# About Dr Razz

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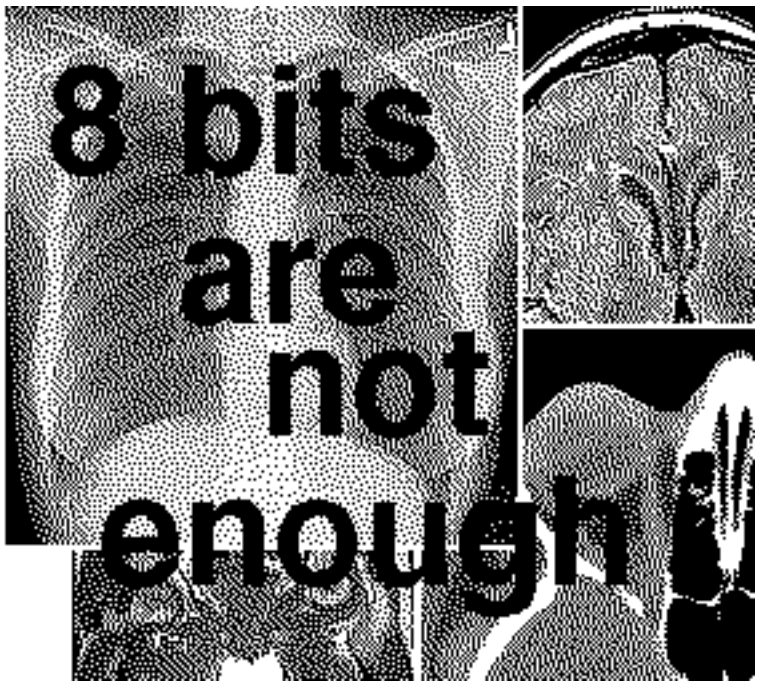
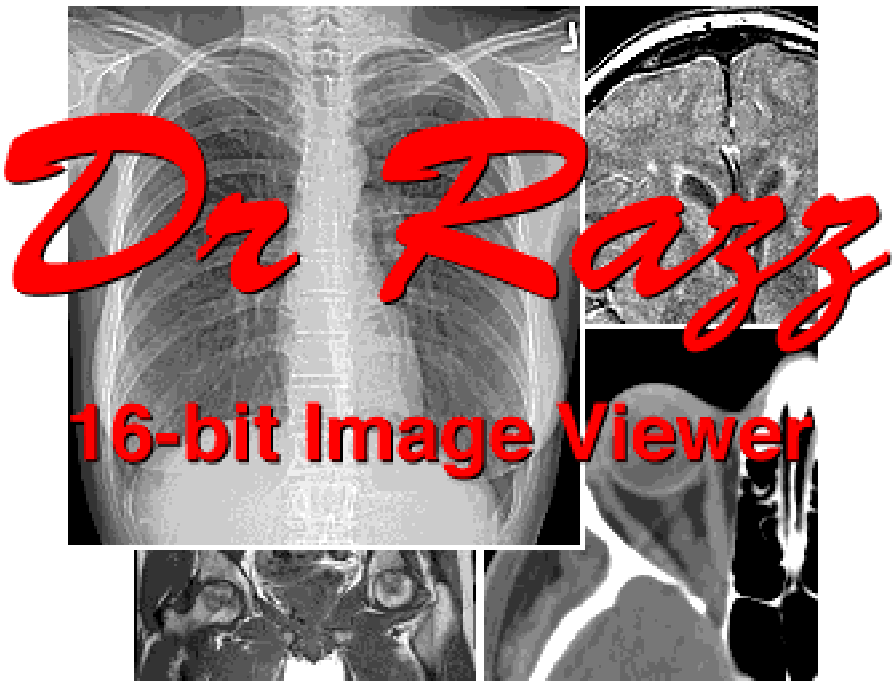
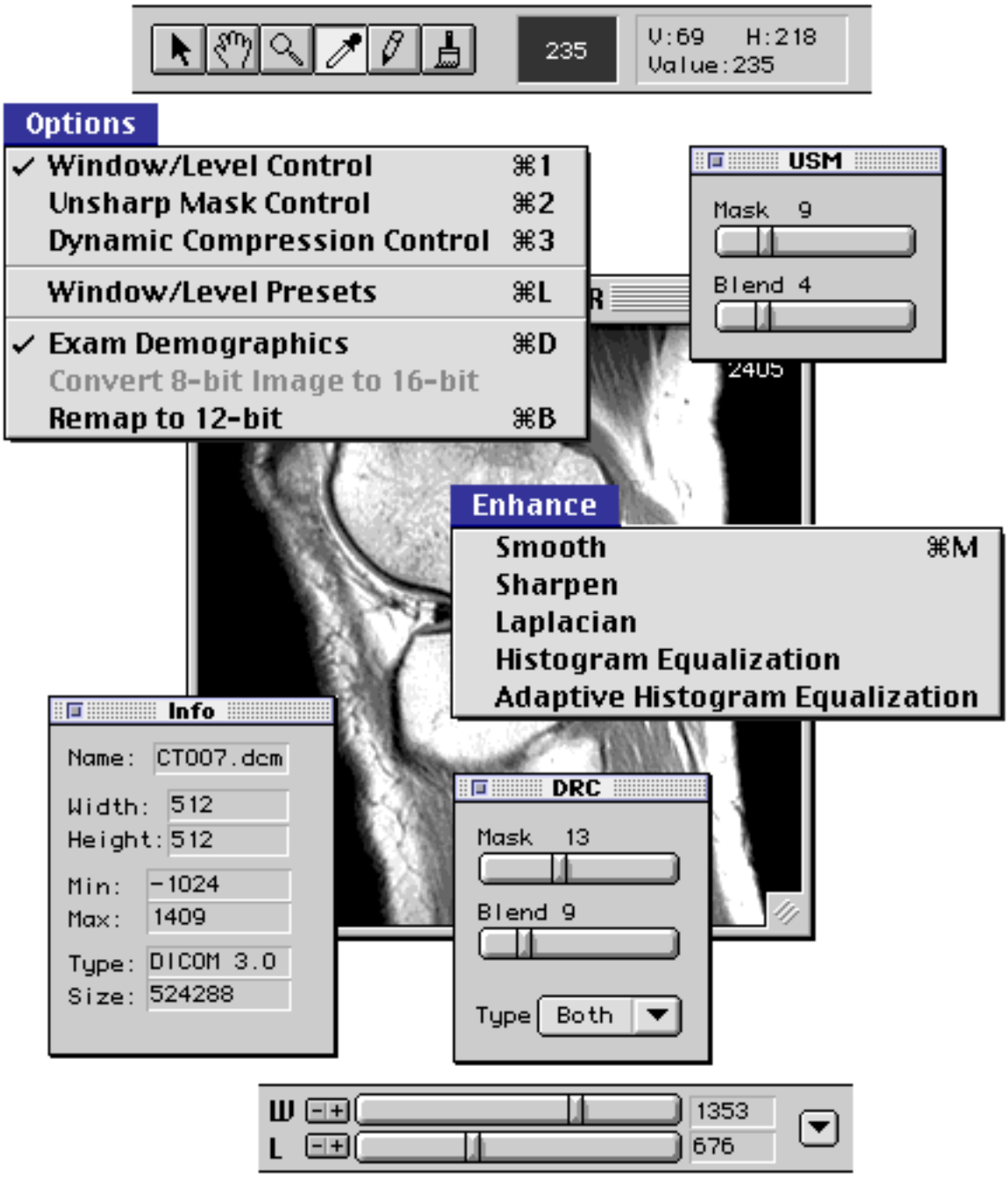

