Chapter 4   **Imaging Options for Data Analysis**

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Chapter Overview

This chapter explains the procedures for performing imaging manipulations and data analyses in NCSA Image. You will learn, for example, how to magnify and interpolate images; generate raster images, shaded data, contour, and ordered dither plots; and use the XY graphing and animation functions provided in the program.

If you are planning just to skim through or skip over this chapter, be sure to read the notes that are scattered throughout. They may save you from unnecessary frustration.

Basic Imaging Options

NCSA Image initially displays your image data as a color raster image, but provides alternative means of viewing and studying your image data. NCSA Image allows you to perform several basic imaging options such as magnifying, interpolating, and plotting. Complete descriptions of more complex imaging options that permit in-depth analysis of your data are presented in the section entitled "Features for Advanced Analysis."
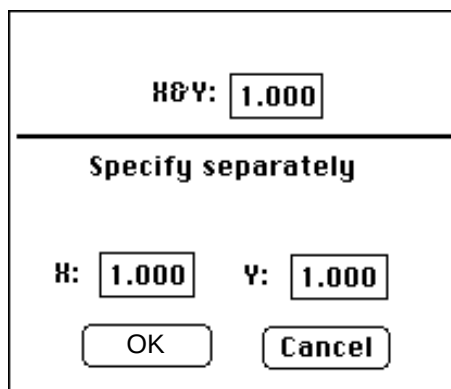
NOTE: Only one of the following imaging options affects the actual data in the image—Interpolation. Other imaging options change only the *representation* of the data.

Magnifying and Reducing Images

To magnify or reduce your image:

1. Select Magnify from the Tools menu. The dialog box shown in Figure 4.1 appears on the screen and allows you to specify the degree of magnification or reduction.

2. Use the text box labeled X&Y to specify the same magnification or reduction for both axes.

3. Use the individual text boxes labeled X or Y to specify different degrees of magnification or reduction for each axis.

4. Enter a value greater than 1 but no larger than 99 (for example, 1.5) in the appropriate text box to magnify the image.

5. Enter a fractional value less than 1 but no smaller than 0.05 (for example, 0.5) in the appropriate text box to reduce the image.

6. Click OK. Your image is enlarged or reduced according to your specifications.

Figure 4.1 **Magnify Dialog Box**

Interpolating an Image

Interpolation is similar to magnification or reduction except that it generates a smoothed image. The effects of interpolation are not reversible, because the pixels are not merely duplicated; rather, a mathematical function is applied to estimate the value of the additional or remaining pixels by taking a weighted average of the known values of their neighboring pixels. For the same reason, interpolation produces a smoother image than the other method of magnification or reduction.

To magnify or reduce your image by means of interpolation:

1. Select Interpolate from the Tools menu. The dialog box shown in Figure 4.1 appears on the screen and allows you to specify the degree of magnification or reduction.

2. Use the text box labeled X&Y to specify the same magnification or reduction for both axes.

3. Use the individual text boxes labeled X or Y to specify different degrees of magnification or reduction for each axis.

4. Enter a value greater than 1 but no larger than 99 (for example, 1.5) in the appropriate text box to magnify the image.

5. Enter a fractional value less than 1 but no smaller than 0.05 (for example, 0.5) in the appropriate text box to reduce the image.

6. Click OK. Your image is interpolated according to your specifications.

NOTE: If you perform an interpolation on an image sequence, the entire sequence is interpolated according to your specifications. You cannot interrupt the interpolation process.

Plotting an Image

NCSA Image provides several methods of visualizing your datasets in color and black-and-white. The various plots you may generate from image data are described in the following sections.

NOTE: When you plot an image, the entire dataset associated with the image window is represented in the plot. NCSA Image does not plot just a selected region of an image.

Color Raster Plots

To represent your data as a color raster plot, as NCSA Image does when it initially displays your dataset, select Raster from the Plot menu, shown in Figure 4.2.

Figure 4.2   **Plot Menu**

In a color raster plot, each data value is represented by color. In a process called *color mapping*, pixel values are converted to color by interpreting the value as an index in the color table. The *color table* is a set of hardware registers that determine which of the 16 million available colors are displayed for each of the 256 possible pixel values. The color table contains red, green, and blue values that determine how the values in the image data are displayed.

