

A Introduction to Excel

Homer: [reading screen] “To Start Press Any Key”. Where's the ANY key?

From: *The Simpsons*

A.1 Introduction

Microsoft *Excel* is a software program that organizes and manipulates data using a spreadsheet interface. In the dark ages before the personal computer, accountants commonly used spreadsheets (paper ones) to organize complex computations. This computational style was quickly adapted to the PC and became one of the principal market forces driving sales of computers to businesses. Today, spreadsheet style programs are pervasive, not just in the business world, but in much of the scientific community in a variety of data analysis and high-powered graphics packages. Although all these programs have different specific features, there are many elements of commonality, so that learning the details about one of them reduces the effort needed to learn a new one.

In this text we have chosen to use *Excel* as our computational tool because it is widely available and readily customizable for the variety of computational tasks we need to study. This customization allows you to work with the program initially with a minimal knowledge of the software. Where appropriate in the text we have included sections of “Tech Notes” that describe in some detail a particular *Excel* application that you need to use. As you go through the text you will gradually learn more details about using *Excel* and should become comfortable in using it to do the sort of data analysis that is very commonly needed in laboratory courses.

This introduction is not meant as a comprehensive guide to *Excel*. For that, the interested reader should consult the shelves of his local bookstore where he will find a veritable cornucopia of books on *Excel*, many with accompanying CD (we have listed a few in the bibliography). Our goal in this Appendix is to present an overview of some essential features. Each section describes some aspect of *Excel* that is relevant to scientific computation. The material is further illustrated in step-by-step fashion in the workbook *tutorial.xls*. The reader should work through the worksheets in the latter file to reinforce the ideas presented here. Finally, we have given some exercises to test your understanding of the material.

A.2 The Spreadsheet Interface

Figure A.1 shows the *Excel* screen. It shares many similarities with any other screen for a Windows application. We assume that the reader is familiar with certain common aspects of all Windows programs, such as opening and saving a file and using the mouse to select parts of the workspace for further manipulation.

