

# Creating Interactive Worksheets in Excel

This introduction assumes that you already have basic familiarity using Excel. The screen shots are taken from Microsoft Excel 2000. You will be learning how to include interactive tools (sliders, buttons, drop-down boxes, etc.) into your Excel worksheets.

## If-Then Conditional Statements

An *If-Then* conditional statement is one of the form

If <condition>, then <result>

This statement says that if the condition is satisfied or true, then the result is obtained. Two examples are:

1. If your average is 90% or higher, then your grade is an A.
2. If  $a \cdot b = 0$ , then  $a = 0$  or  $b = 0$ .

An *If-Then-Else* conditional statement is one of the form

If <condition>, then <result> else <different result>

This statement says that if the condition is satisfied or true, then the result is obtained. Otherwise, if the condition is not satisfied (or false), then the different result is obtained. Two examples are:

3. If your average is 60% or higher, then you pass, else you fail.
4. If  $x \geq 0$ , then  $|x| = x$ , else  $|x| = -x$ .

Excel has a built-in IF-statement with the following syntax:

**=IF(conditional statement, value to return if true, value to return if false)**

The conditional statement can refer to values in other cells. Then the value to return will be displayed in the cell where the conditional statement is typed. You must have the first two argument (in bold), the *value to return if false* is optional.

Download the Excel Examples from the class website. You should see the following example for grades:

	A	B	C	D	E	F	G	H	I
1	<b>Name</b>	<b>Exam 1</b>	<b>Exam 2</b>	<b>Exam 3</b>		<b>Total</b>	<b>Average</b>	<b>Grade</b>	
2	Bob	67	50	43		160	53%		
3	Tom	71	88	87		246	82%		
4	Sue	100	97	94		291	97%		
5									
6	Possible	100	100	100		300	100%		
7									
8									
9									

Enter formulas in to compute the total and the average. Change the format for the averages to that it displays as a percentage, as above.

Using If-Then statement #1 from above, we would like the letter grade A to be displayed in column H when the average is 90% or higher. So the result in column H depends on the value in column G. Type the following If-statement into cell H2\*:

=IF(G2>0.89, "A")

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\* The values in column G are percents, so we must use the decimal equivalent in the If-statement

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Fill this formula into the other two cells in column H. What is returned if the percent is less than 90?

Now suppose we want to return only P for passing and F for failing given by conditional statement #3 above. Fill in the following If-statement exactly as you would type it in Excel.

$$=IF(\text{conditional statement}, \text{result}, \text{other result})$$

Type this statement into cell H2 and fill in the column. Make sure it worked properly.


A nested IF-statement would another contain IF-statement in either of the result positions. For example, if you want to return each letter grade A-F depending on the percentage, the statement would be

$$=IF(g2>.89, "A", IF(g2>.79, "B", IF(g2 > .69, "C", IF(g2 > .59, "D", "F"))))$$

So if  $g2 > .89$  is false then Excel goes to the *other result*, which is the If statement  $g2 > .79$ , which returns B if true, but looks at the If-statement  $g2 > .69$  if it is false, and so on. Type this statement into cell H2 and fill column H. Did it return the correct letter grades?

### Scroll Bars (Sliders)

Now we will learn how to include scroll bars (or sliders) into an Excel worksheet to make it more interactive. Open the worksheet entitled sliders to see the following example:

	A	B	C
1	value of the slider:	47	
2			
3			
4			

This slider ranges from the value 0 to 100 in increments of 1. Click and drag the slider or click on the arrows to change the value.

To create a new slider, from the View menu, select Toolbars. Choose Forms and the following toolbar should appear.



There are several options available on this toolbar such as check boxes, option buttons, drop-down boxes, etc. We will only be learning about sliders or scroll-bars today.

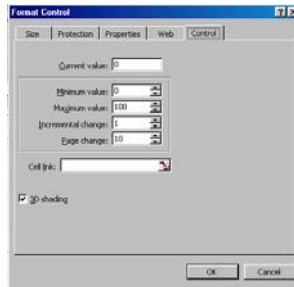
- Select the scroll bar.
- Place your cursor over cell C6 and click your mouse. This will cause a large vertical slider to appear. Resize the slider by dragging on one corner. If you experiment with this you will see that it changes from vertical to horizontal depending on the size. If you would like the size of your slider to

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correspond to your cell borders, hold the ALT-key down while dragging the corner. Resize and move the slider to fit into cell C6.

If you drag this slider, you will not see any values changing. We have to tell Excel which cell we want the value of the slider to be given. We can also change the integer range that the slider uses:

- Right click on the slider in cell C6. Select Format Control and the following window should open.



The Format Control box is used to set the values for the slider. The *Minimum and Maximum values* must be **positive integers** and the *Incremental change* must also be an **integer**. The Cell link box is the cell where you would like the value of the slider to appear.

Format this slider to range between 0 and 20 using increments of 2. Link the slider to cell C5. Click OK.

Click in any cell away from the slider to de-select it. Now move the slider by clicking on the arrows to see that the values change by 2 and the value should appear in cell C5.