Contour Plots

A *contour plot* represents a matrix of data values by drawing contour lines between areas of differing contour levels. A *contour level* is a range of data values that you want distinguished from other ranges of values. A contour plot is much like a topographical map, on which lines are drawn between areas of differing altitude.

To generate a contour plot for your image data, select Contour from the Plot menu.

The dialog box that appears is shown in Figure 4.3. To define spacing for the contour levels and vary the number of levels drawn:

1. Specify a number of contour levels and the maximum and minimum data values.

    NOTE: NCSA Image does not allow you to specify fewer than two contour levels.

2. Select Evenly Spaced Intervals or User Defined Levels to determine the spacing between contour lines.

   If you select User Defined Levels, the dialog box pictured in Figure 4.4 appears. Enter the spacing you desire in number of pixels, spacing between each as directed.
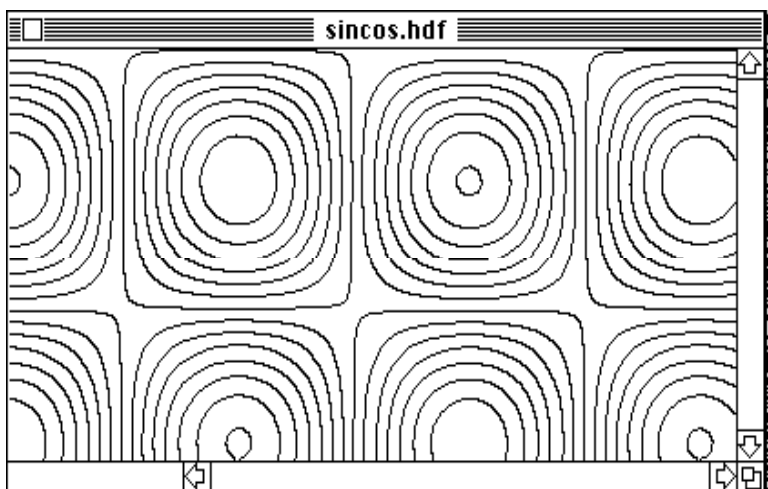
3. Click OK or press RETURN.

   A contour plot of your data is plotted in the image window according to your specifications. A sample contour plot is shown in Figure 4.5.

Figure 4.3 Contour Plot Dialog Box

Figure 4.4   User Defined Contour Levels

Figure 4.5   Contour Plot Window
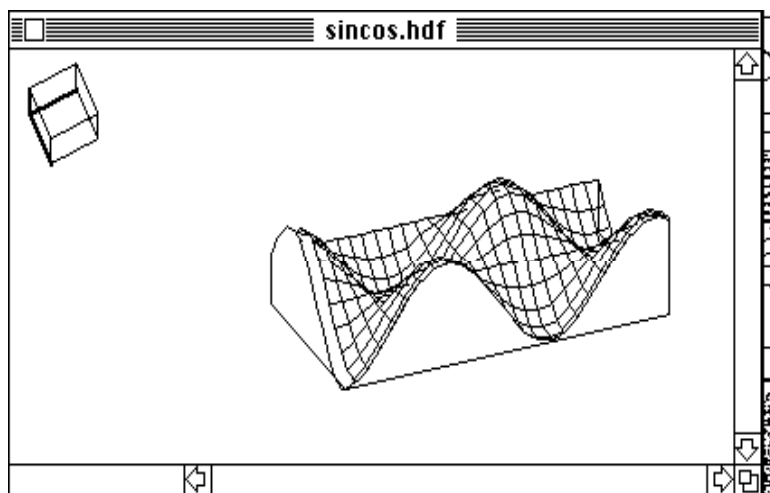
3D Plots

To generate a 3D surface plot to visualize your image data, select 3D from the Plot menu.

A 3D plot for the current dataset and the *Angle Cube* is drawn in the image window.

In a 3D plot, the height of the surface represents the magnitude of the associated value. The surface is represented by *cross-hatching*, a grid-like pattern that resembles a fishing net. The surface may be rotated interactively using the Angle Cube.