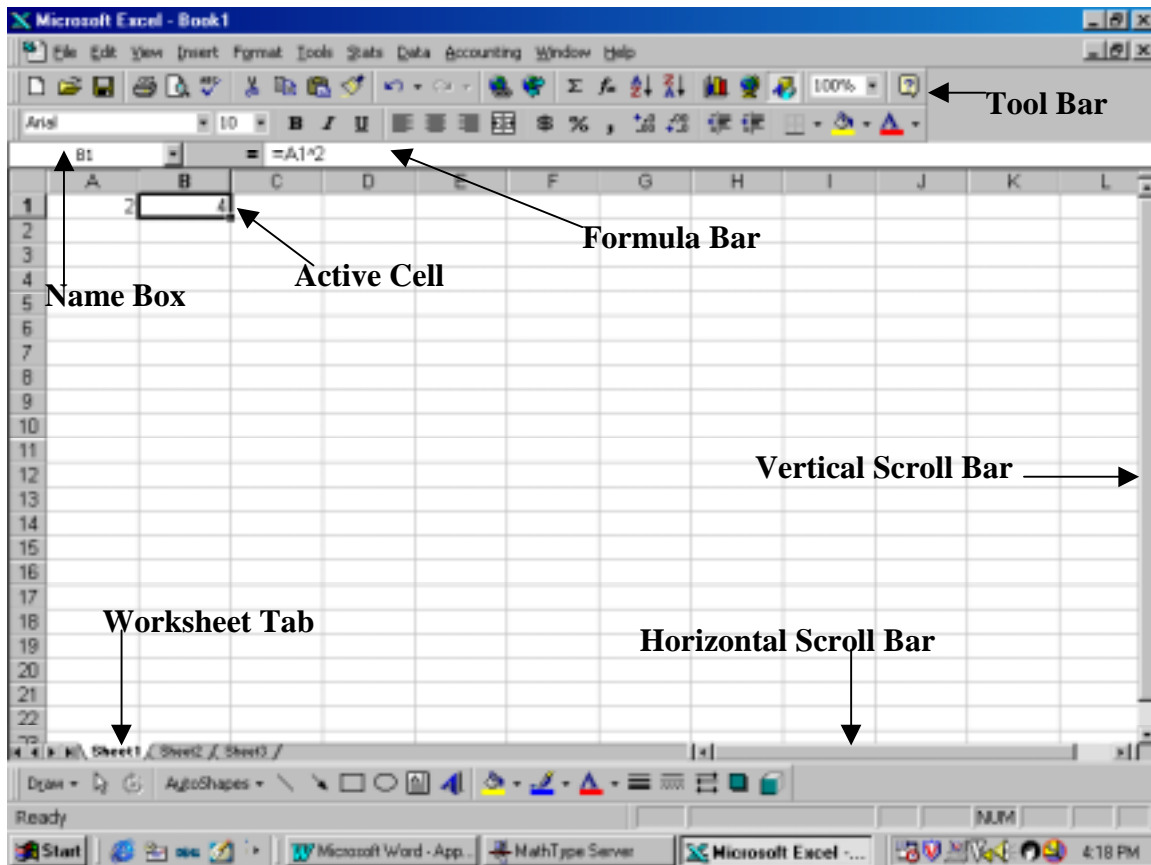


Figure A.1

Below the menu bar at the top of the screen is a **toolbar** containing icons that act as shortcuts for many common tasks. Pointing the mouse at an icon brings up a very brief explanation of its function. A **vertical scroll bar** is on the right side of the window and a smaller **horizontal scroll bar** is at the bottom right. Also along the bottom are three tabs labeled "Sheet1", "Sheet2", and "Sheet3." Each sheet is called a **worksheet** and the collection of sheets (of which there can be more than three) is called a **workbook**. Clicking a tab brings the associated worksheet to the top of the screen.

The work area on a sheet is divided into a rectangular array. Each box in the array is called a **cell**. The cell in which data is currently being entered is called the **active cell** and appears with its bounding box highlighted. To specify a cell's location (called a **cell reference**) you give the column letter and row number in which it lies. In Figure A.1 the active cell is B1 (or b1 - the capitalization is not important, but no space is allowed between the letter and the number). The reference of the active cell is listed in the **name box** in the upper left portion of the screen.

The cells in a worksheet can contain numbers, text or formulas. Entering numbers or text is rather straightforward. Click the mouse (or use the arrow keys) to highlight the cell in which you want to enter the data. Type your entry then press the Enter key or hit an arrow key to move to any adjacent cell. In Figure A.1 the number 2 was entered into cell A1 in this way. However, the

number 4 in cell B1 appears as the result of a calculation. We entered in B1 a formula that tells *Excel* to square the entry in A1. This formula ($= A1^2$) is displayed in the **formula bar** below the toolbar. When you enter a formula, *Excel* writes the result of the computation in the active cell, but displays the formula in the formula bar. Formulas have a special syntax to distinguish them from plain text. A formula always begins with an = sign. The conventional keyboard symbols are used for mathematical operations: + for addition, - for subtraction, * for multiplication, / for division, and ^ for exponentiation. A common error is to omit the multiplication sign. *Excel* will usually display some error indication if you do so.

The table below contains on the left a copy of a portion of a spreadsheet in which data was entered in column A and formulas in column B. The right side shows the same sheet, but with the formulas printed in column B, rather than the results.

	A	B		A	B
1	2	-0.5	1	2	=A1/A2+A3
2	4	0.666667	2	4	=A1/(A2+A3)
3	-1	#REF!	3	-1	=A1(A2+A3)
4	7	a1(a2+a3)	4	7	a1(a2+a3)
5	2	6	5	2	=A1*(A2+A3)

Table A.1

Observe the different results in B1 and B2 depending on the placement of parentheses and the customary rules regarding order of operations. The expression evaluated in B1 would be written in more conventional notation as $\frac{A1}{A2} + A3$, whereas in B2 we have $\frac{A1}{A2 + A3}$. The entries in B3 and B4 exhibit errors. In B3 the multiplication sign has been omitted and *Excel* returns an invalid reference error (#REF!). In B4 the equality sign was omitted so *Excel* interprets the result as text and simply prints it as such. B5 contains the intended formula and the correct result is displayed.

Often it is necessary to refer to a block of cells (called a **range**), instead of just a single cell. The reference for a range is obtained by using the cell references for the upper left corner and the lower right corner of the range. For example, the cells marked with **X**'s in the figure below would be referred to as A1:C3.

	A	B	C	D
1	XXXXX	XXXXX	XXXXX	
2	XXXXX	XXXXX	XXXXX	
3	XXXXX	XXXXX	XXXXX	
4				

Range references are particularly useful with *Excel's* built-in functions. For example, suppose we want to add the nine numbers that appear in the range A1:C3 and place the result in D4. We could of course write a formula in D4 to do this: =A1+A2+ ... +C2+C3. Certainly you get the point of the ... representing missing terms. Unfortunately, *Excel* is not that smart, so you would have to type all nine cell references. Clearly a larger range would pose an unacceptable amount of typing. Fortunately, *Excel* has a built-in function, the **sum** function that will easily accomplish the task. In the worksheet below we entered into D4 the formula =sum(a1:c3) and the result 45 appears.

