Lab 5: Applications of the Gradient

In Lab 4 we defined the gradient function of a given function of two variables. This lab investigates various applications of the gradient function. It also introduces the use of the WriteNow spelling checker and the NeXT's **Digital Webster** utility.

Step 1

Copy the **/math235/notebooks/Lab5** notebook into your own notebooks subdirectory, as you did in Labs 3 and 4. Open the main cell of the notebook to see the section headings.

Step 2

Launch the *WriteNow* text processor as you did in Labs 3 and 4. Insert your name and your lab partner's name at the top, change the heading to read **Lab 5: Applications of the Gradient**, and change the section headings to **The Gradient Function**, **The Differential**, **The Tangent Plane**, and **The Chain Rule**. (See Fig. 5.1.) Save your WriteNow file as **Lab5** in your **reports** subdirectory.

Step 3

Begin working through the notebook. Be sure to open all subcells, execute all *Mathematica* commands, and to work all exercises. You may wish to refer to the Appendix at the end of this Lab; it lists most of the *Mathematica* commands that you might need in the notebook.

After completing each section, write a description in your lab report of what you learned. Copy *Mathematica* commands from your notebook wherever needed.

Step 4

WriteNow has a spelling checker that you should use to check the spelling in your lab reports. To activate this subsystem, click **Edit** in the WriteNow menu and then click **Spelling…** in the Edit submenu. This brings up the Spelling Panel (Fig 5.2).

The Spelling Checker will scan through your document, selecting any word that it does not recognize. It keeps its own separate dictionary of words whose spelling it knows.

Set the insertion point at the beginning of your lab report, and then click on the **Find Next** button at the bottom right corner of the Spelling Panel. It will highlight the first word in your file that it does not recognize— probably your name. If it is a word that you know is spelled correctly (such as your name), then click on the Learn button at the top lest of the panel. The Spelling Checker will then "learn" this word by inserting it into its dictionary. If it is a word[1] that is spelled correctly but is not likely to be used again, then click on the Ignore button at the bottom left of the panel.

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[1] By "word" we mean any string of characters. The Spelling Checker will flag abbreviations and words like R2D2.