The Angle Cube is located in the upper-left hand corner of the display. You may use the Angle Cube to alter the viewing angle of the 3D plot. To do so, click and drag within the plot window while holding down the mouse button. The Angle Cube shifts its position, reflecting the viewing angle, and the plot is redrawn accordingly. The window depicted in Figure 4.6 shows a sample 3D Plot.

Figure 4.6 3D Plot Window

Shaded Data Plots

You can visualize your image data by using a shaded data plot, which represents the values as eight different intensities of shading. To do so, select Shade from the Plot menu. A shaded data plot window appears on the screen.
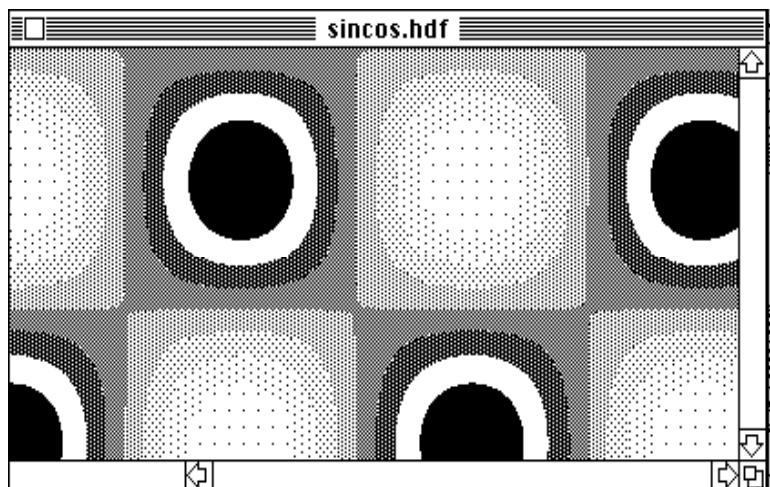
The eight patterns used in the shaded data plot represent the values in the ranges 0-31, 32-63, 64-95, 96-127, 128-159, 160-191, 192-223, and 224-256.

NOTE: NCSA Image initially represents the higher magnitudes with darker shades and the lower magnitudes with lighter shades. To reverse this representation, select Preferences from the Edit menu. In the dialog box that appears, select the command *Darker shades for lower magnitudes*. A complete description of the

Preferences dialog box and options is presented in Chapter 2 in the section entitled "Preferences."

A sample shaded data plot is shown in Figure 4.7.
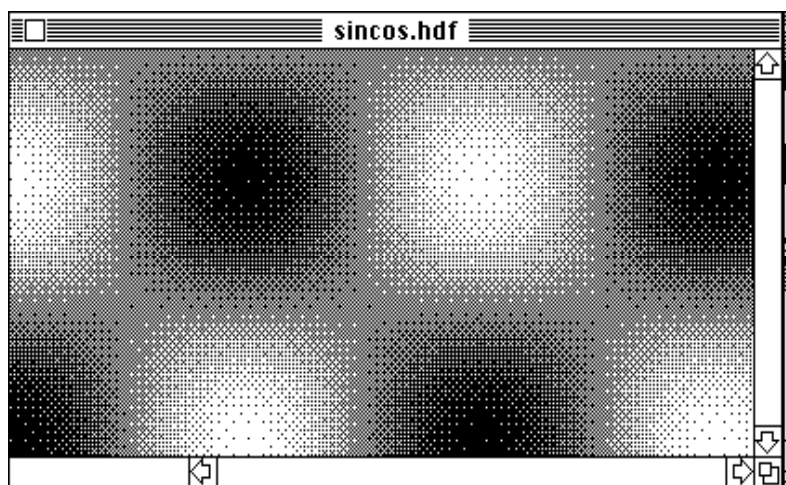
Figure 4.7 Shaded Data Plot Window

Ordered Dither Plots

Like the shaded data plot, an ordered dither plot represents your data as different intensities of shading; however, the ordered dither plot uses calculated, rather than predefined, patterns to do so. The patterns are generated to present numerous levels of intensity. Consequently, the ordered dithered plot may display many more gray levels than the shaded data plot, which uses only eight.

To generate an ordered dither plot from your dataset, select Dither from the Plot menu. A dither plot window such as the sample window shown in Figure 4.8 appears in the image window.

