Lab 2 -- Derivative Play Demonstration

Overview

In this exercise, you will make a spreadsheet that calculates the derivative of a function at a point and graphs both the function and the tangent line.

Skills to be learned

Mathematical Skills:

1. Calculating the derivative numerically.
2. Finding the equation of a tangent line.
3. Creating and organizing information.

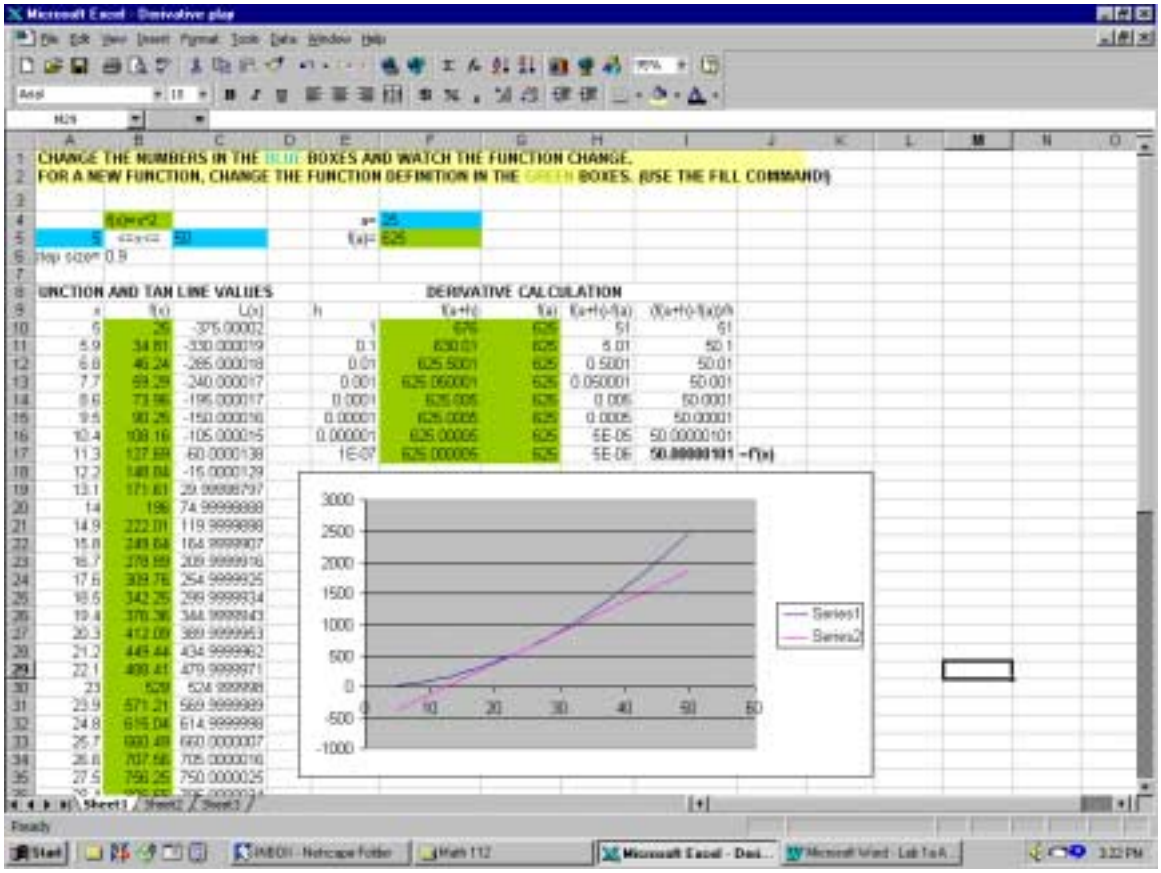
Excel Skills:

1. Graphing with Excel.
2. Working with absolute and relative cells.

The Lab

Create a spreadsheet that looks like the following pictured demo. This spreadsheet takes an inputted function, a range of x-values, and a point, and calculates the derivative at that point, as well as giving the graph of the function and the graph of the tangent line.

Before you try to build this sheet, experiment with the sample sheet on the Math 112 course web page (http://mathweb.uccs.edu/mlc/courses/112/112_home.html**), to be sure that you know how it works.**



Excel Skills to Master:

Graphing

Excel makes graphs by plotting points, probably the same way you learned to graph functions in your first algebra class. Before starting on your derivative spreadsheet, do this practice exercise to get Excel to plot the function $f(x) = 3x^2 - 2$ from x=0 to x=10

1. Put this practice exercise on sheet 3 of your workbook. Click on the "Sheet 3" tab on the bottom of the workbook.
2. Make an x and y table of values for Excel to plot.

In Cell	Enter, or tell Excel to
A1	0
A2	=A1+.2
A3:A51	Fill down
B1	=3*A1^2-2
B2:B51	Fill down

3. Have Excel graph your data
   a. Highlight A1:B51
   b. Click on the chart icon on the Excel toolbar.
   c. Choose XY (Scatter)
   d. In the right hand side of the chart type dialog box, click on the upper right picture, with the smooth graphs.
   e. Click on Next. You'll get Step 2 of the chart dialog box.
   f. Click on the series tab.
   g. Name = My Graph.
   h. Click on Next. You'll get step 3.
   i. On the title tab, give your graph the title "Practice graph." Name the X axis "X values" and the Y axis "Y values"
   j. Under Gridlines, click on x and y major and minor gridlines, watch to see how this affects the graph.
   k. Under legend, choose the different options and see how this affects the graph.
   l. Click on next. You'll get to step 4 of the chart dialog box. You can choose to have your chart appear on a new sheet of the workbook, or within an existing workbook. For now, leave your chart as an object in Sheet 3, the current sheet.
   m. Click on Finish. Your graph should appear next to your data.