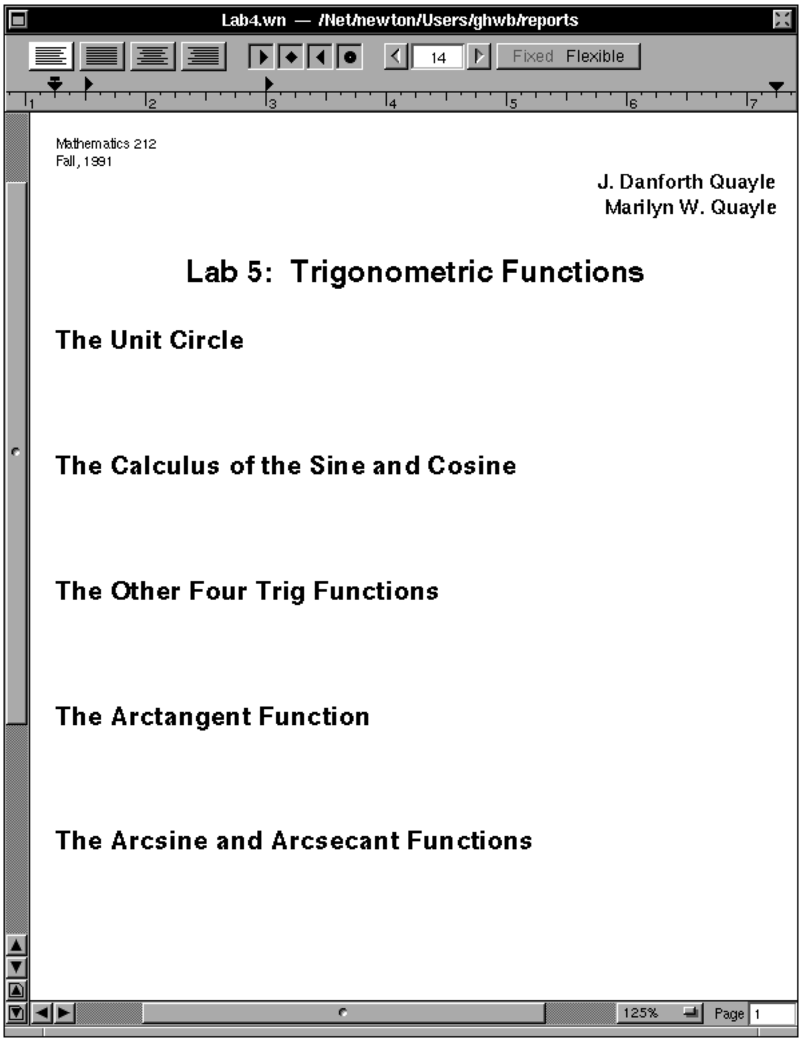

Figure 5.1 Outline of lab report for Lab 5

Figure 5.2 The Spelling Panel

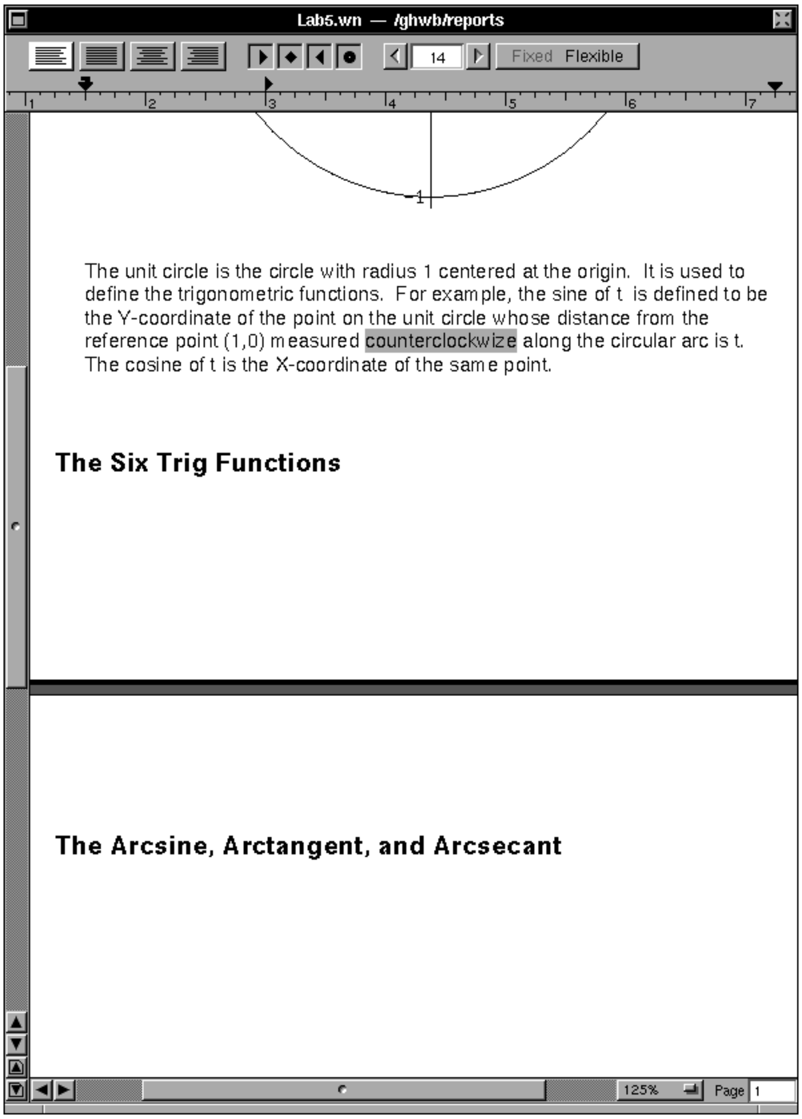

Figure 5.3

Figure 5.4 The correct spelling offered as a ‘Guess’

If the flagged word is misspelled, then click on the Guess button. For example, in Fig. 5.3, the misspelled word “differintial” has been flagged. If the word offered (Fig. 5.4) is what you want, just click on it. The Spelling Checker responds by replacing your misspelled word with the correct one.

If the Spelling Checker offers several guesses, double-click on the one you want.