Figure 4.8 Ordered Dither Plot Window

Working with Multiple Images

The number of images you can load into NCSA Image is limited only by the amount of memory you have available. Each image is presented in a separate window. Any commands that you issue apply only to the active window.

Features for Advanced Analysis

NCSA Image provides several alternative means of visualizing your datasets other than simple raster images and black-and-white plots. For instance, you may generate XY graphs, histograms, and animations from your image data, and you may view the actual data values in a dataset.

Generating an XY Graph

NCSA Image provides a rudimentary XY graphing capability which allows you to select three different types of lines of data from images: horizontal, vertical, and freehand.

To generate an XY graph:

Figure 4.9   Graphing Tool

1. Select the graphing tool from the tool chest. The graphing tool is shown in Figure 4.9. This puts you in the *XY line mode*. In this mode you may select data points from the image to be plotted and add them to the XY graph.

2. Select a line mode, as instructed in the section entitled "Selecting a Line Mode."

3. Select a dataset from an image, as instructed in the section entitled "Selecting a Dataset."

4. Add the dataset to the XY plot, as instructed in the section entitled "Adding Lines to the XY Plot."

Selecting a Line Mode

You may draw lines in any of three line modes: *horizontal, vertical,* and *freehand*. To select one of these modes, choose Options from the XY menu. In the dialog box that appears, you may specify the line drawing mode. The Options dialog box is presented in Figure 4.12, which appears in the following section.

NOTE: If you attempt to draw a line on an image before specifying a line mode, the Options dialog box appears and prompts you to choose a line mode.

Selecting a Dataset

To select data points from an image, activate the image window and draw a line by clicking and dragging through the image. The *line* is a selection of values; these values become highlighted when you drag over them.

When you draw a horizontal or vertical line, the starting point is at the offset where you initially click; the end point is where you release the mouse button. In freehand mode, you may draw a line of any slope. The starting point of such a line is the horizontal and vertical offset at which you initially click.

In horizontal and vertical line modes, dragging vertically or horizontally, respectively, allows you to reposition the line you have drawn on different values.

You can plot up to nine horizontal or nine vertical lines simultaneously in a single graph, but only a single freehand line at one time. In horizontal or vertical graphing mode, the horizontal or vertical offset, respectively, is displayed in the text box. The text box is further described in Chapter 3 in the section entitled "Working with Image and Palette Windows."

Adding Lines to the XY Plot

After you draw a line, whether horizontal, vertical, or freehand, you need to add the data points it contains to the XY graph. To do so, select Add Dataset from the XY menu, shown in Figure 4.10, or press ⌘-A. An XY window appears behind the active window, and the data you have selected is plotted in it.

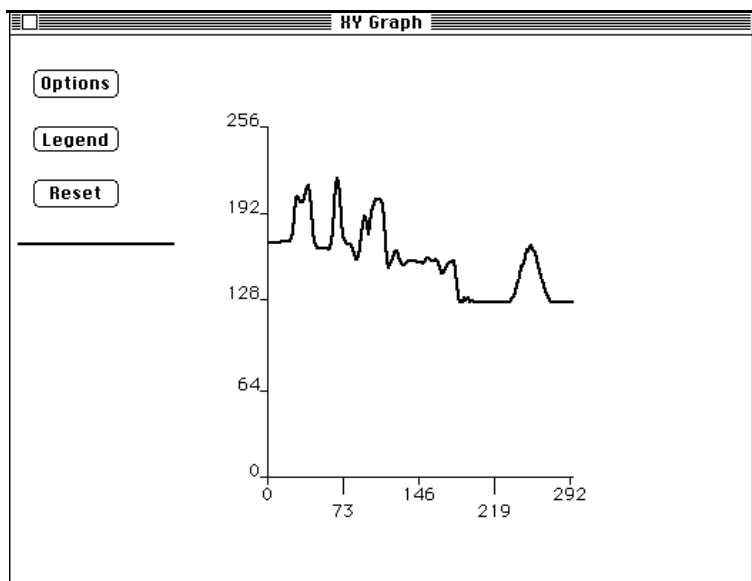**Figure 4.10 XY Menu**

/Show XY /Hide XY

NOTE: There is no way to remove just a single plot from the XY graph. To clear the entire graph, use the Reset command in the XY menu (described in a subsequent section).