8 bits
are
not
enough


Dr Razz
16-bit Image Viewer


235
V:69 H:218
Value:235
Options
Window/Level Control ⌘1
Unsharp Mask Control ⌘2
Dynamic Compression Control ⌘3
Window/Level Presets ⌘L
Exam Demographics ⌘D
Convert 8-bit Image to 16-bit
Remap to 12-bit ⌘B
USM
Mask 9
Blend 4
2405
Enhance
Smooth ⌘M
Sharpen
Laplacian
Histogram Equalization
Adaptive Histogram Equalization
Info
Name: CT007.dcm
Width: 512
Height: 512
Min: -1024
Max: 1409
Type: DICOM 3.0
Size: 524288
DRC
Mask 13
Blend 9
Type Both
W
L
1353
676

# Table of Contents

# Introduction

Dr Razz is a 16-bit grayscale image display and analysis program for Macintosh computers. The program has been optimized for display of radiology image formats, including computed tomography (CT), magnetic resonance imaging (MRI), computed radiography (CR) and digitized radiographs.

## Program Features

• Near real-time window width and window level adjustments on 8 and 16-bit image data.

• Images can be viewed individually, or a group of images (e.g., a CT or MRI scan) can be viewed in an image series.

• Many different file formats are supported, including DICOM 3.0, ACR/NEMA, TIFF, and JPEG/JFIF (including 12-bit grayscale). The program features advanced algorithms that allow most non-compressed CT and MR images to be opened even if the specific file format is not supported, regardless of byte order and image header size. Images created with the GE Image Extract Tool ('ximg') are well supported, and compressed images created with this tool are opened automatically.

• Patient demographic overlay on the image is supported for ACR/NEMA, DICOM, Picker and GE ximg images.

• Images can be saved as 8/16-bit raster files, 8/16-bit grayscale TIFF (with LZW, JPEG or deflate compression), 8/16-bit grayscale JPEG, or 8-bit grayscale PICT or PICS files.