Step 5

Select a word in your lab report about whose spelling or meaning you are unsure; for example, “increment,” or any flagged word for which the Spelling Checker has no guesses. Then click on Services in the WriteNow menu. This lists several utilities that are often used with *WriteNow*.

Figure 5.5

Click on the first command: Define in Webster.[2] This launches the Digital Webster dictionary and thesaurus utility.

For example, suppose you have the word “counterclockwise” selected in your lab report.

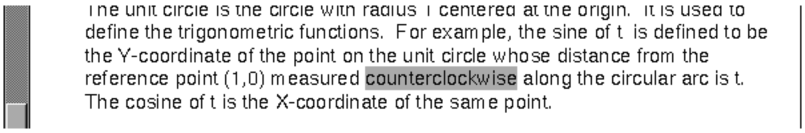

Figure 5.6 The word “counterclockwise” is selected

Then when the Digital Webster panel comes up (Fig. 5.7), it will display the dictionary listing for that word.

The Digital Webster utility is also used to find synonyms. Select another word in your lab report; pick a common word, like “plane” (Fig. 5.8). Then click on **Define in Webster** in the Services submenu.[3] The Digital Webster panel comes up showing definitions for the selected word because the icon labeled Dictionary shows an open book.

Click on the button (Fig. 5.10) with the open book icon labeled Dictionary. That closes the book, indicating that the dictionary is no longer active.

[2] If that item is gray instead of black, it is because you don’t have a word selected in your *WriteNow* file. Double-click on some word in your lab report to select it.

[3] Or, more efficiently, just press Command-= (i.e. hold one of the green Command keys down and press the key with the equals sign on it).

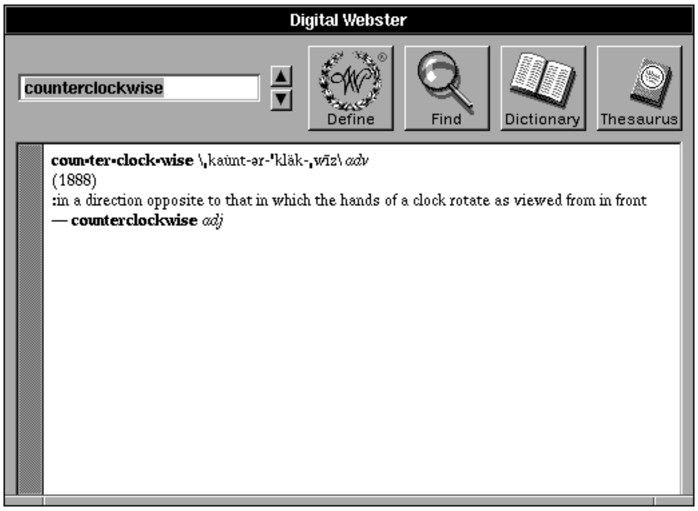

Figure 5.7 The **Digital Webster** panel

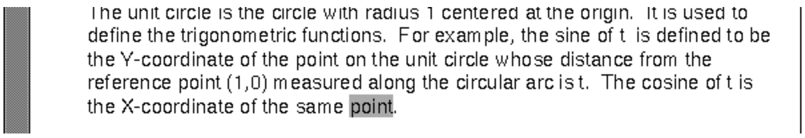

Figure 5.8 The word “plane” is selected

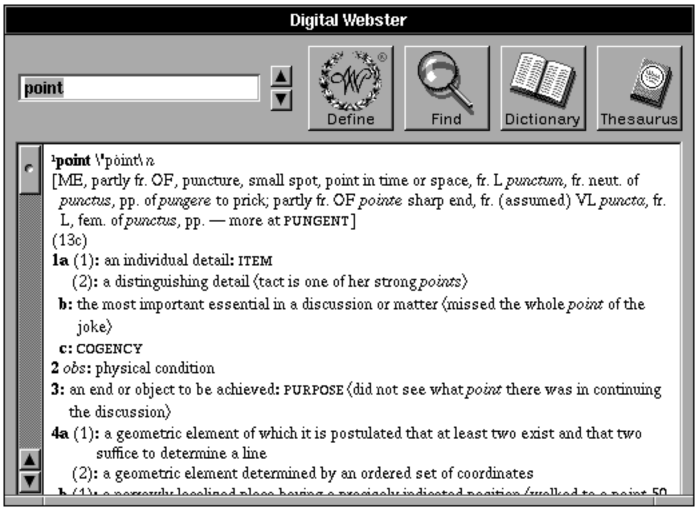

Figure 5.9 Definitions for the word “plane”

Now click on the button (Fig. 5.10) with the closed book icon labeled Thesaurus. That opens the thesaurus book, indicating that now the thesaurus is now active.[4]

[4] A thesaurus is a catalog of synonyms.