The XY Window

To display the XY window, choose Show XY Window from the XY menu. The XY window is brought to the front of the screen, and any datasets you have added to the XY graph are plotted. A sample XY window is shown in Figure 4.11. The XY window contains an XY

plot and three buttons: Options, Legend, and Reset. These buttons are described in the following sections. To remove the XY window from sight, select Hide XY Window from the XY menu.

Figure 4.11   Sample XY Window

Options

NCSA Image allows you to specify a number of option parameters related to XY graphing. To do so, press the Options button in the XY window or select Options from the XY menu.

The Options dialog box, shown in Figure 4.12, appears on the screen.

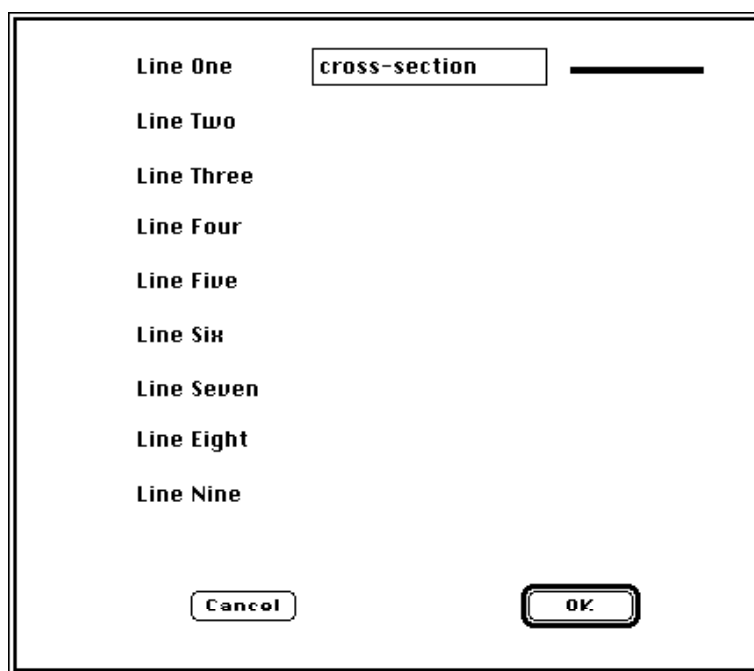**Figure 4.12   Options Dialog Box**

Using the Options dialog box, you may enter a title for your plot and for each of its axes. You may also specify a boundary rectangle from which datasets are extracted, so that any selection line that falls outside the boundary rectangle is clipped off. In addition, you can specify the number of tick marks for the x and y axes and choose an XY line mode.

The Legend

You may also specify names for each line that is displayed in the XY window. To do so, click the Legend button in the XY window or select Legend from the XY menu. A dialog box, shown in Figure 4.13, appears on the screen and prompts you to name the lines in the order that they are drawn.

The default label for a line is its vertical offset when you are in horizontal mode, and the horizontal offset when you are in vertical mode. In freehand mode, no default label is provided. Line One in Figure 4.13 was drawn in freehand mode and manually labeled.

Figure 4.13 Legend Dialog Box

Resetting the Plot

To erase your XY graph, click the Reset button in the XY window or select Reset from the XY menu. This clears the plot and deletes all the datasets you added to the XY graph, so that you may add new datasets. It does not delete the axis and title labels or the boundary rectangle.

Viewing Actual Data Values

Figure 4.14 Scope Tool

To view the data values associated with the image, select the scope tool from the tool chest. The scope tool is depicted in Figure 4.14. This puts you in *scope mode*. When you depress the mouse and drag within a raster window in this mode, the text box shows the data value currently under the cursor. When you move the mouse outside of the window, the text box is cleared.

Making a Selection

Several operations may be performed on a selected portion of an image rather than the entire image. Specifically, you may copy, print, or generate histograms from selected regions of an image.

Suppose you wish to generate a histogram of only those values which occur in a hot spot on your image. To make a selection:

Figure 4.15 Selection Tool

1. Choose the selection tool from the tool chest. The selection tool is shown in Figure 4.15.

2. Select an area of a raster image by clicking and dragging out a rectangular region within the image window. Note that the area of the selection is highlighted as you select it.

