $\bar{x} - E$ to $\bar{x} + E$ at the designated confidence level.

GRAPHICS

Use the Insert Ribbon to create graphs for column charts (bar graphs), pie charts circle graphs), line graphs (for time series), or scatter diagrams. Right-click a data point and click Add trend line to show a regression line and formula. Use >**Data>Data Analysis>Histogram** to open the histogram dialog box.

RANDOM SAMPLES

Use the Insert Function button on the standard tool bar or type directly.

- =**RAND()** returns a random number between 0 and 1.
- =**RANDBETWEEN(bottom,top)** returns a random number between the designated values.

Use the menu selection >**Data>Data Analysis** to access the dialog box.

- Sampling** returns a random sample from a designated cell range.
- Random Number Generator** returns a random sample from a designated distribution (uniform, normal, binomial, poisson, patterned, discrete).

PROBABILITY

Use the Insert Function button on the standard tool bar or type directly.

=BINOM.DIST(# of success,# of trials,probability of success,cumulative)

Returns the probability of exactly r success if the value of cumulative is false. The probability of at most r successes if the value of cumulative is true.

=CHI.DIST(x degrees of freedom)

Returns the area to the right of x under a chi-square distribution with the designated degrees of freedom. The area is the probability that a value is greater than or equal to x .

=CHI.INV(probability,degrees of freedom)

Returns the chi-square value x such that the probability that a value falls to the right of x is the designated probability.

=F.DIST(x,degrees of freedom numerator,degrees of freedom denominator)

Returns area in the right tail of the distribution beyond x .

=F.INV(probability,degrees of freedom numerator,degrees of freedom denominator)

Returns the value x such that the probability of a value falling to the right of x is the designated probability.

=HYPGEOM.DIST(# of success in sample,size of sample,number of successes in population,population size)

Returns the probability that the designated number of successes in the sample occurs.

=NORM.DIST(x,mean,standard deviation,cumulative)

Returns the probability that a value is less than or equal to x for true as the value of cumulative.

Returns the density function value of x for false as the value of cumulative.

=NORM.INV(probability,mean,standard deviation)

Returns the x value such that the area under the normal distribution to the left of x equals the designated probability.

=NORM.S.DIST(z)

Returns the area to the left of z under the standard normal.

=NORM.S.INV(probability)

Returns the z value such that the area to the left of z is equal to the specified probability.

=POISSON(x,mean,cumulative)

Returns the probability that the number of random events occurring will be between zero and x inclusive when the value of cumulative is true.

The density function value that the number of events occurring will be exactly x when the value of cumulative is false

=T.DIST(x,degrees of freedom)

Returns the area in the tail to the right of x when the value of tails is 1.

=T.DIST.2T(x,degrees of freedom)

Returns the area in the tail of Student's t distribution beyond the specified value of x , for the specified number of degrees of freedom and two tails.

=T.INV(probability, degrees of freedom)

Returns the t_c value such that the area in the left tail beyond the t_c value equals the specified probability for the specified degrees of freedom.

=T.INV.2T(probability, degrees of freedom)

Returns the t_c value such that the area in the two tails beyond the t_c value equals the specified probability for the specified degrees of freedom.

CONFIDENCE INTERVAL

Use Insert Function or type directly.

=CONFIDENCE(alpha,standard deviation,size) returns the value of E in the confidence interval for a mean \bar{x} - E to $\bar{x} + E$. The confidence level equals $100(1-\alpha)\%$. The value of E is computed using a normal distribution.

Confidence intervals for other parameters are included in some of the outputs for certain dialog boxes contained in the >Data>Data Analysis choices.

HYPOTHESIS TESTING

Use the Insert Function on the standard tool bar or type directly

=CHISQ.TEST(observed value data cells,expected value data cells)

Returns the P value of the sample chi-square statistics for a test of independence.

=F.TEST(cells containing the data of first sample,cells containing data of second sample)

Returns P value for a two-tailed test of variances.

=T.TEST(cells containing first sample,cells containing second sample,tails,type)

Returns the P value of a one-tailed test if the value of tails is 1 and a two-tailed test if the value of tails is 2.

The type of test performed is as follows:

type = 1: a paired test is performed.

type = 2: a two-sample equal variance test is performed.

type = 3: a two-sample unequal variance test is performed.

=Z.TEST(cells containing data,x,sigma)

Returns the P value for a right tailed test where $H_0: \mu = x$ is the null hypothesis and $H_1: \mu > x$ is the alternate hypothesis. For sigma, use the population standard deviation, if it is known. Otherwise leave out sigma, and Excel will use the sample standard deviation computed from the data. The normal distribution is the sampling distribution used.

These dialog boxes are under the menu choice >Data>Data Analysis.

F-Test: Two Sample for Variances

Returns the P value for a one-tailed test as well as some summary statistics for the data.

t-Test: Paired Two Sample for Means

Returns P values for a one-tailed test and P values for a two-tailed test, the t value of the sample test statistic, critical one-tail or two-tail values, and summary statistics for the data.

t-Test: Two-Sample Assuming Equal Variances

Returns P values for a one-tailed test and P values for a two-tailed test, the t value of the sample test statistic, critical one-tailed or two-tailed values, and summary statistics for the data.

t-Test: Two-Sample Assuming Unequal Variances

Returns P values for a one-tailed test and P values for a two-tailed test, the t value of the sample test statistic, critical one-tailed or two-tailed values, and summary statistics for the data.

z-Test: Two-Sample for Means

Returns P values for a one-tailed test and P values for a two-tailed test, the z value of the sample test statistic, critical one-tailed or two-tailed values, and summary statistics for the data.

ANALYSIS OF VARIANCE

These dialog boxes are under the menu choice >Data>Data Analysis.

Anova: Single Factor

Anova: Two-Factor With Replication (equal number greater than 1 of measurements per factor combination)

Anova: Two-Factor Without Replication (one measurement per factor combination)

Each of these dialog boxes returns summary statistics for the factors and a summary table giving degrees of freedom, sum of squares, mean squares, F values, P values.

LINEAR REGRESSION

Use Insert Function on the standard tool bar or type the command directly into the formula bar.

=CORREL(y range,x range)

Returns the correlation coefficient r between two data sets.

=FORECAST(x value,y range,x range)

Returns the y value for the specified x as computed using the least-squares regression equation.

=INTERCEPT(y range,x range)

Returns the y -intercept of the least -squares regression line.

=LINEST(y range,x range)

Returns the slope and y -intercept of the least-squares line. (We are ignoring two optional parameters.) Since this is an array formula, two cells need to be activated to receive the output. The command needs to be typed into the formula bar and entered with the **Ctrl+Shift+Enter** combination.

=PEARSON(y range,x range)

Returns the Pearson product moment correlation coefficient r for the two data sets.

=RSQ(y range,x range)

Returns r^2 (the square of the Pearson product moment correlation coefficient).

=SLOPE(y range,x range)

Returns the slope of the least-squares line.

=STEXY(y range,x range)

Returns the standard error of estimate for the predicted y value.

These dialog boxes are under the menu choice >**Data>Data Analysis**.

Correlation

Returns the correlation between all variables in a multiple linear regression model.

Regression

Returns the coefficients for a simple or multiple linear regression model. Other options provide for a table of residuals, a residual plot, a line fit plot, a normal probability plot, and an ANOVA table. An output table including coefficients, standard error of y estimates, r^2 values, number of observations, and standard error of coefficients is provided.

MISCELLANEOUS

Under the Insert Function button on the standard menu bar:

=STANDARDIZE(x,mean,standard deviation)

Returns the z value for the specified x value.

On the tool bars:

Σ button: gives the sum of the selected cells

Sort buttons: sort data in increasing or decreasing order

\$ button: formats numbers in selected cells in dollar and cent format

% button: formats numbers in selected cells to percents

, button: puts numbers in selected cells in comma format

$\leftarrow .0$ button: formats numbers in selected cells with one more digit after the decimal each time the button is pushed

$\rightarrow .00$ button: formats numbers in selected cells with one less digit after the decimal each time the button is pushed

Appendix: Descriptions of Data Sets on the Student Website

Preface

There are over 70 data sets saved in Excel, Minitab Portable, SPSS, TI-83 Plus, TI-84 Plus, TI-Nspire/ASCII formats to accompany *Understanding Statistics*, 6th edition. These files can be found on the Brase/Brase statistics site at <http://www.cengage.com/statistics/brase>. The data sets are organized by category.

- A. The following are provided for each data set:
 - 1. The category
 - 2. A brief description of the data and variables with a reference when appropriate
 - 3. File names for Excel, Minitab, SPSS, and TI-83 Plus, TI-84 Plus, TI-Nspire/ASCII formats
- B. The categories are
 - 1. **Single variable large and small sample**
File name prefix **Sv** followed by the data set number
42 data sets.....page A-4
 - 2. **Two variable independent samples** (large and small sample)
File name prefix **Tvis** followed by the data set number
10 data sets.....page A-21
 - 3. **Two variable dependent samples** appropriate for *t*-tests
File name prefix **Tveds** followed by the data set number
10 data sets.....page A-26
 - 4. **Simple linear regression**
File name prefix **Slr** followed by the data set number
12 data sets.....page A-30
- C. The formats are
 - 1. Excel files in subdirectory **Excel_10e**. These files have suffix **.xls**
 - 2. Minitab portable files in subdirectory **Minitab_10e**. These files have suffix **.zip**
 - 3. TI-83 Plus and TI-84 Plus/ASCII files in subdirectory **TI8384_10e**. These files have suffix **.zip**
 - 4. SPSS files in subdirectory **SPSS_10e**. These files have suffix **.zip**

Suggestions for Using the Data Sets

- 1. Single variable large and small sample (file name prefix **Sv**)
These data sets are appropriate for:
Graphs: Histograms, box plots
Descriptive statistics: Mean, median, mode, variance, standard deviation, coefficient of variation, 5 number summary
Inferential statistics: Confidence intervals for the population mean, hypothesis tests of a single mean

2. Two independent data sets (file name prefix Tvis)

Graphs: Histograms, box plots for each data set

Descriptive statistics: Mean, median, mode, variance, standard deviation, coefficient of variation, 5-number summary for each data set

Inferential statistics: Confidence intervals for the difference of means, hypothesis tests for the difference of means

3. Paired data, dependent samples (file name prefix Tvcds)

Descriptive statistics: Mean, median, mode, variance, standard deviation, coefficient of variation, 5 number summary for the difference of the paired data values.