	A	B	C	D
1	1	2	3	
2	4	5	6	
3	7	8	9	
4				45


In entering a function it is important not to leave any space between the name of the function, for example *sum*, and the parentheses that contain the argument(s) of the function. Typing =sum (a1:c3) will result in the error statement #NAME!, meaning that there is no function of that name.

Excel contains many standard mathematical functions, such as sin, cos and exp, the latter standing for the natural exponential function. Table A.2 illustrates how some of these may be used. On the left side is the actual display, while the right side shows the formulas that are typed. For example =EXP(A1) computes e^2 .

	A	B		A	B
1	2	7.389056	1	2	=EXP(A1)
2	0.693147		2	=LN(2)	
3	9	3	3	9	=SQRT(A3)

Table A.2

Quite often it is necessary to enter in a worksheet a series of numbers that follow a pattern. A very common pattern that is useful in graphing is one in which each number in the series equals the preceding number plus a constant. For example, .5, 1.0, 1.5, 2.0 form such a series, known as a linear series in *Excel* (and an arithmetic progression in mathematics texts). Such a list can be generated automatically by a method described in lesson 1 of *tutorial.xls*, which you should work through after reading this section.

 **Finally, you should expect to make mistakes using a new program, especially one as complicated as Excel.** Fortunately you can undo whatever you have done using the Undo command on the Edit menu or the undo icon on the tool bar. The moral is that you shouldn't be afraid to experiment.

A.3 Relative & Absolute References

Spreadsheets are often used to carry out the same computation on each data value in a certain range, typically a column or a row. Usually, the formula required for the computation is entered once and then it is copied en masse to the other locations. The actual mechanics of this copying process are described in lesson 2 of the tutorial and will not be repeated here. It is important to understand though how this copying works because it is not quite the same as copying something in a word processor. In a word processor, copying creates a duplicate of the selected item. In a spreadsheet, copying modifies the copied formula in an important way.

In Table A.3 below we have entered the numbers 1, 2 and 3 in column A. We want to square each of these entries and place the result in the same row, but in column B. We accomplish this by entering the formula `=A1^2` in cell B1 and then copying this formula (using the Fill/down command on the Edit menu) to the cells B2:B3. As the right side of the table shows, the copied formulas are not identical to the original formula, which would not do what we needed done, but in fact are exactly the right formulas for the computation that we desire.

	A	B		A	B
1	1	1	1	1	<code>=A1^2</code>
2	2	4	2	2	<code>=A2^2</code>
3	3	9	3	3	<code>=A3^2</code>

Table A.3

Our formulas are modified when they are copied because the standard reference system we described in section 2 is a **relative reference** system. Cell B1 contains a formula that has a reference to cell A1. The latter cell is one column to the left of B1 and in the same row. When the formula is copied to another location, say B3, the reference to cell A1 is replaced by a reference to the cell one column to the left of B3 and in the same row, i.e. cell A3. If the formula in B1 is copied to cell C3 it would read `=B3^2`.

Relative referencing is a very powerful tool that vastly simplifies the process of constructing complicated spreadsheets. However, there are situations when one wants to copy a formula and not have a reference change. In such a case the formula should use **absolute references**, indicated by a \$ sign. In Table A.4 we have entered the formula in B1 using an absolute reference to cell A1, namely `=A1^2`. When this formula is copied to another location it is simply duplicated, thus giving the results shown.

	A	B		A	B
1	1	1	1	1	<code>=\$A\$1^2</code>
2	2	1	2	2	<code>=\$A\$1^2</code>
3	3	1	3	3	<code>=\$A\$1^2</code>

Table A.4

It is possible, and sometimes necessary, to mix absolute and relative references. For example, the formula in B1 could have been written as $=\$A1^2$ or $=A\$1^2$. When such a formula is copied the absolute reference remains fixed, while the relative reference is modified according to the method discussed above. In this case the reader should verify that after copying to B2:B3, the first of these options would produce the same results as in Table A.3, while the second formula would produce results identical to those in Table A.4.

A.4 Graphing

Graphical displays of data are one of the principal uses of spreadsheets. *Excel* provides a very convenient mechanism for constructing graphs - the so-called **chart wizard**. You activate this step-by-step process by clicking the chart wizard icon (see Figure A.2) on the toolbar.