3. Release the mouse button. The selection remains highlighted.

To remove a selection from a window, click again within the window and the highlighted area reverts to its original state.

Creating a Histogram

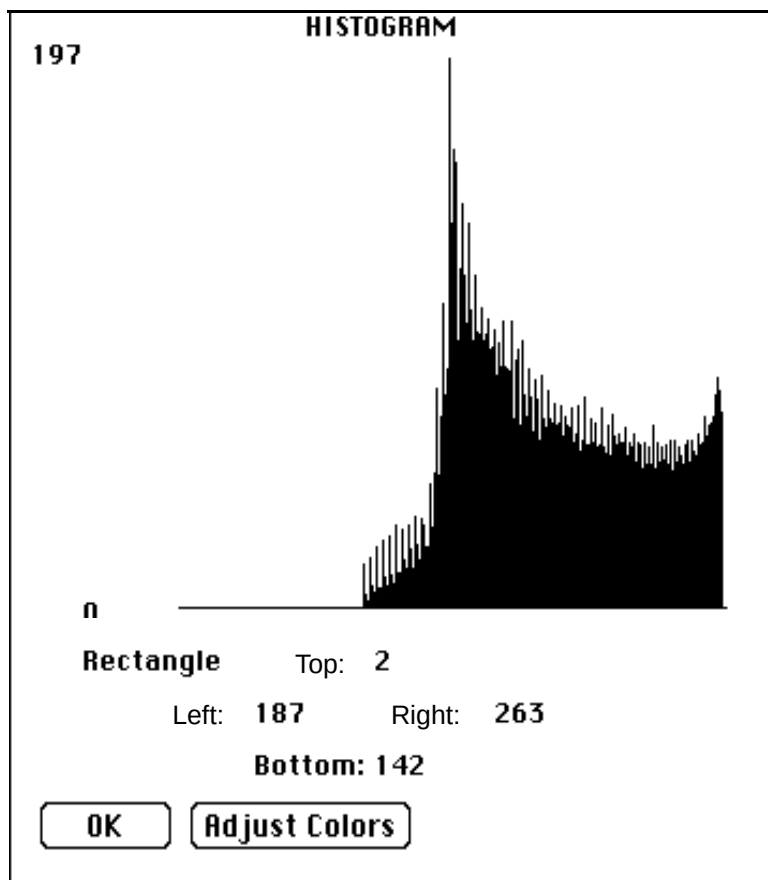To generate a histogram of the frequency distribution of data:

1. Select the region of interest using the selection tool.

2. Choose Histogram from the Tools menu. A dialog box, shown in Figure 4.16, appears on the screen.

The histogram in the dialog box represents along the y axis the number of instances of a value in the selection. The x axis denotes the values in ascending order from left to right.

More specifically, the y axis indicates the relative number of pixels found in the image or selection for each of the 256 palette entries, and the x axis represents the 256 entries.

A histogram provides a means of examining how different colors or grays are distributed in your image. This information allows you to determine how to enhance the image or manipulate the palette. To perform a histogram color adjustment, click the button labeled Adjust Colors. This adjusts the color table to increase contrast in the areas where the most data values are located.
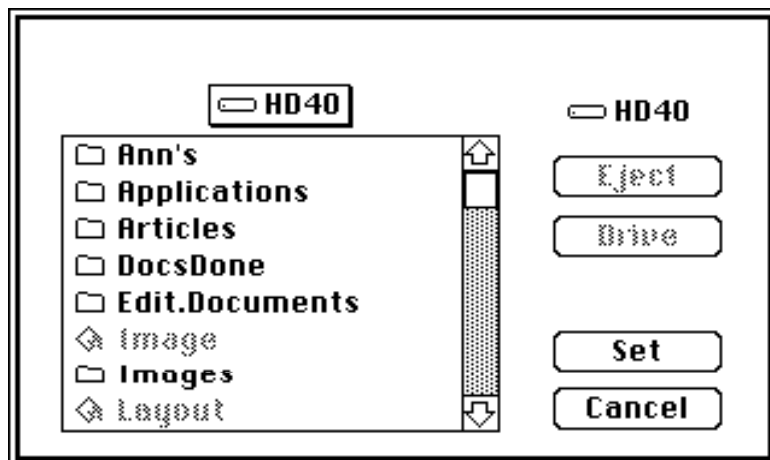
Animating a Sequence of Images

You may also do some quasi-real-time animations in NCSA Image. The animation may be run from memory or disk.