Open the Format Control Box again. Change the incremental change to be 0.25. Click OK. Check to see if the slider works properly both by dragging the slider and by clicking on the arrows to increment on step. Is it working correctly?

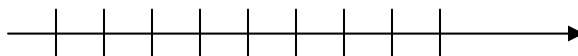
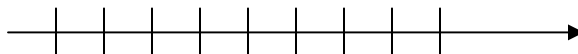
Open Format Control Box again to see what value is in the Incremental change. You should see that it is not 0.25, but rather 0. Excel will not let you use fractions.

Change the Incremental Change back to 1 and try to change the range to be  $-4$  to  $4$ . What happens?

So the difficulty comes when you want your slider to have negative values or increment in values less than one. But you can still use it, you will just have to manipulate the data in other cells.

Let's set up a slider that will give us values between  $-4$  and  $4$ , but still use 1 for the incremental change (i.e.  $-4, -3, -2 \dots, 3, 4$ ).

- On the first number line below, label the desired values of the slider for the interval  $[-4, 4]$ . On the second number line below, start with the **Minimum value** of 0, label all the points with the integers and determine the **Maximum value**.



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Enter the Minimum and Maximum values here and in the format control box for your slider.

Minimum value \_\_\_\_\_ Maximum value \_\_\_\_\_

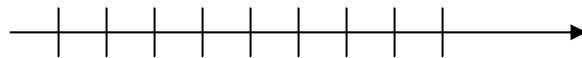
We now need to shift this interval [0,Maxvalue] to give us the interval [-4, 4].

What value can you add to the slider interval to get the desired interval? \_\_\_\_\_

- Change the slider to be linked to cell C7. This will output the slider values starting at 0.
- Click OK. Click you mouse anywhere away from the slider so that it is de-selected.
- In cell C5 type the formula =C\$7-4 which will take the slider value and shift it by down by 4.
- Since we don't really want to see the values in cell C7, we can hide the row from view. Select the entire row 7 and right-click. Select the hide option. This hides the row and you can see that the row numbers skip from 6 to 8. (If needed, you can unhide the rows by highlighting rows 4 and 6, right-clicking, and selecting unhide.)

**Exercise.** Create a slider to vary from 0 to 1 in increments of 0.2. Put a new slider in cell D12 and link it to cell D13.

- Start by sketching the points from 0 to 1 on the number line in increments of 0.2. Below that number line, start with Minimum value of 0 and label the integers that must be used in the slider to determine the Maximum value.



- What formula must you apply to the values on the 2<sup>nd</sup> number line to obtain the corresponding values on the 1<sup>st</sup> number line. [Hint: Think of the integers as input values (x) and the decimal numbers as the output values (y), so that you get a line  $y = mx+b$  that will take the integers x and output the values you want y]

Enter this formula in to cell D11 (with a reference to the values in cell D13) and make sure that it gives you the desired values. Hide row 13.

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## Interactive Worksheets

Open the worksheet labeled quadratic. This worksheet is made to explore how the different coefficients  $a$ ,  $b$ , and  $c$  affect the roots of a quadratic equation  $ax^2 + bx + c = 0$ . This worksheet is what your students will see and get to play with. The following is the process of setting it up.

Given the quadratic equation  $ax^2 + bx + c = 0$ , we know that the roots are given by the quadratic formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

If the value in the square root is negative, then there are no real roots (the roots are complex). Let's set up an IF-statement to determine whether real roots exist and, if so, compute them.

Before typing everything in Excel using cell references, fill in the following blanks with an appropriate conditional statement and what you would like Excel to do depending on whether it is true or false.

Conditional Statement: \_\_\_\_\_

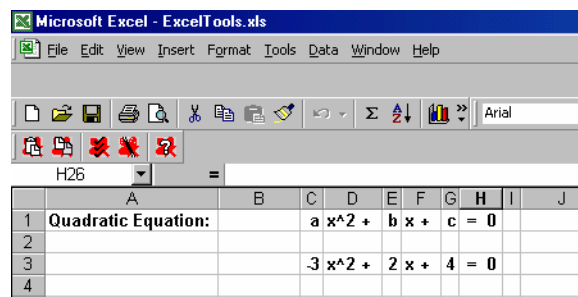
If the Conditional Statement is True, then: \_\_\_\_\_

If the Conditional Statement is False, then: \_\_\_\_\_

Now let's use Excel. Open a new Excel Spreadsheet.

- In the cell A1, type Quadratic Equation:
- In cell D1, type  $x^2 +$ . In cell F1, type  $x +$ . In cell, H1, type  $= 0$ . Copy these cells and paste them into cells D3, F3, and H3.
- In cells C1, E1, and G1, type the letters a, b, and c, respectively. Right align these 3 cells.
- In cells C3, E3, and G3, enter values for the coefficients  $a$ ,  $b$ , and  $c$ .
- Select all the columns A-H and double-click the right boundary to auto-resize the column width.

Your spreadsheet should look similar to the one below:



- In cell E5, type D=
- In cell F5, enter the formula for  $D = b^2 - 4ac$  using references to cells A3, C3, and E3.

Now we can refer to the value computed in cell F5 in the IF statement.


