
Forming Lab Groups

Much of your work in lab in this course will be done in groups of three (or sometimes two) people. Begin by forming groups, introducing yourselves, and exchanging contact information (phone, e-mail, etc.) Also agree upon a time and location that you can meet as a group at least one day before lab meets again next week.

Today's lab will develop your understanding of piecewise linear functions, especially as they can be used to approximate other functions. To begin, take out your "Class 3" handout and work as a group to complete the questions which were not completed in class. When you are done, check your work with the professor for the lab and then move to one of the computers. Your whole group should share one computer. Each of you will take a turn at the mouse and keyboard. The rest of the group should assist by making suggestions about what to do and discussing results.

Using the Lab Computers

No prior experience with computers is necessary. You will learn everything you need to know about computing for this course in the labs themselves. To begin, make sure the computer is on, there is no disc in the floppy drive and that Windows is running. If Windows is not up, reboot.

Introduction to Excel

Opening Excel: In the Desktop, find the folder labeled `Spreadsheets`. In this folder, double-click on the `Microsoft Excel 97` icon. If the Excel window is not as large as possible, you may wish to maximize its size. You can do so by either double-clicking on the colored bar at the top of the window or by clicking on the middle box in the upper right-hand corner of the window. Be careful! Clicking on the box containing the **X** will close Excel.

Opening Specific Excel Files: The standard name of an Excel file has the form

drive:/*folder 1*/.../*folder n*/*filename*.xls

which also tells you its location. To open an Excel file, click on the `File` menu and select `Open...` (or click on the yellow folder in the toolbar). The `Open` dialog box will appear. Click on the downward pointing arrow next to the field labeled `Look in:`. A box with the drive and directory structure for your machine will appear. Select the appropriate drive. The first level directories for that drive should appear as folders in the large field. Select the top level directory, *folder 1*. The subdirectories in *folder 1* will appear. Keep selecting the appropriate folders until you reach *folder n*. The Excel file *filename*.xls should appear. Select it by double-clicking on its name or icon.

Use this procedure to open the file `h:/Math Courses/Math110/Wk02F00Lab.xls`.

Sheets in Excel Files: Excel is a spreadsheet program. A spreadsheet is a large table in which one may enter and manipulate data. Most Excel files contain one or more spreadsheets and may also contain charts and other diagrams. We will refer to all of these as *sheets*. Each sheet is labeled on a tab found on the bottom left-hand edge.

When you first opened Excel, the program created a new *Workbook* for you automatically. It had three sheets, labeled `Sheet 1`, `Sheet 2` and `Sheet 3`. In most Excel files for your computer labs, the sheets will have labels which indicate their intended use or contents. Sometimes an Excel file will have so many sheets that you will have to scroll back and forth using the arrow buttons on the bottom left-hand side of the window to find a particular tab. In `Wk02F00Lab.xls`, you will find two sheets, labeled (1) `Using Points` and (2) `Using Slopes`.

Saving Excel Files: Any Excel file you open for your computer lab will come from a *Read-only* drive or directory. This means that you can modify it as much as you want, but you cannot save your revisions by writing over the original file. You may want to save a copy of each Excel file for future work. We encourage you to save your file even before you modify it.

You may either save a copy on your disk, using the A:-drive or in the `MyDocuments` folder on the C:-drive. In either case, click on the `File` menu and select `Save as...`. This will open a dialog box similar to the `Open` box. Select the appropriate drive and/or folder and type a name for the file in the field labeled `File name:`. **WARNING!** The copy you make on the C:-drive will be deleted from the computer within 24 hours, so do not depend on it being there more than a few hours later.

Using Points to Specify a Piecewise Linear Function

1. You know that the equation for a line can be found if you know two points on the line. To refresh your memory, in the two cases below find the equation of the line passing through the pair of points:

   a) $(0, 0)$ and $(1, 1)$

   b) $(1, 1)$ and $(2, 4)$

2. Use your equations to define a *piecewise linear* function $y = f(x)$ on the interval $0 \leq x \leq 2$. Remember, you will need to divide the domain into two sub-intervals.

3. Now bring up the Excel sheet labeled `Using Points`. You will see a table listing the points you have just been working with, along with some blank entries. The first thing you will do is learn how to use Excel to plot the graph of a piecewise linear function.

a) Begin by highlighting the data range from the cell $A5$ in the top left-hand corner to the cell $B8$ in the lower right-hand corner.