• Image processing operations available include flip, rotate, invert, rescale, sharpen, smooth, Laplacian edge detection, dynamic compression, histogram equalization and adaptive histogram equalization.

• Innovative interface controls include interactive window/level adjustments, unsharp masking(edge enhancement) and dynamic compression (density correction).

• The core AppleEvents and stationary pad documents are supported.

## Program Requirements

• System ≥ 7.0 and a color Macintosh with a 68020 or greater CPU are required, or any Power Macintosh. If the 'Use Internet Config' preference is selected, then version 2.0 or later of the Internet Config extension must be present. The application is distributed as a “fat binary” that contains both the 680x0 and Power Macintosh versions.

• Memory requirements depend on the image size. A 256x256 MRI scan can be viewed in as little as 700k RAM. A 2k Fuji computed radiography image requires about 16M RAM if unsharp masking is required. For CT

series, roughly 0.5M RAM is needed for every image after the first image is loaded. Images can be loaded into either the Dr Razz application memory partition, or into System temporary memory (see 'User Preferences', below).

## Program Configuration

The default user preferences will be adequate for most users. For more information about the different preferences options, see the 'User Preferences' section below. Virtual memory may significantly decrease program performance. **I strongly recommend that you turn off virtual memory, especially on Power Macintoshes.**

The program is optimized for an 8-bit (256 colors) monitor setting. The user preferences determine if the monitor is switched to 8-bit when the program is launched.

## Known Problems

- When the image is magnified, there is a peculiar 'pixel shifting' when using the pencil or paint brush tools.
- The pencil and paint brush tool do not work with 8-bit images.
- There may be a problem with the Apple 8•24 graphics card that causes the image to turn black after adjusting the window/level control.

## About This Document

This document looks best if the monitor is set to 8-bit (256) or greater colors. When printing, be sure the color/grayscale printing is selected (Figs. 1 and 2).

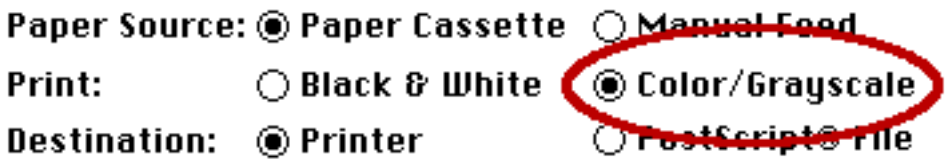



Figure 1. Color/grayscale printing option in the 'Print' dialog (LaserWriter 7 version).

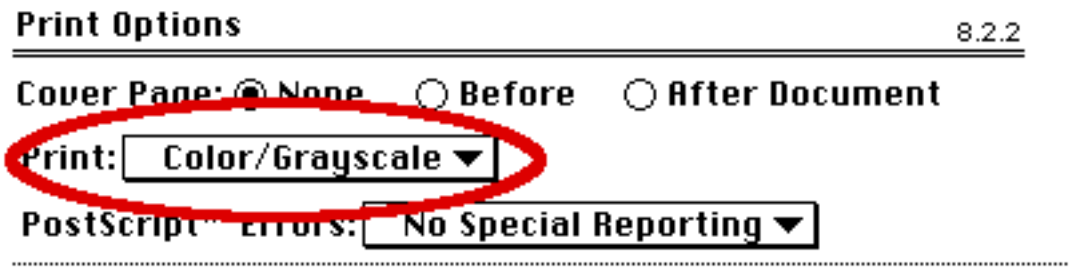



Figure 2. Color/grayscale printing option in the 'Options' subdialog of the 'Print' dialog (LaserWriter 8 version).

Program functions which are not yet implemented or are under development are displayed in the italic font style:

*[this feature is not yet implemented]*

Uniform resource locators (URLs), keyboard options and email addresses are displayed in the Courier font and are bracketed by the greater than and less than characters:

```
<http://www.dr-razz.com/>
<Home>, <Page up>, <Page down>
```

Menus, menu items and dialog options are delimited by single quotes:

'Save All' menu item under the 'File' menu

## Registration

Please register your copy of Dr Razz. Registration is easily performed at the Dr Razz web site.

```
<http://www.dr-razz.com/register.html>
```

You have the option of being notified of updates and other Dr Razz related news.

## Debug Version

This is a “debug” version of the program. If a programming error is encountered , an “assertion failure” is generated (Fig. 3).


Figure 3. The assertion failure dialog.

The error message and other important information is recorded in the file 'Dr Razz error log'. Please email the file and a description of how the error occurred to:

```
<tg3@u.washington.edu>
```

Bug reports can also be submitted at the Dr Razz web site:

```
<http://www.dr-razz.com/bug.html>
```

If your computer is connected to the internet, you can connect to the Dr Razz web site from the 'Intenet' menu in Dr Razz.