Inferential statistics: Hypothesis tests for the difference of means (paired data)

4. Data pairs for simple linear regression (file name prefix Slr)

Graphs: Scatter plots, for individual variables histograms and box plots

Descriptive statistics:

 - Mean, median, mode, variance, standard deviation, coefficient of variation, 5 number summary for individual variables.
 - Least squares line, sample correlation coefficient, sample coefficient of determination

Inferential statistics: Testing ρ , confidence intervals for β , testing β

Descriptions of Data Sets

SINGLE VARIABLE LARGE AND SMALL SAMPLE

File name prefix: Sv followed by the number of the data file

01. Disney Stock Volume (Single Variable Large Sample $n \geq 30$)

The following data represents the number of shares of Disney stock (in hundreds of shares) sold for a random sample of 60 trading days

Reference: *The Denver Post*, Business section

12584	9441	18960	21480	10766	13059	8589	4965
4803	7240	10906	8561	6389	14372	18149	6309
13051	12754	10860	9574	19110	29585	21122	14522
17330	18119	10902	29158	16065	10376	10999	17950
15418	12618	16561	8022	9567	9045	8172	13708
11259	10518	9301	5197	11259	10518	9301	5197
6758	7304	7628	14265	13054	15336	14682	27804
16022	24009	32613	19111				

File names	Excel: Sv01.xls
	Minitab: Sv01.zip
	SPSS: Svspss01.zip
	TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Svl01.zip

02. Weights of Pro Football Players (Single Variable Large Sample $n \geq 30$)

The following data represents weights in pounds of 50 randomly selected pro football linebackers.

Reference: The Sports Encyclopedia Pro Football

225	230	235	238	232	227	244	222
250	226	242	253	251	225	229	247
239	223	233	222	243	237	230	240
255	230	245	240	235	252	245	231
235	234	248	242	238	240	240	240
235	244	247	250	236	246	243	255
241	245						

File names Excel: Sv02.xls
 Minitab: Sv02.zip
 SPSS: Svspss02.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv02.zip

03. Heights of Pro Basketball Players (Single Variable Large Sample $n \geq 30$)

The following data represents heights in feet of 65 randomly selected pro basketball players.

Reference: All-Time Player Directory, The Official NBA Encyclopedia

6.50	6.25	6.33	6.50	6.42	6.67	6.83	6.82
6.17	7.00	5.67	6.50	6.75	6.54	6.42	6.58
6.00	6.75	7.00	6.58	6.29	7.00	6.92	6.42
5.92	6.08	7.00	6.17	6.92	7.00	5.92	6.42
6.00	6.25	6.75	6.17	6.75	6.58	6.58	6.46
5.92	6.58	6.13	6.50	6.58	6.63	6.75	6.25
6.67	6.17	6.17	6.25	6.00	6.75	6.17	6.83
6.00	6.42	6.92	6.50	6.33	6.92	6.67	6.33
6.08							

File names Excel: Sv03.xls
 Minitab: Sv03.zip
 SPSS: Svspss03.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv03.zip

04. Miles per Gallon Gasoline Consumption (Single Variable Large Sample $n \geq 30$)

The following data represents miles per gallon gasoline consumption (highway) for a random sample of 55 makes and models of passenger cars.

Reference: Environmental Protection Agency

30	27	22	25	24	25	24	15
35	35	33	52	49	10	27	18
20	23	24	25	30	24	24	24

18	20	25	27	24	32	29	27
24	27	26	25	24	28	33	30
13	13	21	28	37	35	32	33
29	31	28	28	25	29	31	

File names Excel: Sv04.xls
 Minitab: Sv04.zip
 SPSS: Svspss04.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv04.zip

05. Fasting Glucose Blood Tests (Single Variable Large Sample $n \geq 30$)

The following data represents glucose blood level (mg/100mL) after a 12-hour fast for a random sample of 70 women.

Reference: *American J. Clin. Nutr.*, Vol. 19, 345-351

45	66	83	71	76	64	59	59
76	82	80	81	85	77	82	90
87	72	79	69	83	71	87	69
81	76	96	83	67	94	101	94
89	94	73	99	93	85	83	80
78	80	85	83	84	74	81	70
65	89	70	80	84	77	65	46
80	70	75	45	101	71	109	73
73	80	72	81	63	74		

File names Excel: Sv05.xls
 Minitab: Sv05.zip
 SPSS: Svspss05.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv05.zip

06. Number of Children in Rural Canadian Families (Single Variable Large Sample $n \geq 30$)

The following data represents the number of children in a random sample of 50 rural Canadian families.

Reference: *American Journal Of Sociology*, Vol. 53, 470-480

11	13	4	14	10	2	5	0
0	3	9	2	5	2	3	3
3	4	7	1	9	4	3	3
2	6	0	2	6	5	9	5
4	3	2	5	2	2	3	5
14	7	6	6	2	5	3	4
6	1						

File names Excel: Sv06.xls
 Minitab: Sv06.zip

SPSS: Svspss06.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv06.zip

07. Children as a % of Population (Single Variable Large Sample $n \geq 30$)

The following data represent percentage of children in the population for a random sample of 72 Denver neighborhoods.

Reference: The Piton Foundation, Denver, Colorado

30.2 18.6 13.6 36.9 32.8 19.4 12.3 39.7 22.2 31.2
36.4 37.7 38.8 28.1 18.3 22.4 26.5 20.4 37.6 23.8
22.1 53.2 6.8 20.7 31.7 10.4 21.3 19.6 41.5 29.8
14.7 12.3 17.0 16.7 20.7 34.8 7.5 19.0 27.2 16.3
24.3 39.8 31.1 34.3 15.9 24.2 20.3 31.2 30.0 33.1
29.1 39.0 36.0 31.8 32.9 26.5 4.9 19.5 21.0 24.2
12.1 38.3 39.3 20.2 24.0 28.6 27.1 30.0 60.8 39.2
21.6 20.3

File names Excel: Sv07.xls
 Minitab: Sv07.zip
 SPSS: Svspss07.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv07.zip

08. Percentage Change in Household Income (Single Variable Large Sample $n \geq 30$)

The following data represent the percentage change in household income over a five-year period for a random sample of $n = 78$ Denver neighborhoods.

Reference: The Piton Foundation, Denver, Colorado

27.2 25.2 25.7 80.9 26.9 20.2 25.4 26.9 26.4 26.3
27.5 38.2 20.9 31.3 23.5 26.0 35.8 30.9 15.5 24.8
29.4 11.7 32.6 32.2 27.6 27.5 28.7 28.0 15.6 20.0
21.8 18.4 27.3 13.4 14.7 21.6 26.8 20.9 32.7 29.3
21.4 29.0 7.2 25.7 25.5 39.8 26.6 24.2 33.5 16.0
29.4 26.8 32.0 24.7 24.2 29.8 25.8 18.2 26.0 26.2
21.7 27.0 23.7 28.0 11.2 26.2 21.6 23.7 28.3 34.1
40.8 16.0 50.5 54.1 3.3 23.5 10.1 14.8

File names Excel: Sv08.xls
 Minitab: Sv08.zip
 SPSS: Svspss08.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv08.zip

09. Crime Rate per 1,000 Population (Single Variable Large Sample $n \geq 30$)

The following data represent the crime rate per 1,000 population for a random sample of 70 Denver neighborhoods.

Reference: The Piton Foundation, Denver, Colorado

84.9	45.1	132.1	104.7	258.0	36.3	26.2	207.7
58.5	65.3	42.5	53.2	172.6	69.2	179.9	65.1
32.0	38.3	185.9	42.4	63.0	86.4	160.4	26.9
154.2	111.0	139.9	68.2	127.0	54.0	42.1	105.2
77.1	278.0	73.0	32.1	92.7	704.1	781.8	52.2
65.0	38.6	22.5	157.3	63.1	289.1	52.7	108.7
66.3	69.9	108.7	96.9	27.1	105.1	56.2	80.1
59.6	77.5	68.9	35.2	65.4	123.2	130.8	70.7
25.1	62.6	68.6	334.5	44.6	87.1		

File names Excel: Sv09.xls
 Minitab: Sv09.zip
 SPSS: Svspss09.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv09.zip

10. Percentage Change in Population (Single Variable Large Sample $n \geq 30$)

The following data represent the percentage change in population over a nine-year period for a random sample of 64 Denver neighborhoods.