From Memory

To run an animation sequence from memory:

1. Select From Memory from the Animate submenu under the File menu. You are presented with the directory dialog box shown in Figure 4.17.

2. Open the directory that contains the files you wish to animate by double-clicking on it. Do not, however, double-click on any specific files.

3. Click Set to set up the animation sequence and return to the image window.

Figure 4.17   Animation Dialog Box

The files in the directory you selected are loaded into memory before the animation sequence begins. If the directory contains more files than you have memory available to animate, the animation proceeds with whatever files fit.

From Disk

To run an animation sequence from disk, select From Disk from the Animate submenu under the File menu. Animation from a disk proceeds similarly to animation from memory, although only one file is loaded into memory at a time. Before each image is displayed, it must be loaded from disk.

Controlling an Animation

After you load an animation sequence, the Animation menu shown in Figure 4.18 appears in the menu bar. You may use this menu or key commands to control the animation.
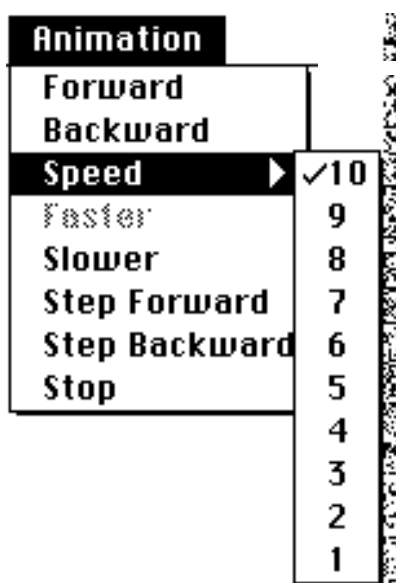
Figure 4.18 Animation Menu

Using the Animation Menu

1. Select Forward or Backward to initiate the animation sequence in either direction.

2. Select a value from the Speed submenu, where 10 is the fastest and 1 the slowest, to determine the speed of the animation (see Figure 4.19).

3. Select Faster or Slower to increase or decrease the speed of the animation by a single degree.

4. Select Step Forward or Step Backward to advance a single frame in either direction.

5. Select Stop to stop the animation.

Figure 4.19 Speed Submenu

Using Keyboard Commands

1. Press the left or right ARROW key to initiate the animation sequence backward or forward, respectively.

2. Press a number key, where 1 is the slowest and 0 the fastest, to determine the speed of the animation.

3. Press the up or down ARROW to advance a single frame forward or backward, respectively.

4. Press any key other than those mentioned in steps 1 through 3 to stop the animation.

Deleting an Image

To purge an image window, first verify that the window is active, then click in the close box or select Close from the File menu. The image, window, and associated color table are discarded.

NOTE: This procedure does *not* save your image or associated information to a file before removing it from the screen. If you need to retain this information, you must save the data in the manner described in the following section.

Saving an Image

To save an image with its dimensions and associated color table to a file, select Save As from the File menu or press ⌘-S. A directory dialog box appears and prompts you to name the file and indicate the directory in which to store the data. When you click Save, the data is stored in HDF format, unless otherwise specified.

Copying and Pasting Images

You can copy black-and-white plots, color raster images, or selected portions of these onto the Clipboard, which is used to transfer information between applications on the Macintosh. The copied portion of the image can then be pasted into other image processing packages, such as NCSA DataScope or NCSA Layout.

To copy an image or selection region, choose Copy from the Edit menu or press ⌘-C. You can paste this image into NCSA Image by choosing Paste from the Edit menu or pressing ⌘-V.

NOTE: The Clipboard only holds the latest image or plot that you copied. Subsequent copies replace the contents of the Clipboard.

Printing Plots

To print any black-and-white plot, including an XY plot, activate its window and select Print from the File menu or press ⌘-P. More detailed information regarding printing procedures is presented in Chapter 1 in the section entitled "Printing an Image."