Figure A.2

Lesson 3 in the tutorial takes you through the steps necessary to construct the graph of a function over some interval. While the method for doing this in *Excel* is certainly not as convenient as using a graphing calculator or a program specifically designed for graphing mathematical expressions, the procedure will serve to illustrate the use of the wizard in a context that should be familiar to the reader. Other types of graphs will be discussed during the course, which will give us ample opportunity to review the techniques.

A.5 Exercises

1. What is the difference between a worksheet and a workbook?
2. What is the toolbar and what is it used for?
3. When will the contents of the formula bar be different from the display in the active cell?
4. Each picture below shows a portion of a worksheet with some cells containing **X**'s. Give the reference for those cells.

a)

	A	B	C	D
1				
2				
3	XXXXX	XXXXX	XXXXX	XXXXX
4				

b)

	A	B	C	D
1				
2	XXXXX	XXXXX	XXXXX	
3	XXXXX	XXXXX	XXXXX	
4				

c)

	A	B	C	D
1			XXXXX	
2			XXXXX	
3			XXXXX	
4			XXXXX	

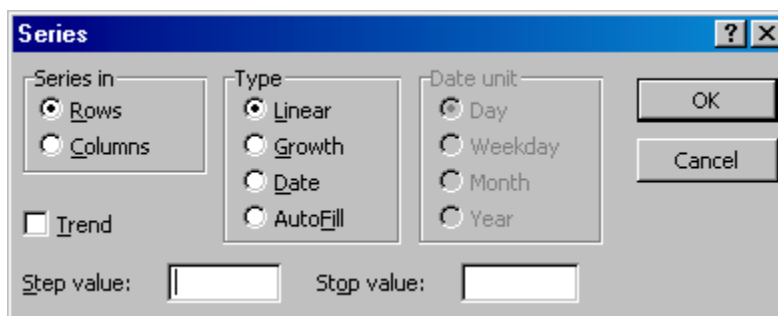
5. The worksheet below contains numbers, text and formulas. Determine the values that would appear in the following cells.

a) A3 b)B3 c) C1 d) C2 e) C3 f) D1 g) D2 h) D3

	A	B	C	D
1	3	2	=A1*B1	=2/5
2	5	6	=A1+C1	2/5
3	=SUM(A1:B2)	=SQRT(A3)	EXP(0)	=EXP(0)

6. You wish to generate the linear series 2,5,8, ..., 32 in column A beginning with cell A2.

a) How must you fill in the series dialog box below?



b) What cell will contain the final number in your series?

7. In the worksheet below, if we copy cells B3 and B4 to C3 and C4 respectively, what formulas will the latter two cells contain and what values will be displayed in these cells?

	A	B	C	D
1	-2	2	3	1
2	4	5	-1	0
3		=A\$1+B1+C1		
4		=SUM(B1:C2)		

8. You want to construct a table showing the area and perimeter of various rectangles, given the length and width. The length and width are recorded in the following worksheet table under the appropriate heading.

	A	B	C	D
1	length	width	area	perimeter
2				
3				
4				

- What formula (using cell references) should you enter in C2?
 - What formula (using cell references) should you enter in D2?
 - How would you simultaneously copy the formulas in a) and b) to the remainder of columns C and D using the Fill/Down option from the Edit menu?
9. The following portion of a worksheet provides a method for generating a famous series of numbers called the Fibonacci sequence. Similar constructions are used in Chapter 17 of the text. If the formula in C1 is copied to the range D1:G1,
- What formulas will be written in each cell?
 - What numbers will be displayed in the range C1:G1?

	A	B	C	D	E	F	G
1	1	1	=A1+B1				



10. Prepare a table (with appropriate column headings and title) showing the values of the $\sin(\theta)$, where θ has values of $1^\circ, 2^\circ, \dots, 45^\circ$.

N.B.: The SIN function in *Excel* is defined for radian arguments. You will have to convert your angles to radians using the conversion formula: $\text{radians} = \text{degrees} \times \pi / 180$. The value of π can be obtained using the built-in constant PI(). Check your answers for some simple values, such as 30° and 45° .



11. Construct a graph of the function $y = e^{-x^2}$ for x between -3 and +3. The graph is related to the normal distribution that we will study in chapter 13. (Warning! In *Excel* changing a sign has precedence over exponentiation. Thus $=-3^2$ evaluates to 9, not -9 as is usually the case in algebra. You will need parentheses to recover the usual value.)