Reference: The Piton Foundation, Denver, Colorado

6.2	5.4	8.5	1.2	5.6	28.9	6.3	10.5	-1.5	17.3
21.6	-2.0	-1.0	3.3	2.8	3.3	28.5	-0.7	8.1	32.6
68.6	56.0	19.8	7.0	38.3	41.2	4.9	7.8	7.8	97.8
5.5	21.6	32.5	-0.5	2.8	4.9	8.7	-1.3	4.0	32.2
2.0	6.4	7.1	8.8	3.0	5.1	-1.9	-2.6	1.6	7.4
10.8	4.8	1.4	19.2	2.7	71.4	2.5	6.2	2.3	10.2
1.9	2.3	-3.3	2.6						

File names Excel: Sv10.xls
 Minitab: Sv10.zip
 SPSS: Svspss10.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv10.zip

11. Thickness of the Ozone Column (Single Variable Large Sample $n \geq 30$)

The following data represent the January mean thickness of the ozone column above Arosa, Switzerland (Dobson units: one milli-centimeter ozone at standard temperature and pressure). The data is from a random sample of years from 1926 on.

Reference: Laboratorium fuer Atmosphaerensphysik, Switzerland

324	332	362	383	335	349	354	319	360	329
400	341	315	368	361	336	349	347	338	332
341	352	342	361	318	337	300	352	340	371
327	357	320	377	338	361	301	331	334	387
336	378	369	332	344					

File names Excel: Sv11.xls
 Minitab: Sv11.zip
 SPSS: Svspss11.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv11.zip

12. Sun Spots (Single Variable Large Sample $n \geq 30$)

The following data represent the January mean number of sunspots. The data is taken from a random sample of Januarys from 1749 to 1983.

Reference: Waldmeir, M, *Sun Spot Activity*, International Astronomical Union Bulletin

12.5	14.1	37.6	48.3	67.3	70.0	43.8	56.5	59.7	24.0
12.0	27.4	53.5	73.9	104.0	54.6	4.4	177.3	70.1	54.0
28.0	13.0	6.5	134.7	114.0	72.7	81.2	24.1	20.4	13.3
9.4	25.7	47.8	50.0	45.3	61.0	39.0	12.0	7.2	11.3
22.2	26.3	34.9	21.5	12.8	17.7	34.6	43.0	52.2	47.5
30.9	11.3	4.9	88.6	188.0	35.6	50.5	12.4	3.7	18.5
115.5	108.5	119.1	101.6	59.9	40.7	26.5	23.1	73.6	165.0
202.5	217.4	57.9	38.7	15.3	8.1	16.4	84.3	51.9	58.0
74.7	96.0	48.1	51.1	31.5	11.8	4.5	78.1	81.6	68.9

File names Excel: Sv12.xls
 Minitab: Sv12.zip
 SPSS: Svspss12.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv12.zip

13. Motion of Stars (Single Variable Large Sample $n \geq 30$)

The following data represent the angular motions of stars across the sky due to the stars own velocity. A random sample of stars from the M92 global cluster was used. Units are arc seconds per century.

Reference: Cudworth, K.M., *Astronomical Journal*, Vol. 81, p 975-982

0.042	0.048	0.019	0.025	0.028	0.041	0.030	0.051	0.026
0.040	0.018	0.022	0.048	0.045	0.019	0.028	0.029	0.018
0.033	0.035	0.019	0.046	0.021	0.026	0.026	0.033	0.046
0.023	0.036	0.024	0.014	0.012	0.037	0.034	0.032	0.035
0.015	0.027	0.017	0.035	0.021	0.016	0.036	0.029	0.031
0.016	0.024	0.015	0.019	0.037	0.016	0.024	0.029	0.025
0.022	0.028	0.023	0.021	0.020	0.020	0.016	0.016	0.016
0.040	0.029	0.025	0.025	0.042	0.022	0.037	0.024	0.046
0.016	0.024	0.028	0.027	0.060	0.045	0.037	0.027	0.028
0.022	0.048	0.053						

File names Excel: Sv13.xls
 Minitab: Sv13.zip

SPSS: Svspss13.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv13.zip

14. Arsenic and Ground Water (Single Variable Large Sample $n \geq 30$)

The following data represent (naturally occurring) concentration of arsenic in ground water for a random sample of 102 Northwest Texas wells. Units are parts per billion.

Reference: Nichols, C.E. and Kane, V.E., Union Carbide Technical Report K/UR-1

7.6	10.4	13.5	4.0	19.9	16.0	12.0	12.2	11.4	12.7
3.0	10.3	21.4	19.4	9.0	6.5	10.1	8.7	9.7	6.4
9.7	63.0	15.5	10.7	18.2	7.5	6.1	6.7	6.9	0.8
73.5	12.0	28.0	12.6	9.4	6.2	15.3	7.3	10.7	15.9
5.8	1.0	8.6	1.3	13.7	2.8	2.4	1.4	2.9	13.1
15.3	9.2	11.7	4.5	1.0	1.2	0.8	1.0	2.4	4.4
2.2	2.9	3.6	2.5	1.8	5.9	2.8	1.7	4.6	5.4
3.0	3.1	1.3	2.6	1.4	2.3	1.0	5.4	1.8	2.6
3.4	1.4	10.7	18.2	7.7	6.5	12.2	10.1	6.4	10.7
6.1	0.8	12.0	28.1	9.4	6.2	7.3	9.7	62.1	15.5
6.4	9.5								

File names Excel: Sv14.xls
 Minitab: Sv14.zip
 SPSS: Svspss14.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv14.zip

15. Uranium in Ground Water (Single Variable Large Sample $n \geq 30$)

The following data represent (naturally occurring) concentrations of uranium in ground water for a random sample of 100 Northwest Texas wells. Units are parts per billion.

Reference: Nichols, C.E. and Kane, V.E., Union Carbide Technical Report K/UR-1

8.0	13.7	4.9	3.1	78.0	9.7	6.9	21.7	26.8
56.2	25.3	4.4	29.8	22.3	9.5	13.5	47.8	29.8
13.4	21.0	26.7	52.5	6.5	15.8	21.2	13.2	12.3
5.7	11.1	16.1	11.4	18.0	15.5	35.3	9.5	2.1
10.4	5.3	11.2	0.9	7.8	6.7	21.9	20.3	16.7
2.9	124.2	58.3	83.4	8.9	18.1	11.9	6.7	9.8
15.1	70.4	21.3	58.2	25.0	5.5	14.0	6.0	11.9
15.3	7.0	13.6	16.4	35.9	19.4	19.8	6.3	2.3
1.9	6.0	1.5	4.1	34.0	17.6	18.6	8.0	7.9
56.9	53.7	8.3	33.5	38.2	2.8	4.2	18.7	12.7
3.8	8.8	2.3	7.2	9.8	7.7	27.4	7.9	11.1
24.7								

File names Excel: Sv15.xls
 Minitab: Sv15.zip

SPSS: Svspss15.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv15.zip

16. Ground Water pH (Single Variable Large Sample $n \geq 30$)

A pH less than 7 is acidic, and a pH above 7 is alkaline. The following data represent pH levels in ground water for a random sample of 102 Northwest Texas wells.

Reference: Nichols, C.E. and Kane, V.E., Union Carbide Technical Report K/UR-1

7.6	7.7	7.4	7.7	7.1	8.2	7.4	7.5	7.2	7.4
7.2	7.6	7.4	7.8	8.1	7.5	7.1	8.1	7.3	8.2
7.6	7.0	7.3	7.4	7.8	8.1	7.3	8.0	7.2	8.5
7.1	8.2	8.1	7.9	7.2	7.1	7.0	7.5	7.2	7.3
8.6	7.7	7.5	7.8	7.6	7.1	7.8	7.3	8.4	7.5
7.1	7.4	7.2	7.4	7.3	7.7	7.0	7.3	7.6	7.2
8.1	8.2	7.4	7.6	7.3	7.1	7.0	7.0	7.4	7.2
8.2	8.1	7.9	8.1	8.2	7.7	7.5	7.3	7.9	8.8
7.1	7.5	7.9	7.5	7.6	7.7	8.2	8.7	7.9	7.0
8.8	7.1	7.2	7.3	7.6	7.1	7.0	7.0	7.3	7.2
7.8	7.6								

File names Excel: Sv16.xls
 Minitab: Sv16.zip
 SPSS: Svspss16.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv16.zip

17. Static Fatigue 90% Stress Level (Single Variable Large Sample $n \geq 30$)

Kevlar Epoxy is a material used on the NASA space shuttle. Strands of this epoxy were tested at 90% breaking strength. The following data represent time to failure in hours at the 90% stress level for a random sample of 50 epoxy strands.

Reference: R.E. Barlow University of California, Berkeley

0.54	1.80	1.52	2.05	1.03	1.18	0.80	1.33	1.29	1.11
3.34	1.54	0.08	0.12	0.60	0.72	0.92	1.05	1.43	3.03
1.81	2.17	0.63	0.56	0.03	0.09	0.18	0.34	1.51	1.45
1.52	0.19	1.55	0.02	0.07	0.65	0.40	0.24	1.51	1.45
1.60	1.80	4.69	0.08	7.89	1.58	1.64	0.03	0.23	0.72

File names Excel: Sv17.xls
 Minitab: Sv17.zip
 SPSS: Svspss17.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv17.zip

18. Static Fatigue 80% Stress Level (Single Variable Large Sample $n \geq 30$)

Kevlar Epoxy is a material used on the NASA space shuttle. Strands of this epoxy were tested at 80% breaking strength. The following data represent time to failure in hours at the 80% stress

level for a random sample of 54 epoxy strands.

Reference: R.E. Barlow University of California, Berkeley

152.2	166.9	183.8	8.5	1.8	118.0	125.4	132.8	10.6
29.6	50.1	202.6	177.7	160.0	87.1	112.6	122.3	124.4
131.6	140.9	7.5	41.9	59.7	80.5	83.5	149.2	137.0
301.1	329.8	461.5	739.7	304.3	894.7	220.2	251.0	269.2
130.4	77.8	64.4	381.3	329.8	451.3	346.2	663.0	49.1
31.7	116.8	140.2	334.1	285.9	59.7	44.1	351.2	93.2

File names Excel: Sv18.xls
 Minitab: Sv18.zip
 SPSS: Svspss18.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv18.zip

19. Tumor Recurrence (Single Variable Large Sample $n \geq 30$)

Certain kinds of tumors tend to recur. The following data represents the length of time in months for a tumor to recur after chemotherapy (sample size: 42).