- In cell A5, type Roots (x =):
- In cell B5, enter the IF-statement as follows:

=IF(\$F\$5<0, "No Real Roots", (-\$E\$3+SQRT(\$F\$5))/(2\*\$C\$3))

Copy this statement into cell B6 and change the appropriate +sign to a -sign to get the other root.

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Test your conditional statement using the values  $a=1$ ,  $b=0$ , and  $c=-4$ , (i.e.  $x^2 - 4 = 0$ ). Then change  $c = 4$  (i.e.  $x^2 + 4 = 0$ ) and verify the correct results. Play around with other values of the coefficients.

*Aesthetic Hint:* Select a rectangular region including all of your equations and text. Then using the background fill color button , shade this rectangular region. By choosing a lighter background color, the text is easy to read.

	A	B	C	D	E	F	G	H	I	J	K
1	Quadratic Equation:		a x^2 +	b x +	c = 0						
2											
3			3 x^2 +	6 x +	-2 = 0						
4											
5			Roots (x =):	0.290994		D=	60				
6				-2.29099							
7											
8											
9											
10											
11											
12											
13											
14											

Notice that the color covers the gridlines making the equations easier to read.

Now we will include sliders into an Excel worksheet to make it more interactive. We will be working with the same quadratic equation as before.

- Copy all of your previous work and past it into a new Excel worksheet. Remove the background color using the button and selecting No Fill. Resize only column A. Leave the other columns as they are. Insert a two new rows between rows 3 and 5.
- Add sliders to your worksheet in cells C4, E4 and G4.

These sliders will be used to control the changes to the coefficients  $a$ ,  $b$ , and  $c$ . We must format them to represent the values we would like. Let's have all of the coefficients range from  $-10$  to  $10$ .

Let's set up the slider for coefficient  $c$  to range between  $-10$  and  $10$ :

- Set Minimum value to 0 and Maximum value to 20.
- Select cell G5 for the Cell link.
- Click OK. Click your mouse anywhere away from the slider so that it is de-selected.
- Use your pointer to move the slider bar. The numbers in cell G5 should change with the slider.
- In cell G3 type the formula  $=G5-10$ . Notice that this will use the value from the slider and subtract 10 from it. For example, if the slider is at 0, then the value in cell G3 is  $-10$ . Likewise, if the slider is at 20, then cell G3 is at 10. Note that this formula has shifted the slider range from  $[0,20]$  to  $[-10,10]$ .

Repeat this process for the coefficients  $a$  and  $b$ .

As you move the sliders, you should see how the root solutions change accordingly. Move the slider so that the coefficient for  $a$  is 0.

What happens to your roots? \_\_\_\_\_

Why? \_\_\_\_\_

Since we only want to consider quadratic equations, we don't want  $a=0$  (that would be a linear equation). However, we do want to consider negative values of  $a$ . There are several ways to deal with this problem. We use an IF-statement to make a simple change:

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- Enter the following IF-statement into cell C3:  $=IF(C\$5-10=0,1,C\$5-10)$ . Fill in the box below to explain this IF-statement.

Conditional Statement: \_\_\_\_\_  
If the Conditional  
Statement is True, then: \_\_\_\_\_  
If the Conditional  
Statement is False, then: \_\_\_\_\_

To complete this interactive worksheet we will add a graph, hide unnecessary details, and color the background.

To add a graph, we must compute a set of points for Excel to plot.

- In cell J7 enter the value  $-10$
- In cell J8 enter the formula  $=J7+1$ . Fill this formula until you have values ranging from  $-10$  to  $10$ .
- In cell K7 enter the formula for the quadratic:  
 $=\$C\$3*J7^2+\$E\$3*J7+\$G\$3$
- Select the data in columns J and K. Create a scatter plot without markers. Add titles, labels, and coloring as desired. Place this graph conveniently below the equations and roots.

Since we don't really want the actual values of the sliders in row 5, we can hide them from view.

- Select the entire row 5.
- Right-click and select the option hide. This hides the row and you can see that the row numbers skip from 4 to 6. (If needed, you can unhide the rows by highlighting rows 4 and 6, right-clicking, and selecting unhide.)

Finally, color the background of your worksheet and you should have a slick-looking interactive worksheet.

### Exercises

1. Suppose you wanted the coefficient for  $a$  to range from  $-2$  to  $2$  (excluding  $0$ ) but in increments of  $0.25$ . Make appropriate changes to the Format Controls and the formula in cell C3.
2. Remove the IF-statement from cell C3 so that you allow the coefficient  $a$  to be  $0$ . Modify the statement in cell B7 to be a nested IF-statement to compute the single root in the case that  $a=0$ . Make a similar modification to the statement in cell B8, but have it return the statement "Linear Equation: Only 1 Root".

Hints:

Nested IF-statements have an additional IF-statement in either or both of the *value to return if true* or *value to return if false* positions.

Consider the formula to compute the root of a linear equation. You will see that another coefficient may give you problems. You will need to include an additional IF-statement to deal with this.

Test your worksheet to make sure it works correctly. Save it as **quad\_yourname.xls**, then email it to [crawford@elmhurst.edu](mailto:crawford@elmhurst.edu)