Naming cells and working with absolute cells

If you examine the formulae in Column B of your spreadsheet, you'll find that Excel automatically changes the cell references as it works down the column. This is called using *relative cell references*. Sometimes you don't want this -- you want an *absolute cell reference* instead. There are two ways to do this:

   a. Put dollar signs in front of the column and row of a cell that you want to keep referring to. E.g., use A15 instead of A15.
   b. Name the cell (described below).

In this exercise, you will improve on the graph you made so that you can graph a function on any *x* values you specify.

1. Insert two new rows at the top of the spreadsheet.
2. Enter 0 in cell A1.

3. Highlight that cell. In the toolbar, below the font style box, there is a box that should say A1. This is the *name box*. Highlight this box and enter the word "xleft."
4. Enter the number 10 in cell B1 and name that cell "xright."
5. Enter the formula =(xright-xleft)/50 in cell A2 and name that cell "stepup."
6. Change cell A3 to read =xleft.
7. Change cell A4 to read =A3+stepup.
8. Fill down column A to cell A54.
9. Now, change cell A1 to 5 and B1 to 200. All the remaining cells in the spreadsheet should change to accommodate these values. Your graph should change also, so that you are looking at the graph of $f(x)=3x^2-2$, but now the graph is shown from $x=5$ to $x=200$. Did it work the way it should? If not, go back and fix your work.

Naming Spreadsheet Pages

1. Right click on the Sheet 3 tab of your workbook.
2. Select "rename."
3. Rename this sheet "Exercise."
4. Rename Sheet 1 "Derivative Demo." **Put the rest of your work on the Derivative Demo page. When you hand in your lab, your work will include *both* pages of the workbook.**

The Derivative Demo Page
Features Your Spreadsheet Should Have:

Cell(s)	Entry
Rows 1 and 2	General directions for someone who runs the spreadsheet. These are just text entries.
B4	Name of the function being analyzed. This is just a text entry. For your prototype, use f(x)=x^2.
A5:C5	These are the domain values to graph the function over. Cell B5 is just the text input <= x <=. Cells A5 and C5 will be the x-values of the interval graphed. For your prototype, use -1 and 5. Name Cell A5 "left" and cell C5 "right."
E4:F4	The *a* value where you want to take the derivative and graph the tangent line. Cell E4 is just the title (right justified) a=. In Cell F4, you will enter the actual *a* value (left justified). For your prototype, use the value 3. Name this cell "a."
E5:F5	The *y* ($f(a)$) value that goes with your *a* value. Just like the row above, cell E5 is just the title f(a)=, right justified. Use a formula to have Excel automatically calculate the value in cell F5. Name this cell "fa," and left-justify the entry
A6:B6	The step size used to graph your functions. Calculate this like you did in the exercise, and name cell B6 "step."
Rows 8 and 9	These rows contain titles to label the work you have done, so that others can use your spreadsheet.
A10:B60	These are entries for the graph of the function $f(x)$. Use your knowledge from the graphing and naming exercises to fill in these

	cells.
E10:I17	These cells are where you will build the derivative when $x=a$.
E10:E17	These are decreasing values of h, so that you can have Excel estimate $\lim_{h\to 0} \frac{f(a+h)-f(a)}{h}$. Enter 1 into E10, and have Excel fill in the rest of the column by dividing the previous entry by 10.
F10:F17	Use formulas and the fill function to have Excel calculate $f(a+h)$. Remember that a is in a named cell!
H10:I17	Continuation of the derivative building process. Cell I17 will have the derivative calculated when $x=a$. Name this cell "fprime."
C10:C60	This column will have the y-values for the tangent line. Recall that you can define the tangent line of $f(x)$ at point a with the formula $L(x) = f(a) + f'(a)(x-a)$. Use Column A for the x value, and use the named cells fa, a and fprime for the other values. Use the fill feature to fill the entire column.

Graphing

Insert a graph of $f(x)$ and its tangent line at $x=a$ like you did in the exercises. To have Excel graph two functions at once, simply highlight all three columns before clicking on the chart icon. Label Series 1 "f(x)" and Series 2 "Tangent Line." Label your x and y axes. Put your name(s) on the title of your graph.

Testing Your Spreadsheet

1. Change cells A5, C5 and F4. Be sure that your spreadsheet cells and graph change to reflect these new values.
2. Change the formula for another function. You will need to change cells B4, B10:60, F5 and F10:17. Be sure that your spreadsheet cells and graph change to reflect the new values.

Formatting and Handing In

1. Change your spreadsheet so that it gives the graph of $f(x) = 2x^3 + 5x$ from $x = -6$ to $x = 12$, and the tangent line is at $a = 7$.
2. Shade cells A5, C5 and F4 one color and cells B4, F5, B10;60 and F10:G17 a second color.
3. ADD A NEW ROW AT THE TOP OF THE SPREADSHEET, AND ENTER YOUR NAME(S). Email your lab to me. Use the subject line XL Lab 2.