Reference: Byar, D.P, *Urology* Vol. 10, p 556-561

19	18	17	1	21	22	54	46	25	49
50	1	59	39	43	39	5	9	38	18
14	45	54	59	46	50	29	12	19	36
38	40	43	41	10	50	41	25	19	39
27	20								

File names Excel: Sv19.xls
 Minitab: Sv19.zip
 SPSS: Svspss19.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv19.zip

20. Weight of Harvest (Single Variable Large Sample $n \geq 30$)

The following data represent the weights in kilograms of maize harvest from a random sample of 72 experimental plots on the island of St Vincent (Caribbean).

Reference: Springer, B.G.F. *Proceedings, Caribbean Food Corps. Soc.* Vol. 10 p 147-152

24.0	27.1	26.5	13.5	19.0	26.1	23.8	22.5	20.0
23.1	23.8	24.1	21.4	26.7	22.5	22.8	25.2	20.9
23.1	24.9	26.4	12.2	21.8	19.3	18.2	14.4	22.4
16.0	17.2	20.3	23.8	24.5	13.7	11.1	20.5	19.1
20.2	24.1	10.5	13.7	16.0	7.8	12.2	12.5	14.0
22.0	16.5	23.8	13.1	11.5	9.5	22.8	21.1	22.0
11.8	16.1	10.0	9.1	15.2	14.5	10.2	11.7	14.6
15.5	23.7	25.1	29.5	24.5	23.2	25.5	19.8	17.8

File names Excel: Sv20.xls
Minitab: Sv20.zip
SPSS: Svspss20.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv20.zip

21. Apple Trees (Single Variable Large Sample $n \geq 30$)

The following data represent the trunk girth (mm) of a random sample of 60 four-year-old apple trees at East Malling Research Station (England)

Reference: S.C. Pearce, University of Kent at Canterbury

108 99 106 102 115 120 120 117 122 142
106 111 119 109 125 108 116 105 117 123
103 114 101 99 112 120 108 91 115 109
114 105 99 122 106 113 114 75 96 124
91 102 108 110 83 90 69 117 84 142
122 113 105 112 117 122 129 100 138 117

File names Excel: Sv21.xls
Minitab: Sv21.zip
SPSS: Svspss21.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv21.zip

22. Black Mesa Archaeology (Single Variable Large Sample $n \geq 30$)

The following data represent rim diameters (cm) of a random sample of 40 bowls found at Black Mesa archaeological site. The diameters are estimated from broken pot shards.

Reference: Michelle Hegmon, Crow Canyon Archaeological Center, Cortez, Colorado

17.2 15.1 13.8 18.3 17.5 11.1 7.3 23.1 21.5 19.7
17.6 15.9 16.3 25.7 27.2 33.0 10.9 23.8 24.7 18.6
16.9 18.8 19.2 14.6 8.2 9.7 11.8 13.3 14.7 15.8
17.4 17.1 21.3 15.2 16.8 17.0 17.9 18.3 14.9 17.7

File names Excel: Sv22.xls
Minitab: Sv22.zip
SPSS: Svspss22.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv22.zip

23. Wind Mountain Archaeology (Single Variable Large Sample $n \geq 30$)

The following data represent depth (cm) for a random sample of 73 significant archaeological artifacts at the Wind Mountain excavation site.

Reference: Woosley, A. and McIntyre, A. *Mimbres Mogolian Archaeology*, University New Mexico press.

85 45 75 60 90 90 115 30 55 58
78 120 80 65 65 140 65 50 30 125

75	137	80	120	15	45	70	65	50	45
95	70	70	28	40	125	105	75	80	70
90	68	73	75	55	70	95	65	200	75
15	90	46	33	100	65	60	55	85	50
10	68	99	145	45	75	45	95	85	65
65	52	82							

File names Excel: Sv23.xls
 Minitab: Sv23.zip
 SPSS: Svspss23.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv23.zip

24. Arrow Heads (Single Variable Large Sample $n \geq 30$)

The following data represent the lengths (cm) of a random sample of 61 projectile points found at the Wind Mountain Archaeological site.

Reference: Woosley, A. and McIntyre, A. *Mimbres Mogolian Archaeology*, University New Mexico press.

3.1	4.1	1.8	2.1	2.2	1.3	1.7	3.0	3.7	2.3
2.6	2.2	2.8	3.0	3.2	3.3	2.4	2.8	2.8	2.9
2.9	2.2	2.4	2.1	3.4	3.1	1.6	3.1	3.5	2.3
3.1	2.7	2.1	2.0	4.8	1.9	3.9	2.0	5.2	2.2
2.6	1.9	4.0	3.0	3.4	4.2	2.4	3.5	3.1	3.7
3.7	2.9	2.6	3.6	3.9	3.5	1.9	4.0	4.0	4.6
1.9									

File names Excel: Sv24.xls
 Minitab: Sv24.zip
 SPSS: Svspss24.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv24.zip

25. Anasazi Indian Bracelets (Single Variable Large Sample $n \geq 30$)

The following data represent the diameter (cm) of shell bracelets and rings found at the Wind Mountain archaeological site.

Reference: Woosley, A. and McIntyre, A. *Mimbres Mogolian Archaeology*, University New Mexico press.

5.0	5.0	8.0	6.1	6.0	5.1	5.9	6.8	4.3	5.5
7.2	7.0	5.0	5.6	5.3	7.0	3.4	8.2	4.3	5.2
1.5	6.1	4.0	6.0	5.5	5.2	5.2	5.2	5.5	7.2
6.0	6.2	5.2	5.0	4.0	5.7	5.1	6.1	5.7	7.3
7.3	6.7	4.2	4.0	6.0	7.1	7.3	5.5	5.8	8.9
7.5	8.3	6.8	4.9	4.0	6.2	7.7	5.0	5.2	6.8
6.1	7.2	4.4	4.0	5.0	6.0	6.2	7.2	5.8	6.8
7.7	4.7	5.3							

File names Excel: Sv25.xls
Minitab: Sv25.zip
SPSS: Svspss25.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv25zip

26. Pizza Franchise Fees (Single Variable Large Sample $n \geq 30$)

The following data represent annual franchise fees (in thousands of dollars) for a random sample of 36 pizza franchises.

Reference: *Business Opportunities Handbook*

25.0 15.5 7.5 19.9 18.5 25.5 15.0 5.5 15.2 15.0
14.9 18.5 14.5 29.0 22.5 10.0 25.0 35.5 22.1 89.0
17.5 33.3 17.5 12.0 15.5 25.5 12.5 17.5 12.5 35.0
30.0 21.0 35.5 10.5 5.5 20.0

File names Excel: Sv26.xls
Minitab: Sv26.zip
SPSS: Svspss26.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv26.zip

27. Pizza Franchise Start-up Requirement (Single Variable Large Sample $n \geq 30$)

The following data represent annual the start-up cost (in thousands of dollars) for a random sample of 36 pizza franchises.

Reference: *Business Opportunities Handbook*

40 25 50 129 250 128 110 142 25 90
75 100 500 214 275 50 128 250 50 75
30 40 185 50 175 125 200 150 150 120
95 30 400 149 235 100

File names Excel: Sv27.xls
Minitab: Sv27.zip
SPSS: Svspss27.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv27.zip

28. College Degrees (Single Variable Large Sample $n \geq 30$)

The following data represent percentages of the adult population with college degrees. The sample is from a random sample of 68 Midwest counties.

Reference: *County and City Data Book* 12th edition, U.S. Department of Commerce

9.9 9.8 6.8 8.9 11.2 15.5 9.8 16.8 9.9 11.6
9.2 8.4 11.3 11.5 15.2 10.8 16.3 17.0 12.8 11.0
6.0 16.0 12.1 9.8 9.4 9.9 10.5 11.8 10.3 11.1
12.5 7.8 10.7 9.6 11.6 8.8 12.3 12.2 12.4 10.0
10.0 18.1 8.8 17.3 11.3 14.5 11.0 12.3 9.1 12.7

5.6	11.7	16.9	13.7	12.5	9.0	12.7	11.3	19.5	30.7
9.4	9.8	15.1	12.8	12.9	17.5	12.3	8.2		

File names Excel: Sv28.xls
 Minitab: Sv28.zip
 SPSS: Svspss28.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv28.zip

29. Poverty Level (Single Variable Large Sample $n \geq 30$)

The following data represent percentages of all persons below the poverty level. The sample is from a random collection of 80 cities in the Western U.S.

Reference: *County and City Data Book* 12th edition, U.S. Department of Commerce

12.1	27.3	20.9	14.9	4.4	21.8	7.1	16.4	13.1
9.4	9.8	15.7	29.9	8.8	32.7	5.1	9.0	16.8
21.6	4.2	11.1	14.1	30.6	15.4	20.7	37.3	7.7
19.4	18.5	19.5	8.0	7.0	20.2	6.3	12.9	13.3
30.0	4.9	14.4	14.1	22.6	18.9	16.8	11.5	19.2
21.0	11.4	7.8	6.0	37.3	44.5	37.1	28.7	9.0
17.9	16.0	20.2	11.5	10.5	17.0	3.4	3.3	15.6
16.6	29.6	14.9	23.9	13.6	7.8	14.5	19.6	31.5
28.1	19.2	4.9	12.7	15.1	9.6	23.8	10.1	

File names Excel: Sv29.xls
 Minitab: Sv29.zip
 SPSS: Svspss29.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv29.zip

30. Working at Home (Single Variable Large Sample $n \geq 30$)

The following data represent percentages of adults whose primary employment involves working at home. The data is from a random sample of 50 California cities.