# Tool Bar

The Dr Razz **tool bar** (beneath the menu bar) (Fig. 4) contains most of the application user interface elements, including the **window/level control**, the **window/level presets** menu, the **tools palette**, the **color picker display** and the **pixel value display**. The tool bar can be hidden by selecting the 'Hide Tool Bar' menu item of the 'Windows' menu.

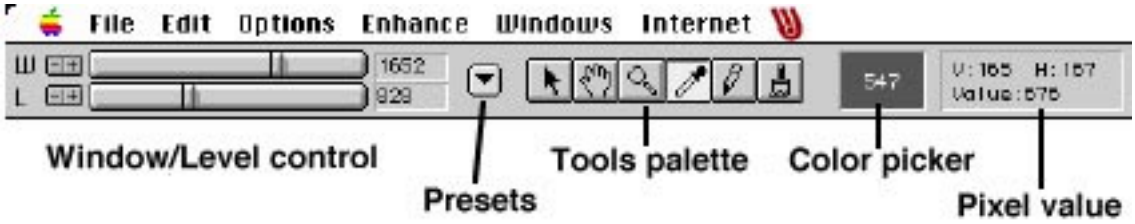



Figure 4. The Dr Razz Tool Bar.

## Window/Level Control

The **window/level control** determines the 16-bit to 8-bit grayscale mapping for 16-bit images, and determines the brightness and contrast mapping for 8-bit images (Fig. 5). The control is comprised of the window/level sliders, the tweak control, and the window/level edit fields.

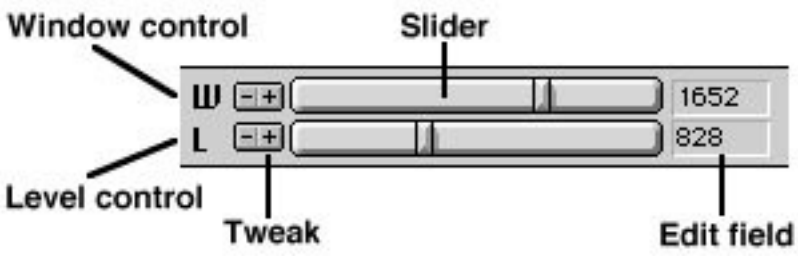



Figure 5. The Window/Level Control.

The **window** and **level sliders** interactively adjust the individual settings. Clicking in the slider track bar also changes the control setting by approximately 10%. Holding the <Option> key increases the control setting change. The **tweak** control increases or decreases the control setting by one unit, permitting very fine adjustment of the window and level setting. Holding the <Option> key while selecting the tweak control changes the control setting by five units.

The current window and level settings are displayed in the **window/level edit fields** to the right of the sliders. The settings can be directly edited by clicking in either field and typing a new control value. Pressing the <Return>, <Enter> or <Tab> keys applies the new control setting to the frontmost image. Pressing the <Tab> key also selects the other control edit field. A window/level edit field is "active" if it is highlighted (selected) (Fig. 6) or if the field contains a blinking text cursor. The 'Cut', 'Copy', 'Paste' and 'Clear' menu items under the 'Edit' menu work on an active edit field as per standard Macintosh practice. To deselect a window/level edit field, click on an "empty" (non interface) portion of the tool bar.


Figure 6. Active window edit field.

The **arrow keys** also adjust the window/level settings: the **left/right arrows** adjust the **window** setting, and the **up/down arrows** adjust the **level** setting (Fig. 7). Holding the <Option> key increases the amount of change.

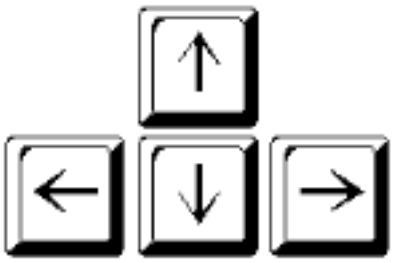


Figure 7. The arrow keys also adjust the window/level settings.

If a window or level edit field is active, the arrow keys will move the text cursor in the edit field, and the window/level setting will not be affected. To deselect the edit field, click on an empty part of the tool bar.

If no image display window is opened, the window/level control is dimmed (inactive) (Fig. 8).


Figure 8. The inactive window/level control.

## Window/Level Presets

The window/level settings can be changed by selecting the **window/level presets** menu in the tool bar (Fig. 9). The presets can also be selected by selecting the function key (F-key) number listed to the left of the preset menu item. The window/level presets labels and settings can be edited in the Window/Level Presets dialog (Fig. 10).

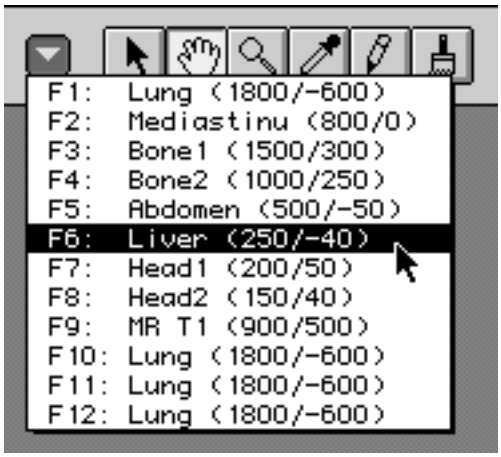



Figure 9. The window/level presets menu.