Highlighting in Excel: *Highlighting* a rectangular region of cells is an essential skill. This is done by starting in one corner of the desired region, clicking and holding the left button, dragging the white cross to the opposite corner of the region and releasing. When you click on the first cell, be careful not to release before dragging. It is possible to copy and paste rather than highlight if you are not careful. Copying and pasting will occur if the white cross becomes a dark, thin cross.

b) Click on the `Chart Wizard` button on the first toolbar (it looks like a bar graph with a blue bar, a yellow bar and a red bar). Select `XY(Scatter)` as the graph type and select the lower, left-hand sub-type. Click on `Next`.

c) Click on the `Series` tab. Currently there should be only one series listed in the box on the left. There are three fields on the right side of the dialog box. The top one allows you to name a particular series. The second field (labeled `X-values:`) indicates which cells provide the input values. The third field (labeled `Y-values:`) indicates which cells contain the output values. Excel is a smart program. It has automatically selected the first column of your data as the input values; the second column comprises the output values for `Series 1`. First, name `Series 1` by clicking in the top field `Name:` and typing `f(x) vs x`.

d) Click on `Next` and proceed to give the chart the title `f(x) vs. x`, labeling the appropriate axes `x` and `f(x)`.

e) Click again on `Next`. This window is the `Chart Location` dialog box. Select to save the chart as a new sheet and change the name of the sheet to `f(x)` and then click on `Finish`. You will be taken to the new sheet and the graph just created.

You have have noticed that AT THE SPECIFIED POINTS, $y = x^2$. This is NOT the formula for the piecewise linear function you have just graphed, but the function you have just graphed could be said to APPROXIMATE the graph of $y = g(x) = x^2$. (If you like, graph $y = x^2$ on your graphing calculator a compare.)

4. How could you use Excel to plot a piecewise linear function $h(x)$ that did a BETTER job of approximating $y = g(x) = x^2$? First determine a strategy, then carry it out. Label your new chart $h(x)$ vs. x. In what way is $h(x)$ a better approximation to $g(x) = x^2$ than $f(x)$ was?

Using An Initial Point With Slopes

5. A piecewise linear function can sometimes also be defined by specifying an initial point, a sequence of subintervals in the domain, and the slopes to use on each subinterval. To see this, select the `Using Slopes` sheet. The table here is a bit more involved. You have an initial (x, y) point given, and also columns labled `Delta_x`, `Slope` and `Delta_y`. Discuss in your group how you could compute `Delta_y` if you were given the `Slope` value and `Delta_x`.

If you point to the cells in this table, you will see that there is a formula attached to them. The formula appears on the toolbar above when you point to the cell. To *copy* the formula into cells below a given cell, select the given cell and then move the cursor to its lower right-hand corner. When it turns into a cross, move it down across the cells below in that column to copy the formula into them.

5. Do this to complete the table, with each of the columns listed in the following order: `Delta_x`, `x`, `Delta_y`, then `y`. CHECK: YOUR LAST `x` value should read 2. Why does the order matter? Discuss in your group exactly what is being calculated. Confirm this with your calculator, if necessary.

6. Use Excel to plot the graph of this piecewise linear function (call it $p(x)$). Compare it with your graph of $f(x)$ and with a graph (on your calculator) of $g(x) = x^2$.

7. Again, $p(x)$ could be used as an approximation to $g(x)$. Discuss with your group how you could improve the approximation to $g(x)$ for $0 \leq x \leq 2$. (Hint: What is the relationship between the value of x and the value of `Slope`? Try to continue this pattern.) Carry out your plan and use Excel to construct a plot of the resulting piecewise linear function $q(x)$.

Preparing Your Lab Report

Your report should consist of a cover page with the title of the report and the names and signatures of your lab group members. **Also indicate your Lab Section.** Each person (in a group of three) should complete a first draft of one of the three parts, and the group should meet to read and discuss these drafts before submitting the final report. The final report is DUE IN NEXT WEEK'S LAB. Grading will be Credit/No Credit with, however, a high standard for receiving credit. If you do not initially receive credit you will have one week to revise the report to correct any problems with it.

You will need to refer to your Excel worksheets for this lab to answer these questions.

Part 1

Describe how the piecewise linear approximation to $g(x) = x^2$ was constructed in the "Using Points" section. In what ways was it a good approximation and in what ways was it a poor approximation? What did you do to improve the approximation?

Part 2

Describe how the piecewise linear approximation to $g(x) = x^2$ was constructed in the "Using Slopes" section. In what ways was it a good approximation and in what ways was it a poor approximation? What did you do to improve the approximation?

Part 3

Compare these two methods of producing a piecewise linear approximation to $g(x) = x^2$. Which one gives you better approximations for a given number of points? If you could use as many points as you wished, would both of these approximations be good ones?