Reference: *County and City Data Book* 12th edition, U.S. Department of Commerce

4.3	5.1	3.1	8.7	4.0	5.2	11.8	3.4	8.5	3.0
4.3	6.0	3.7	3.7	4.0	3.3	2.8	2.8	2.6	4.4
7.0	8.0	3.7	3.3	3.7	4.9	3.0	4.2	5.4	6.6
2.4	2.5	3.5	3.3	5.5	9.6	2.7	5.0	4.8	4.1
3.8	4.8	14.3	9.2	3.8	3.6	6.5	2.6	3.5	8.6

File names Excel: Sv30.xls
 Minitab: Sv30.zip
 SPSS: Svspss30.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv30.zip

31. Number of Pups in Wolf Den (Single Variable Small Sample $n < 30$)

The following data represent the number of wolf pups per den from a random sample of 16 wolf dens.

Reference: *The Wolf in the Southwest: The Making of an Endangered Species*, Brown, D.E., University of Arizona Press

5 8 7 5 3 4 3 9
5 8 5 6 5 6 4 7

File names Excel: Sv31.xls
 Minitab: Sv31.zip
 SPSS: Svspss31.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv31.zip

32. Glucose Blood Level (Single Variable Small Sample $n < 30$)

The following data represent glucose blood level (mg/100ml) after a 12-hour fast for a random sample of 6 tests given to an individual adult female.

Reference: *American J. Clin. Nutr. Vol. 19*, p345-351

83 83 86 86 78 88

File names Excel: Sv32.xls
 Minitab: Sv32.zip
 SPSS: Svspss32.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv32.zip

33. Length of Remission (Single Variable Small Sample $n < 30$)

The drug 6-mP (6-mercaptopurine) is used to treat leukemia. The following data represent the length of remission in weeks for a random sample of 21 patients using 6-mP.

Reference: E.A. Gehan, University of Texas Cancer Center

10 7 32 23 22 6 16 34 32 25
11 20 19 6 17 35 6 13 9 6
10

File names Excel: Sv33.xls
 Minitab: Sv33.zip
 SPSS: Svspss33.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv33.zip

34. Entry Level Jobs (Single Variable Small Sample $n < 30$)

The following data represent percentage of entry-level jobs in a random sample of 16 Denver neighborhoods.

Reference: The Piton Foundation, Denver, Colorado

8.9 22.6 18.5 9.2 8.2 24.3 15.3 3.7
9.2 14.9 4.7 11.6 16.5 11.6 9.7 8.0

File names Excel: Sv34.xls
 Minitab: Sv34.zip
 SPSS: Svspss34.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv34.zip

35. Licensed Child Care Slots (Single Variable Small Sample $n < 30$)

The following data represents the number of licensed childcare slots in a random sample of 15 Denver neighborhoods.

Reference: The Piton Foundation, Denver, Colorado

523 106 184 121 357 319 656 170
241 226 741 172 266 423 212

File names Excel: Sv35.xls
 Minitab: Sv35.zip
 SPSS: Svspss35.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv35.zip

36. Subsidized Housing (Single Variable Small Sample $n < 30$)

The following data represent the percentage of subsidized housing in a random sample of 14 Denver neighborhoods.

Reference: The Piton Foundation, Denver, Colorado

10.2 11.8 9.7 22.3 6.8 10.4 11.0
5.4 6.6 13.7 13.6 6.5 16.0 24.8

File names Excel: Sv36.xls
 Minitab: Sv36.zip
 SPSS: Svspss36.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv36.zip

37. Sulfate in Ground Water (Single Variable Small Sample $n < 30$)

The following data represent naturally occurring amounts of sulfate SO₄ in well water. Units: parts per million. The data is from a random sample of 24 water wells in Northwest Texas.

Reference: Union Carbide Corporation Technical Report K/UR-1

1850 1150 1340 1325 2500 1060 1220 2325 460
2000 1500 1775 620 1950 780 840 2650 975
860 495 1900 1220 2125 990

File names Excel: Sv37.xls
 Minitab: Sv37.zip
 SPSS: Svspss37.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv37.zip

38. Earth's Rotation Rate (Single Variable Small Sample $n < 30$)

The following data represent changes in the earth's rotation (i.e. day length). Units: 0.00001 second. The data is for a random sample of 23 years.

Reference: *Acta Astron. Sinica*, Vol. 15, p79-85

-12 110 78 126 -35 104 111 22 -31 92
51 36 231 -13 65 119 21 104 112 -15
137 139 101

File names Excel: Sv38.xls
 Minitab: Sv38.zip
 SPSS: Svspss38.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv38.zip

39. Blood Glucose (Single Variable Small Sample $n < 30$)

The following data represent glucose levels (mg/100ml) in the blood for a random sample of 27 non-obese adult subjects.

Reference: *Diabetologia*, Vol. 16, p 17-24

80 85 75 90 70 97 91 85 90 85
105 86 78 92 93 90 80 102 90 90
99 93 91 86 98 86 92

File names Excel: Sv39.xls
 Minitab: Sv39.zip
 SPSS: Svspss39.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv39.zip

40. Plant Species (Single Variable Small Sample $n < 30$)

The following data represent the observed number of native plant species from random samples of study plots on different islands in the Galapagos Island chain.

Reference: *Science*, Vol. 179, p 893-895

23 26 33 73 21 35 30 16 3 17
9 8 9 19 65 12 11 89 81 7
23 95 4 37 28

File names Excel: Sv40.xls

Minitab: Sv40.zip
SPSS: Svspss40.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv40.zip

41. Apples (Single Variable Small Sample $n < 30$)

The following data represent mean fruit weight (grams) of apples per tree for a random sample of 28 trees in an agricultural experiment.

Reference: *Aust. J. Agric Res.*, Vol. 25, p783-790

85.3 86.9 96.8 108.5 113.8 87.7 94.5 99.9 92.9
67.3 90.6 129.8 48.9 117.5 100.8 94.5 94.4 98.9
96.0 99.4 79.1 108.5 84.6 117.5 70.0 104.4 127.1
135.0

File names Excel: Sv41.xls
 Minitab: Sv41.zip
 SPSS: Svspss41.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv41.zip

Space Shuttle: Epoxy (Single Variable Large Sample $n \geq 30$)

The following data represent time to failure (in hours) for a random sample of 50 epoxy strands.

Reference: R. E. Barlow, University of California, Berkeley

0.54 1.80 1.52 2.05 1.03 1.18 0.80 1.33 1.29
1.11 3.34 1.54 0.08 0.12 0.60 0.72 0.92 1.05
1.43 3.03 1.81 2.17 0.63 0.56 0.03 0.09 0.18
0.34 1.51 1.45 1.52 0.19 1.55 0.02 0.07 0.65
0.40 0.24 1.51 1.45 1.60 1.80 4.69 0.08 7.89
1.58 1.64 0.03 0.23 0.72

File names Excel: Sv42.xls
 Minitab: Sv42.zip
 SPSS: Svspss42.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Sv42.zip

TWO VARIABLE INDEPENDENT SAMPLES

File name prefix: Tvis followed by the number of the data file

01. Heights of Football Players Versus Heights of Basketball Players (Two variable independent large samples)

The following data represent heights in feet of 45 randomly selected pro football players and 40 randomly selected pro basketball players.

Reference: *Sports Encyclopedia of Pro Football* and *Official NBA Basketball Encyclopedia*

X1 = heights (ft.) of pro football players

6.33	6.50	6.50	6.25	6.50	6.33	6.25	6.17	6.42	6.33
6.42	6.58	6.08	6.58	6.50	6.42	6.25	6.67	5.91	6.00
5.83	6.00	5.83	5.08	6.75	5.83	6.17	5.75	6.00	5.75
6.50	5.83	5.91	5.67	6.00	6.08	6.17	6.58	6.50	6.25
6.33	5.25	6.67	6.50	5.83					

X2 = heights (ft.) of pro basketball players

6.08	6.58	6.25	6.58	6.25	5.92	7.00	6.41	6.75	6.25
6.00	6.92	6.83	6.58	6.41	6.67	6.67	5.75	6.25	6.25
6.50	6.00	6.92	6.25	6.42	6.58	6.58	6.08	6.75	6.50
6.83	6.08	6.92	6.00	6.33	6.50	6.58	6.83	6.50	6.58

File names Excel: Tvis01.xls
 Minitab: Tvis01.zip
 SPSS: Tvisspss01.szip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis01.zip

02. Petal Length for *Iris Virginica* Versus Petal Length for *Iris Setosa* (Two variable independent large samples)

The following data represent petal length (cm.) for a random sample of 35 *iris virginica* and a random sample of 38 *iris setosa*

Reference: Anderson, E., *Bull. Amer. Iris Soc.*

X1 = petal length (c.m.) *iris virginica*

5.1	5.8	6.3	6.1	5.1	5.5	5.3	5.5	6.9	5.0	4.9	6.0	4.8	6.1	5.6	5.1
5.6	4.8	5.4	5.1	5.1	5.9	5.2	5.7	5.4	4.5	6.1	5.3	5.5	6.7	5.7	4.9
4.8	5.8	5.1													