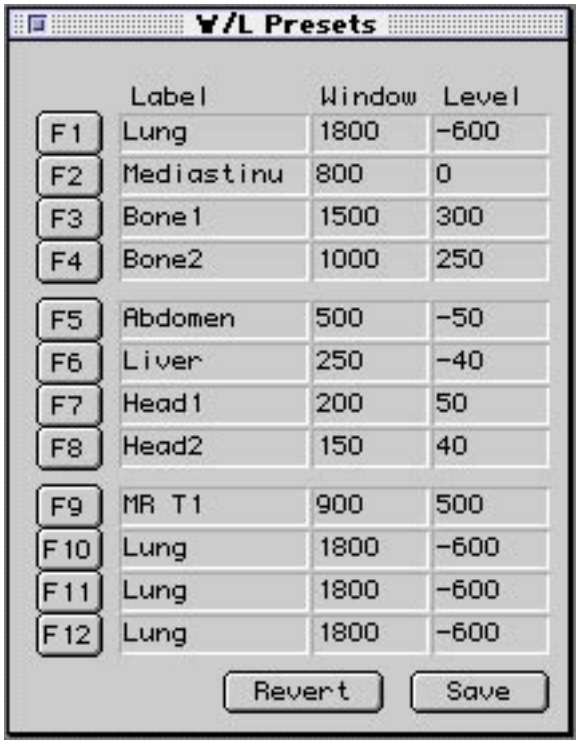



Figure 10. Window/Level Presets Dialog. The label, window and level fields can be separately edited. Clicking the F-Key button to the left of the label field applies the preset to the frontmost image.

## Tools and Cursors

Selecting a tool from the **tools palette** (Fig. 11) changes the current selected tool and associated cursor icon (Fig. 12).

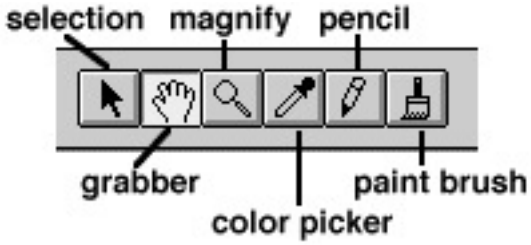



Figure 11. The Tools Palette. The grabber tool is the default.

Each tool is associated with a specific function in the image display window.

- **selection**: *select objects*
- **grabber**: scroll image
- **magnifying glass**: magnify / minify image
- **color picker**: select pixel value (color picker display)
- **pencil**: replace single pixel with color picker value
- **paint brush**: replace group of pixels with color picker value

Selecting the magnify tool changes the cursor to a magnifying glass with a plus ('+') in the glass: clicking the cursor in the image display window will magnify the image. If the `<Option>` key is pressed, the cursor changes to a magnifying glass with an internal minus ('-'), which minifies the image. The magnify tool is limited to 4x magnification and 4x minification. *When either magnification or minification reaches the 4x limit, the magnify tool changes to a magnifying glass with slash through it (magnify limit icon). If the current image is magnified or minified, double clicking the magnify tool returns the image to the non-magnified state.*

The cursor icons associated with each tool are shown in Figure 12. Regardless of the current tool selected, the cursor icon is the arrow when the cursor is outside of an image window. Depressing and holding the `<space bar>` will convert any cursor icon to the grabber if the cursor is within an image display window.


Figure 12. Cursor icons associated with each tool.

## Color Picker and Cursor Value Displays

The **color picker display** (Fig. 13) shows the current color picker pixel value and grayscale hue for the frontmost image. The grayscale hue is dependent on the color picker pixel value and the current window/level setting. The color picker pixel value is selected by the color picker tool in an active image display window. When an image is opened, the default color picker value is the minimum pixel value in the image.

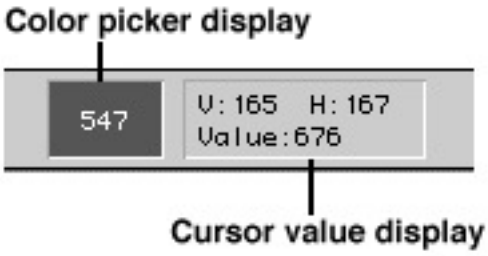



Figure 13. The color picker and cursor value display.

The **cursor value display** (Fig. 13) shows the current vertical position (y-axis location), horizontal position (x-axis location) and image pixel value at the current cursor location in the frontmost image window.