The **Digital Webster** buttons   Neither is active   Thesaurus is active

Figure 5.10

Then click on the Define button. This produces a list of synonyms for the selected word.

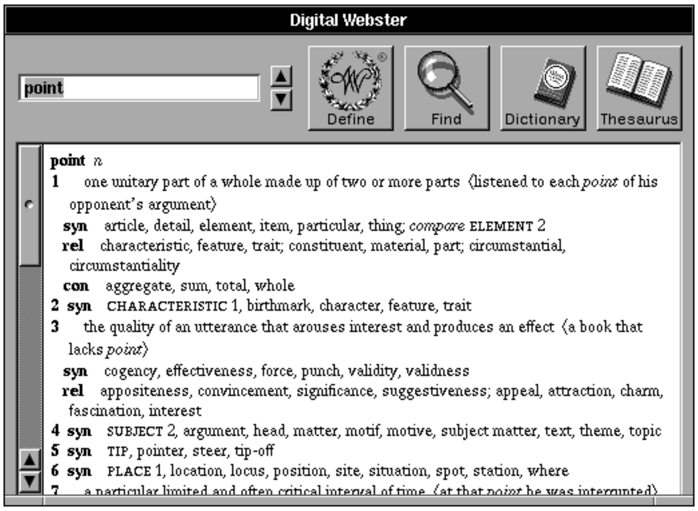

Figure 5.11 Synonyms for the word "point"

If Webster has more information than will fit in its text field, a scroll bar will appear on the left of the text field. It can be used to scroll the text up or down, just like any other text field. Alternatively, you can lengthen the text field window by dragging on the panel's resize bar.

Step 6

While the Digital Webster utility is still active[5], let's examine some more of its features. This application provides a wide variety of information, tools, and options (Fig. 5.12).

Click on Info in the Webster menu. This brings up the Info submenu. It is a prototype of the Info submenus of all other NeXT systems. Its first listing is **Info Panel…** This brings up an information panel that tells who created this Webster system and what its version number is. The Help… command brings up a scrollable text panel that provides more information on *Digital Webster*.

Notice that the Webster menu also has a Services command. Most NeXT systems do.

[5] You can launch the **Webster** utility any time by double-clicking on its icon (the one with the script "W") in the dock.