X2 = petal length (c.m.) *iris setosa*

1.5	1.7	1.4	1.5	1.5	1.6	1.4	1.1	1.2	1.4	1.7	1.0	1.7	1.9	1.6	1.4
1.5	1.4	1.2	1.3	1.5	1.3	1.6	1.9	1.4	1.6	1.5	1.4	1.6	1.2	1.9	1.5
1.6	1.4	1.3	1.7	1.5	1.7										

File names Excel: Tvis02.xls
 Minitab: Tvis02.zip

SPSS: Tvisspss02.zip
TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis02.zip

03. Sepal Width Of *Iris Versicolor* Versus *Iris Virginica* (Two variable independent large samples)

The following data represent sepal width (cm.) for a random sample of 40 *iris versicolor* and a random sample of 42 *iris virginica*

Reference: Anderson, E., *Bull. Amer. Iris Soc.*

X1 = sepal width (c.m.) *iris versicolor*

3.2 3.2 3.1 2.3 2.8 2.8 3.3 2.4 2.9 2.7 2.0 3.0 2.2 2.9 2.9 3.1
3.0 2.7 2.2 2.5 3.2 2.8 2.5 2.8 2.9 3.0 2.8 3.0 2.9 2.6 2.4 2.4
2.7 2.7 3.0 3.4 3.1 2.3 3.0 2.5

X2 = sepal width (c.m.) *iris virginica*

3.3 2.7 3.0 2.9 3.0 3.0 2.5 2.9 2.5 3.6 3.2 2.7 3.0 2.5 2.8 3.2
3.0 3.8 2.6 2.2 3.2 2.8 2.8 2.7 3.3 3.2 2.8 3.0 2.8 3.0 2.8 3.8
2.8 2.8 2.6 3.0 3.4 3.1 3.0 3.1 3.1 3.1

File names Excel: Tvis03.xls

Minitab: Tvis03.zip

SPSS: Tvisspss03.zip

TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis03.spss

04. Archaeology, Ceramics (Two variable independent large samples)

The following data represent independent random samples of shard counts of painted ceramics found at the Wind Mountain archaeological site.

Reference: Woosley and McIntyre, *Mimbres Mogollon Archaeology*, Univ. New Mexico Press

X1 = count Mogollon red on brown

52 10 8 71 7 31 24 20 17 5
16 75 25 17 14 33 13 17 12 19
67 13 35 14 3 7 9 19 16 22
7 10 9 49 6 13 24 45 14 20
3 6 30 41 26 32 14 33 1 48
44 14 16 15 13 8 61 11 12 16
20 39

X2 = count Mimbres black on white

61 21 78 9 14 12 34 54 10 15
43 9 7 67 18 18 24 54 8 10
16 6 17 14 25 22 25 13 23 12
36 10 56 35 79 69 41 36 18 25
27 27 11 13

File names Excel: Tvis04.xls
 Minitab: Tvis04.zip
 SPSS: Tvisspss04.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis04.zip

05. Agriculture, Water Content of Soil (Two variable independent large samples)

The following data represent soil water content (% water by volume) for independent random samples of soil from two experimental fields growing bell peppers.

Reference: *Journal of Agricultural, Biological, and Environmental Statistics*, Vol. 2, No. 2, p 149-155

X1 = soil water content from field I

15.1	11.2	10.3	10.8	16.6	8.3	9.1	12.3	9.1	14.3
10.7	16.1	10.2	15.2	8.9	9.5	9.6	11.3	14.0	11.3
15.6	11.2	13.8	9.0	8.4	8.2	12.0	13.9	11.6	16.0
9.6	11.4	8.4	8.0	14.1	10.9	13.2	13.8	14.6	10.2
11.5	13.1	14.7	12.5	10.2	11.8	11.0	12.7	10.3	10.8
11.0	12.6	10.8	9.6	11.5	10.6	11.7	10.1	9.7	9.7
11.2	9.8	10.3	11.9	9.7	11.3	10.4	12.0	11.0	10.7
8.8	11.1								

X2 = soil water content from field II

12.1	10.2	13.6	8.1	13.5	7.8	11.8	7.7	8.1	9.2
14.1	8.9	13.9	7.5	12.6	7.3	14.9	12.2	7.6	8.9
13.9	8.4	13.4	7.1	12.4	7.6	9.9	26.0	7.3	7.4
14.3	8.4	13.2	7.3	11.3	7.5	9.7	12.3	6.9	7.6
13.8	7.5	13.3	8.0	11.3	6.8	7.4	11.7	11.8	7.7
12.6	7.7	13.2	13.9	10.4	12.8	7.6	10.7	10.7	10.9
12.5	11.3	10.7	13.2	8.9	12.9	7.7	9.7	9.7	11.4
11.9	13.4	9.2	13.4	8.8	11.9	7.1	8.5	14.0	14.2

File names Excel: Tvis05.xls
 Minitab: Tvis05.zip
 SPSS: Tvisspss05.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis05.zip

06. Rabies (Two variable independent small samples)

The following data represent the number of cases of red fox rabies for a random sample of 16 areas in each of two different regions of southern Germany.

Reference: Sayers, B., *Medical Informatics*, Vol. 2, 11-34

X1 = number cases in region 1

10	2	2	5	3	4	3	3	4	0	2	6	4	8	7	4
----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

X2 = number cases in region 2
1 1 2 1 3 9 2 2 4 5 4 2 2 0 0 2

File names Excel: Tvis06.xls
 Minitab: Tvis06.zip
 SPSS: Tvisspss06.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis06.zip

07. Weight of Football Players Versus Weight of Basketball Players (Two variable independent small samples)

The following data represent weights in pounds of 21 randomly selected pro football players, and 19 randomly selected pro basketball players.

Reference: *Sports Encyclopedia of Pro Football and Official NBA Basketball Encyclopedia*

X1 = weights (lb) of pro football players
245 262 255 251 244 276 240 265 257 252 282
256 250 264 270 275 245 275 253 265 270

X2 = weights (lb) of pro basketball
205 200 220 210 191 215 221 216 228 207
225 208 195 191 207 196 181 193 201

File names Excel: Tvis07.xls
 Minitab: Tvis07.zip
 SPSS: Tvisspss07.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis07.zip

08. Birth Rate (Two variable independent small samples)

The following data represent birth rate (per 1000 residential population) for independent random samples of counties in California and Maine.

Reference: *County and City Data Book* 12th edition, U.S. Dept. of Commerce

X1 = birth rate in California counties
14.1 18.7 20.4 20.7 16.0 12.5 12.9 9.6 17.6
18.1 14.1 16.6 15.1 18.5 23.6 19.9 19.6 14.9
17.7 17.8 19.1 22.1 15.6

X2 = birth rate in Maine counties
15.1 14.0 13.3 13.8 13.5 14.2 14.7 11.8 13.5 13.8
16.5 13.8 13.2 12.5 14.8 14.1 13.6 13.9 15.8

File names Excel: Tvis08.xls
 Minitab: Tvis08.zip
 SPSS: Tvisspss08.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis08.zip

09. Death Rate (Two variable independent small samples)

The following data represents death rate (per 1000 resident population) for independent random samples of counties in Alaska and Texas.

Reference: *County and City Data Book* 12th edition, U.S. Dept. of Commerce

X1 = death rate in Alaska counties

1.4 4.2 7.3 4.8 3.2 3.4 5.1 5.4
6.7 3.3 1.9 8.3 3.1 6.0 4.5 2.5

X2 = death rate in Texas counties

7.2 5.8 10.5 6.6 6.9 9.5 8.6 5.9 9.1
5.4 8.8 6.1 9.5 9.6 7.8 10.2 5.6 8.6

File names Excel: Tvis09.xls

Minitab: Tvis09.zip

SPSS: Tvisspss09.zip

TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis09.zip

10. Pickup Trucks (Two variable independent small samples)

The following data represent the retail price (in thousands of dollars) for independent random samples of models of pickup trucks.

Reference: *Consumer Guide* Vol.681

X1 = prices for different GMC Sierra 1500 models

17.4 23.3 29.2 19.2 17.6 19.2 23.6 19.5 22.2
24.0 26.4 23.7 29.4 23.7 26.7 24.0 24.9

X2 = prices for different Chevrolet Silverado 1500 models

17.5 23.7 20.8 22.5 24.3 26.7 24.5 17.8
29.4 29.7 20.1 21.1 22.1 24.2 27.4 28.1

File names Excel: Tvis10.xls

Minitab: Tvis10.zip

SPSS: Tvisspss10.zip

TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvis10.zip

TWO VARIABLE DEPENDENT SAMPLES

File name prefix: Tvd_s followed by the number of the data file

01. Average Faculty Salary, Males vs Female (Two variable dependent samples)

In following data pairs, A = average salaries for males (\$1000/yr) and B = average salaries for females (\$1000/yr) for assistant professors at the same college or university. A random sample of 22 US colleges and universities was used.

Reference: *Academe, Bulletin of the American Association of University Professors*

A: 34.5 30.5 35.1 35.7 31.5 34.4 32.1 30.7 33.7 35.3

B: 33.9 31.2 35.0 34.2 32.4 34.1 32.7 29.9 31.2 35.5

A: 30.7 34.2 39.6 30.5 33.8 31.7 32.8 38.5 40.5 25.3

B: 30.2 34.8 38.7 30.0 33.8 32.4 31.7 38.9 41.2 25.5

A: 28.6 35.8

B: 28.0 35.1

File names Excel: Tvcds01.xls

Minitab: Tvcds01.zip

SPSS: Tvcdsspss01.zip

TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds01.zip

02. Unemployment for College Graduates Versus High School Only

(Two variable dependent samples)

In the following data pairs, A = Percent unemployment for college graduates and B = Percent unemployment for high school only graduates. The data are paired by year.