# Image Display Window

The **image display window** contains a grayscale *or color* image. The file name associated with that window is listed in the window title bar. If a stationery file is opened, the window title is "Untitled." There is a close box in the upper left corner, and a window resize icon in the lower right corner. If the image is larger than the current window size, the grabber tool is used to scroll the image (Fig. 14).


Figure 14. The image display window.

Patient and exam demographics, when present, are displayed in the upper right corner of the image (Fig. 15). They can be “turned off” by selecting the ‘Exam Demographics’ menu item under the ‘Options’ menu. Exam demographics are supported for ACR/NEMA, DICOM 3.0, GE ximg and Picker image formats.

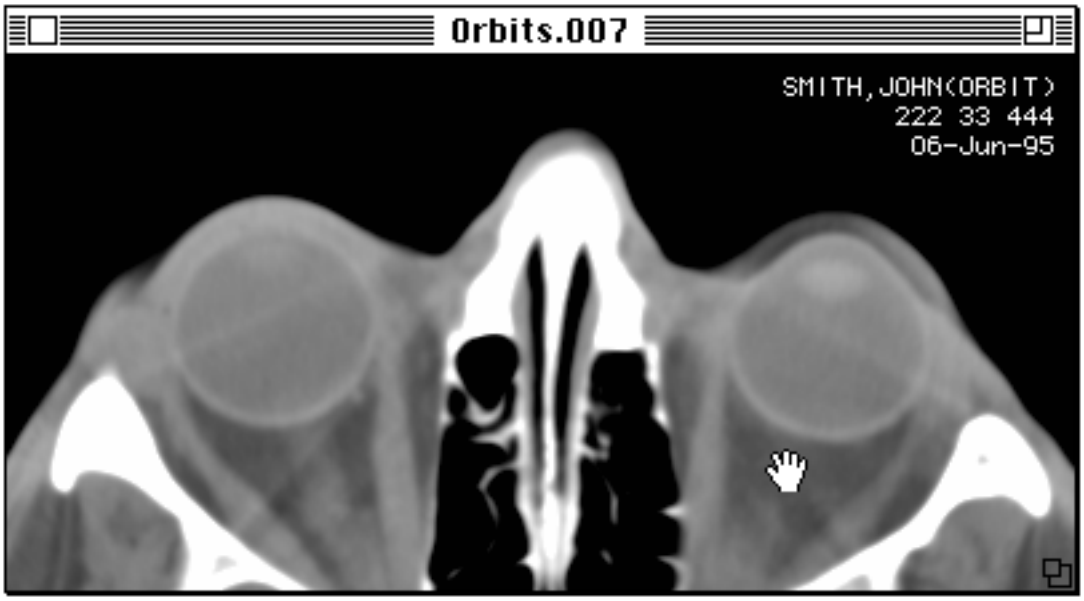



Figure 15. Exam demographics displayed in upper right corner.

If multiple image display windows are open, they are stacked from left to right and from top to bottom (Fig. 16). If all opened windows are subsequently closed, then the next window is opened at the "first" window position.


Figure 16. Multiple image display windows.

# Unsharp Mask Control

The **unsharp mask control** is activated by selecting the 'Unsharp Mask Control' menu item under the 'Options' menu or pressing the <Cmd-2> key combination.

Unsharp masking is a common image processing algorithm that increases the high frequency information in the image (edge enhancement). Dr Razz features an innovative INTERACTIVE unsharp mask control (Fig. 17). The **mask** slider adjusts the NxN smoothing convolution kernel size, which affects the range of frequencies enhanced in the image. A small mask setting will only enhance the highest frequencies in the image, but increasing the setting will progressively enhance the lower frequencies in the image. For CT or MRI scans, a mask of 3 is usually optimum, but for computed radiographs (CR) or digitized radiographs, larger mask sizes are preferred. The **blend** slider adjusts the amount of edge enhancement that is added to the image. The window and level settings are changed via the window/level control in the tool bar.

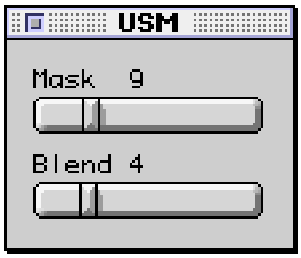



Figure 17. The unsharp mask control.

The unsharp mask control is deactivated (closed) by clicking on the close box (upper left corner), or selecting either the 'Window/Level Control' or 'Dynamic Compression Control' menu items under the 'Options' menu. When the control is deactivated, a dialog asks whether the unsharp mask changes to the image should be retained (Fig. 18).