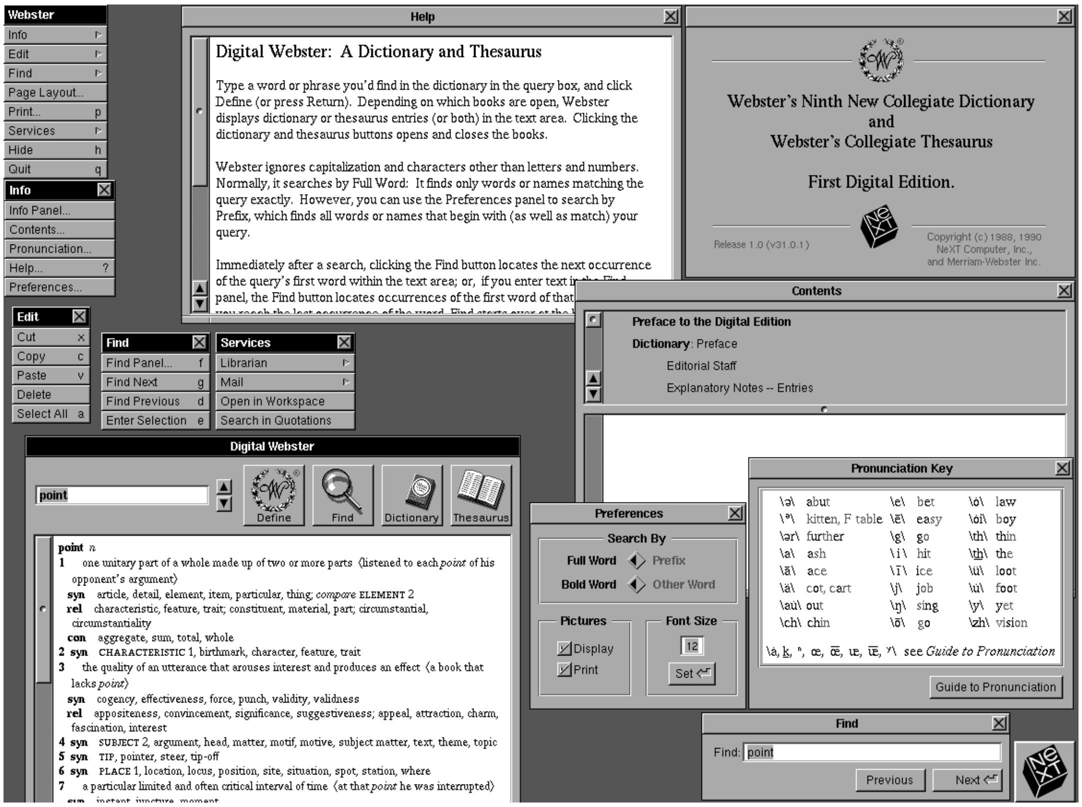

Figure 5.12 Some of the submenus and panels available in **Digital Webster**

Step 7

Reactivate [6] WriteNow and select Services from its main menu again. In addition to Digital Webster this submenu gives direct access to other useful utilities. So it's handy to keep that submenu visible. To do that, simply drag on the title bar of the Services submenu. As you do, the submenu separates from the main menu, and a close button appears in its upper left corner.

Figure 5.13

You can "tear off" any submenu in any NeXT system this way. The submenu will then remain on screen until you close it (by clicking on its close button) or you Hide or Quit the system.

6 Remember, to reactivate any NeXT system, just double-click on its icon in the dock.

Step 8

Launch Mail and send your lab report to **math235** just as you did in Labs 3 and 4.

Appendix: *Mathematica* Commands

Here are some of the *Mathematica* commands that you might use in this lab:

`Clear["@*"]`	Deletes all definitions of variables that begin with a lower-case letter
`grad[f_][x_,y_] = {D[f[x,y],x],D[f[x,y],y]}`	Defines the gradient function.
`grad[f][x,y]`	Displays the current definition of `grad[f][x,y]`.
`Clear[f]`	Deletes the current definition of `f`.
`f[x_,y_] := x^2 y^3`	Defines the function `f`.
`f[x,y]`	Displays the current definition of `f`.
`grad[f][2,5]`	Displays the current definition of `grad[f][2,5]`.
`d[f_][x_,y_,dx_,dy_] = grad[f][x,y].{dx,dy}`	Defines the differential function.
`d[f][x,y,dx,dy]`	Displays the current definition of `d[f][x,y,dx,dy]`.
`d[f][1,2,dx,dy]`	Displays the current definition of `d[f][1,2,dx,dy]`.
`d[f][1,2,0.003,0.005]`	Displays the current definition of `d[f][1,2,0.003,0.005]`.
`// Simplify`	Simplifies the current answer.
`Simplify[%]`	Simplifies the last answer.
`t[f_][x0_,y0_,x_,y_] = f[x0,y0] + d[f][x0,y0,x-x0,y-y0]`	Defines the tangent line function.
`t[f][x0,y0,x,y]`	Displays the current definition of `t[f][x0,y0,x,y]`.
`t[f][2,5,x,y]`	Displays the current definition of `t[f][2,5,x,y]`.
`D[f[g[x]],x]`	Displays the formula for the derivative of `f[g[x]]`.
`Dt[f[x,y]]`	Displays the formula for the total derivative of `f[x,y]`.
`x = 3t^2`	Defines `x` in terms of `t`.
`y = t/3`	Defines `y` in terms of `t`.