Reference: *Statistical Abstract of the United States*

A: 2.8 2.2 2.2 1.7 2.3 2.3 2.4 2.7 3.5 3.0 1.9 2.5

B: 5.9 4.9 4.8 5.4 6.3 6.9 6.9 7.2 10.0 8.5 5.1 6.9

File names Excel: Tvcds02.xls

Minitab: Tvcds02.zip

SPSS: Tvcdsspss02.zip

TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds02.zip

03. Number of Navajo Hogans versus Modern Houses (Two variable dependent samples)

In the following data pairs, A = Number of traditional Navajo hogans in a given district and B = Number of modern houses in a given district. The data are paired by district of the Navajo reservation. A random sample of 8 districts was used.

Reference: *Navajo Architecture, Forms, History, Distributions* by S.C. Jett and V.E. Spencer, Univ. of Arizona Press

A: 13 14 46 32 15 47 17 18

B: 18 16 68 9 11 28 50 50

File names Excel: Tvcds03.xls
 Minitab: Tvcds03.zip
 SPSS: Tvcdsspss03.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds03.zip

04. Temperatures in Miami versus Honolulu (Two variable dependent samples)

In the following data pairs, A = Average monthly temperature in Miami and B = Average monthly temperature in Honolulu. The data are paired by month.

Reference: U.S. Department of Commerce Environmental Data Service

A: 67.5 68.0 71.3 74.9 78.0 80.9 82.2 82.7 81.6 77.8 72.3 68.5
B: 74.4 72.6 73.3 74.7 76.2 78.0 79.1 79.8 79.5 78.4 76.1 73.7

File names Excel: Tvcds04.xls
 Minitab: Tvcds04.zip
 SPSS: Tvcdsspss04.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds04.zip

05. January/February Ozone Column (Two variable dependent samples)

In the following pairs, the data represent the thickness of the ozone column in Dobson units: one milli-centimeter ozone at standard temperature and pressure.

A = monthly mean thickness in January

B = monthly mean thickness in February

The data are paired by year for a random sample of 15 years.

Reference: Laboratorium für Atmosphärenphysik, Switzerland

A: 360 324 377 336 383 361 369 349
B: 365 325 359 352 397 351 367 397

A: 301 354 344 329 337 387 378
B: 335 338 349 393 370 400 411

File names Excel: Tvcds05.xls
 Minitab: Tvcds05.zip
 SPSS: Tvcdsspss05.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds05.zip

06. Birth Rate/Death Rate (Two variable dependent samples)

In the following data pairs, A = birth rate (per 1000 resident population) and B = death rate (per 1000 resident population). The data are paired by county in Iowa

Reference: *County and City Data Book*, 12th edition, U.S. Dept. of Commerce

A: 12.7 13.4 12.8 12.1 11.6 11.1 14.2
B: 9.8 14.5 10.7 14.2 13.0 12.9 10.9

A: 12.5 12.3 13.1 15.8 10.3 12.7 11.1
B: 14.1 13.6 9.1 10.2 17.9 11.8 7.0

File names Excel: Tvcds06.xls
 Minitab: Tvcds06.zip
 SPSS: Tvcdsspss06.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds06.zip

07. Democrat/Republican (Two variable dependent samples)

In the following data pairs A = percentage of voters who voted Democrat and B = percentage of voters who voted Republican in a recent national election. The data are paired by county in Indiana.

Reference: *County and City Data Book*, 12th edition, U.S. Dept. of Commerce

A: 42.2 34.5 44.0 34.1 41.8 40.7 36.4 43.3 39.5
B: 35.4 45.8 39.4 40.0 39.2 40.2 44.7 37.3 40.8

A: 35.4 44.1 41.0 42.8 40.8 36.4 40.6 37.4
B: 39.3 36.8 35.5 33.2 38.3 47.7 41.1 38.5

File names Excel: Tvcds07.xls
 Minitab: Tvcds07.zip
 SPSS: Tvcdsspss07.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds07.zip

08. Santiago Pueblo Pottery (Two variable dependent samples)

In the following data, A = percentage of utility pottery and B = percentage of ceremonial pottery found at the Santiago Pueblo archaeological site. The data are paired by location of discovery.

Reference: Laboratory of Anthropology, Notes 475, Santa Fe, New Mexico

A: 41.4 49.6 55.6 49.5 43.0 54.6 46.8 51.1 43.2 41.4
B: 58.6 50.4 44.4 59.5 57.0 45.4 53.2 48.9 56.8 58.6

File names Excel: Tvcds08.xls
 Minitab: Tvcds08.zip
 SPSS: Tvcdsspss08.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds08.zip

09. Poverty Level (Two variable dependent samples)

In the following data pairs, A = percentage of population below poverty level in 1998 and B = percentage of population below poverty level in 1990. The data are grouped by state and District of Columbia.

Reference: *Statistical Abstract of the United States*, 120th edition

A: 14.5 9.4 16.6 14.8 15.4 9.2 9.5 10.3 22.3 13.1
B: 19.2 11.4 13.7 19.6 13.9 13.7 6.0 6.9 21.1 14.4

A: 13.6 10.9 13.0 10.1 9.4 9.1 9.6 13.5 19.1 10.4
B: 15.8 11.0 14.9 13.7 13.0 10.4 10.3 17.3 23.6 13.1

A: 7.2 8.7 11.0 10.4 17.6 9.8 16.6 12.3 10.6 9.8
B: 9.9 10.7 14.3 12.0 25.7 13.4 16.3 10.3 9.8 6.3

A: 8.6 20.4 16.7 14.0 15.1 11.2 14.1 15.0 11.2 11.6
B: 9.2 20.9 14.3 13.0 13.7 11.5 15.6 9.2 11.0 7.5

A: 13.7 10.8 13.4 15.1 9.0 9.9 8.8 8.9 17.8 8.8 10.6
B: 16.2 13.3 16.9 15.9 8.2 10.9 11.1 8.9 18.1 9.3 11.0

File names Excel: Tvcds09.xls
 Minitab: Tvcds09.zip
 SPSS: Tvcdsspss09.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds09.zip

10. Cost of Living Index (Two variable dependent samples)

The following data pairs represent cost of living index for A = grocery items and B = health care.
The data are grouped by metropolitan areas.

Reference: *Statistical Abstract of the United States*, 120th edition

Grocery

A: 96.6 97.5 113.9 88.9 108.3 99.0 97.3 87.5 96.8
B: 91.6 95.9 114.5 93.6 112.7 93.6 99.2 93.2 105.9

A: 102.1 114.5 100.9 100.0 100.7 99.4 117.1 111.3 102.2
B: 110.8 127.0 91.5 100.5 104.9 104.8 124.1 124.6 109.1

A: 95.3 91.1 95.7 87.5 91.8 97.9 97.4 102.1 94.0
B: 98.7 95.8 99.7 93.2 100.7 96.0 99.6 98.4 94.0

A: 115.7 118.3 101.9 88.9 100.7 99.8 101.3 104.8 100.9
B: 121.2 122.4 110.8 81.2 104.8 109.9 103.5 113.6 94.6

A: 102.7 98.1 105.3 97.2 105.2 108.1 110.5 99.3 99.7
B: 109.8 97.6 109.8 107.4 97.7 124.2 110.9 106.8 94.8

File names Excel: Tvcds10.xls
 Minitab: Tvcds10.zip
 SPSS: Tvcdsspss10.zip
 TI-83 Plus, TI-84 Plus and TI-Nspire/ASCII: Tvcds10.zip

SIMPLE LINEAR REGRESSION

File name prefix: Slr followed by the number of the data file

01. List Price versus Best Price for a New GMC Pickup Truck (Simple Linear Regression)

In the following data, X = List price (in \$1000) for a GMC pickup truck and Y = Best price (in \$1000) for a GMC pickup truck.

Reference: *Consumer's Digest*

X: 12.4 14.3 14.5 14.9 16.1 16.9 16.5 15.4 17.0 17.9
Y: 11.2 12.5 12.7 13.1 14.1 14.8 14.4 13.4 14.9 15.6

X: 18.8 20.3 22.4 19.4 15.5 16.7 17.3 18.4 19.2 17.4
Y: 16.4 17.7 19.6 16.9 14.0 14.6 15.1 16.1 16.8 15.2

X: 19.5 19.7 21.2
Y: 17.0 17.2 18.6

File names Excel: Slr01.xls
 Minitab: Slr01.zip
 SPSS: Slrspss01.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr01.zip

02. Cricket Chirps versus Temperature (Simple Linear Regression)

In the following data, X = chirps/sec for the striped ground cricket and Y = temperature in degrees Fahrenheit.

Reference: *The Song of Insects* by Dr.G.W. Pierce, Harvard College Press

X: 20.0 16.0 19.8 18.4 17.1 15.5 14.7 17.1
Y: 88.6 71.6 93.3 84.3 80.6 75.2 69.7 82.0

X: 15.4 16.2 15.0 17.2 16.0 17.0 14.4
Y: 69.4 83.3 79.6 82.6 80.6 83.5 76.3

File names Excel: Slr02.xls
 Minitab: Slr02.zip
 SPSS: Slrspss02.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr02.zip

03. Diameter of Sand Granules versus Slope on Beach (Simple Linear Regression)

In the following data pairs, X = median diameter (mm) of granules of sand and Y = gradient of beach slope in degrees.