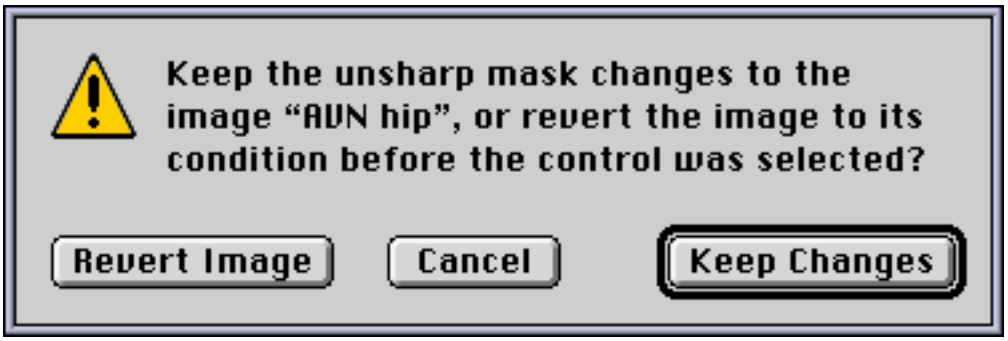



Figure 18. When the unsharp mask control is deactivated, the user can keep the changes to the image, revert the image, or cancel the operation.

# Dynamic Compression Control

The **dynamic compression control** is activated by selecting the 'Dynamic Compression Control' menu item under the 'Options' menu or pressing the <Cmd-3> key combination.

The dynamic compression control adjusts each image pixel value based on the average value of an NxN local neighborhood (Fig. 19). The process is similar to the unsharp masking algorithm described above, but the effect is to equalize the parts of the image that vary greatly in pixel value. This process is sometimes referred to as density correction. As with the unsharp mask control, the **mask** control adjusts the NxN convolution kernel (local neighborhood), and the **blend** control adjusts the amount of density correction.


Figure 19. The dynamic compression control.

Below the blend control is the 'Type' drop menu that selects the type of density correction (Fig. 20). Selecting the **Light** option will decrease the highest pixel values in the image (based on the settings of the **mask** and **blend** controls). Selecting the **Dark** option will increase the lowest pixel values in the image, and selecting **Both** will combine both processes.


Figure 20. Dynamic compression type selection.

An example of the 'Light' dynamic compression type is enhancing the mediastinum detail on a computed radiograph. An example of the 'Dark' compression type is enhancing the soft tissue detail in an extremity computed radiograph or digitized radiograph.

The dynamic compression control is deactivated (closed) by clicking on the close box (upper left corner), or selecting either the 'Window/Level

Control' or 'Unsharp Control' menu items under the 'Options' menu. Similar to the unsharp mask control, when the control is deactivated, a dialog asks whether the changes to the image should be retained.

# Opening a File

## File Types Supported

Many different file formats can be opened using the default 'Auto' (automatic) image parameters mode. Supported image file formats include:

- TIFF: 8-bit and 16-bit grayscale; LZW, JPEG and deflate compression.
- JPEG (JFIF format): 8 and 12-bit grayscale (*)
- PICT (*)
- *PNG (portable network graphics format): 8 and 16-bit grayscale.*
- MCID

(*) color images converted to grayscale

ACR/NEMA and DICOM 3.0 file formats are partially supported -- grayscale, uncompressed, single image file types.

The following vendor specific formats are at least partially supported.

- GE Image Extract Tool (ximg), including compressed formats
- Picker CT and MRI
- Siemens
- Fuji CR (via DASM interface)
- Cemax workstations
- Highspeed Advantage
- SYTEC
- Lumysis
- Vision10
- AFM (Digital Instruments)

## The Open File Dialog

Files can be opened by double clicking on a Dr Razz document in the Finder, dragging and dropping one or more documents onto the Dr Razz application, or selecting the 'Open...' menu item under the 'File' menu which opens the **open file dialog** (Fig. 21).