The data is for naturally occurring ocean beaches

Reference: *Physical geography* by A.M King, Oxford Press, England

X: 0.170 0.190 0.220 0.235 0.235 0.300 0.350 0.420 0.850
Y: 0.630 0.700 0.820 0.880 1.150 1.500 4.400 7.300 11.300

File names Excel: Slr03.xls
 Minitab: Slr03.zip
 SPSS: Slrspss03.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr03.zip

04. National Unemployment Male versus Female (Simple Linear Regression)

In the following data pairs, X = national unemployment rate for adult males and Y = national unemployment rate for adult females.

Reference: *Statistical Abstract of the United States*

X: 2.9	6.7	4.9	7.9	9.8	6.9	6.1	6.2	6.0	5.1	4.7	4.4	5.8
Y: 4.0	7.4	5.0	7.2	7.9	6.1	6.0	5.8	5.2	4.2	4.0	4.4	5.2

File names Excel: Slr04.xls
 Minitab: Slr04.zip
 SPSS: Slrspss04.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr04.zip

05. Fire and Theft in Chicago (Simple Linear Regression)

In the following data pairs, X = fires per 1000 housing units and Y = thefts per 1000 population within the same zip code in the Chicago metro area.

Reference: U.S. Commission on Civil Rights

X: 6.2	9.5	10.5	7.7	8.6	34.1	11.0	6.9	7.3	15.1
Y: 29	44	36	37	53	68	75	18	31	25

X: 29.1	2.2	5.7	2.0	2.5	4.0	5.4	2.2	7.2	15.1
Y: 34	14	11	11	22	16	27	9	29	30

X: 16.5	18.4	36.2	39.7	18.5	23.3	12.2	5.6	21.8	21.6
Y: 40	32	41	147	22	29	46	23	4	31

X: 9.0	3.6	5.0	28.6	17.4	11.3	3.4	11.9	10.5	10.7
Y: 39	15	32	27	32	34	17	46	42	43

X: 10.8 4.8
 Y: 34 19

File names Excel: Slr05.xls
 Minitab: Slr05.zip
 SPSS: Slrspss05.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr05.zip

06. Auto Insurance in Sweden (Simple Linear Regression)

In the following data, X = number of claims and Y = total payment for all the claims in thousands of Swedish Kronor for geographical zones in Sweden

Reference: Swedish Committee on Analysis of Risk Premium in Motor Insurance

X: 108 19 13 124 40 57 23 14 45 10
Y: 392.5 46.2 15.7 422.2 119.4 170.9 56.9 77.5 214.0 65.3

X: 5 48 11 23 7 2 24 6 3 23
Y: 20.9 248.1 23.5 39.6 48.8 6.6 134.9 50.9 4.4 113.0

X: 6 9 9 3 29 7 4 20 7 4
Y: 14.8 48.7 52.1 13.2 103.9 77.5 11.8 98.1 27.9 38.1

X: 0 25 6 5 22 11 61 12 4 16
Y: 0.0 69.2 14.6 40.3 161.5 57.2 217.6 58.1 12.6 59.6

X: 13 60 41 37 55 41 11 27 8 3
Y: 89.9 202.4 181.3 152.8 162.8 73.4 21.3 92.6 76.1 39.9

X: 17 13 13 15 8 29 30 24 9 31
Y: 142.1 93.0 31.9 32.1 55.6 133.3 194.5 137.9 87.4 209.8

X: 14 53 26
Y: 95.5 244.6 187.5

File names Excel: Slr06.xls

Minitab: Slr06.zip

SPSS: Slrspss06.zip

TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr06.zip

07. Gray Kangaroos (Simple Linear Regression)

In the following data pairs, X = nasal length (mm \times 10) and Y = nasal width (mm \times 10) for a male gray kangaroo from a random sample of such animals.

Reference: *Australian Journal of Zoology*, Vol. 28, p607-613

X: 609 629 620 564 645 493 606 660 630 672
Y: 241 222 233 207 247 189 226 240 215 231

X: 778 616 727 810 778 823 755 710 701 803
Y: 263 220 271 284 279 272 268 278 238 255

X: 855 838 830 864 635 565 562 580 596 597
Y: 308 281 288 306 236 204 216 225 220 219

X: 636 559 615 740 677 675 629 692 710 730
Y: 201 213 228 234 237 217 211 238 221 281

X: 763 686 717 737 816
Y: 292 251 231 275 275

File names Excel: Slr07.xls
 Minitab: Slr07.zip
 SPSS: Slrspss07.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr07.zip

08. Pressure and Weight in Cryogenic Flow Meters (Simple Linear Regression)

In the following data pairs, X = pressure (lb/sq in) of liquid nitrogen and Y = weight in pounds of liquid nitrogen passing through flow meter each second.

Reference: *Technometrics*, Vol. 19, p353-379

X: 75.1 74.3 88.7 114.6 98.5 112.0 114.8 62.2 107.0
Y: 577.8 577.0 570.9 578.6 572.4 411.2 531.7 563.9 406.7

X: 90.5 73.8 115.8 99.4 93.0 73.9 65.7 66.2 77.9
Y: 507.1 496.4 505.2 506.4 510.2 503.9 506.2 506.3 510.2

X: 109.8 105.4 88.6 89.6 73.8 101.3 120.0 75.9 76.2
Y: 508.6 510.9 505.4 512.8 502.8 493.0 510.8 512.8 513.4

X: 81.9 84.3 98.0
Y: 510.0 504.3 522.0

File names Excel: Slr08.xls
 Minitab: Slr08.mtp
 SPSS: Slr08.sav
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr08.zip

09. Ground Water Survey (Simple Linear Regression)

In the following data, X = pH of well water and Y = Bicarbonate (parts per million) of well water.
The data is by water well from a random sample of wells in Northwest Texas.

Reference: Union Carbide Technical Report K/UR-1

X: 7.6 7.1 8.2 7.5 7.4 7.8 7.3 8.0 7.1 7.5
Y: 157 174 175 188 171 143 217 190 142 190

X: 8.1 7.0 7.3 7.8 7.3 8.0 8.5 7.1 8.2 7.9
Y: 215 199 262 105 121 81 82 210 202 155

X: 7.6 8.8 7.2 7.9 8.1 7.7 8.4 7.4 7.3 8.5
Y: 157 147 133 53 56 113 35 125 76 48

X: 7.8 6.7 7.1 7.3
Y: 147 117 182 87

File names Excel: Slr09.xls
Minitab: Slr09.zip
SPSS: Slrspss09.zip
TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr09.zip

10. Iris Setosa (Simple Linear Regression)

In the following data, X = sepal width (cm) and Y = sepal length (cm). The data is for a random sample of the wild flower iris setosa.

Reference: Fisher, R.A., *Ann. Eugenics*, Vol. 7 Part II, p 179-188

X: 3.5 3.0 3.2 3.1 3.6 3.9 3.4 3.4 2.9 3.1
Y: 5.1 4.9 4.7 4.6 5.0 5.4 4.6 5.0 4.4 4.9

X: 3.7 3.4 3.0 4.0 4.4 3.9 3.5 3.8 3.8 3.4
Y: 5.4 4.8 4.3 5.8 5.7 5.4 5.1 5.7 5.1 5.4

X: 3.7 3.6 3.3 3.4 3.0 3.4 3.5 3.4 3.2 3.1
Y: 5.1 4.6 5.1 4.8 5.0 5.0 5.2 5.2 4.7 4.8

X: 3.4 4.1 4.2 3.1 3.2 3.5 3.6 3.0 3.4 3.5
Y: 5.4 5.2 5.5 4.9 5.0 5.5 4.9 4.4 5.1 5.0

X: 2.3 3.2 3.5 3.8 3.0 3.8 3.7 3.3
Y: 4.5 4.4 5.0 5.1 4.8 4.6 5.3 5.0

File names Excel: Slr10.xls
Minitab: Slr10.zip
SPSS: Slrspss10.zip
TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr10.zip

11. Pizza Franchise (Simple Linear Regression)

In the following data, X = annual franchise fee (\$1000) and Y = start up cost (\$1000) for a pizza franchise.

Reference: *Business Opportunity Handbook*

X: 25.0 8.5 35.0 15.0 10.0 30.0 10.0 50.0 17.5 16.0
Y: 125 80 330 58 110 338 30 175 120 135

X: 18.5 7.0 8.0 15.0 5.0 15.0 12.0 15.0 28.0 20.0
Y: 97 50 55 40 35 45 75 33 55 90

X: 20.0 15.0 20.0 25.0 20.0 3.5 35.0 25.0 8.5 10.0
Y: 85 125 150 120 95 30 400 148 135 45

X: 10.0 25.0
Y: 87 150

File names Excel: Slr11.xls
 Minitab: Slr11.zip
 SPSS: Slrspss11.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr11.zip

12. Prehistoric Pueblos (Simple Linear Regression)

In the following data, X = estimated year of initial occupation and Y = estimated year of end of occupation. The data are for each prehistoric pueblo in a random sample of such pueblos in Utah, Arizona, and Nevada.

Reference: *Prehistoric Pueblo World*, by A. Adler, Univ. of Arizona Press

X: 1000 1125 1087 1070 1100 1150 1250 1150 1100
Y: 1050 1150 1213 1275 1300 1300 1400 1400 1250

X: 1350 1275 1375 1175 1200 1175 1300 1260 1330
Y: 1830 1350 1450 1300 1300 1275 1375 1285 1400

X: 1325 1200 1225 1090 1075 1080 1080 1180 1225
Y: 1400 1285 1275 1135 1250 1275 1150 1250 1275

X: 1175 1250 1250 750 1125 700 900 900 850
Y: 1225 1280 1300 1250 1175 1300 1250 1300 1200

File names Excel: Slr12.xls
 Minitab: Slr12.zip
 SPSS: Slrspss12.zip
 TI-83 Plus, TI-94 Plus and TI-Nspire/ASCII: Slr12.zip