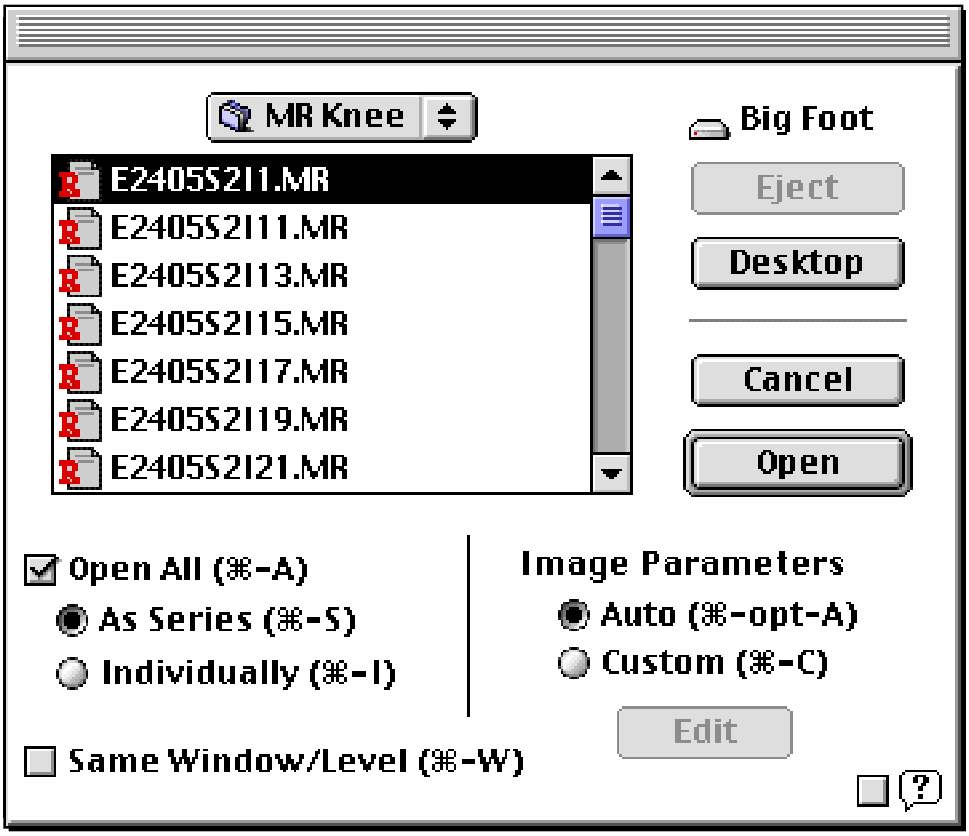



Figure 21. The Open File Dialog. The automatic image parameters option is selected.

If the 'Open All' checkbox in the dialog is selected, all the images in the currently selected directory will be opened (Fig. 22). The images can be opened into individual windows (‘Individually’), or all the images can be opened into an image series (‘As Series’). All the images must have the same image dimensions and must have the same file type in order to be included in an image series. The `'<'`, `'>'`, `<Home>`, `<End>`, `<Page Up>` and `<Page Down>` keys are used to navigate to different images in the series.

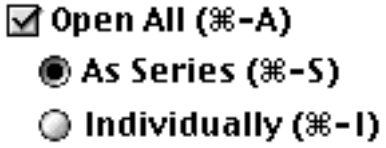



Figure 22. All the images in the selected folder will be opened as an image series.

If the automatic image parameters method cannot open an image, select the 'Custom' image parameters radio button, and then click the 'Edit' button (Fig. 23) to bring up the **custom image parameters** dialog (Fig. 26).

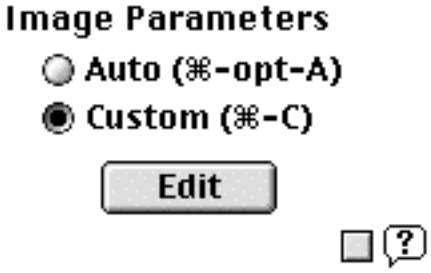



Figure 23. The Custom image parameters option.

If the 'Same Window/Level' option is selected (Fig 24), the window and level settings of the frontmost image window will be used for the new image. The option is only enabled if an image window is already opened.

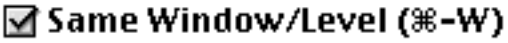



Figure 24. Use the window/level settings of the current image.

Balloon help is available in this and other dialogs by selecting the balloon help checkbox in the lower right corner (Fig. 25), or by selecting the 'Show Balloons' menu item under the balloon help menu bar icon.

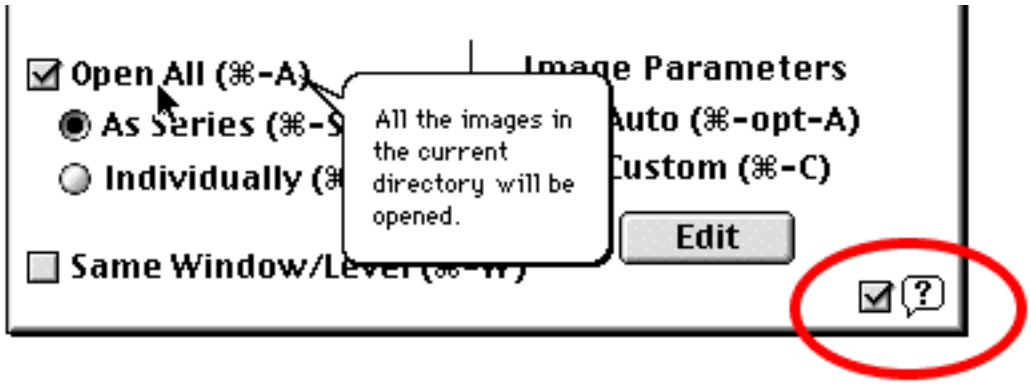



Figure 25. Balloon help in the open file dialog.

If a stationery document is opened, the image display window title is "Untitled." If multiple stationery documents are opened, they are titled, in sequence, "Untitled", "Untitled 2", "Untitled 3", etc.

## Custom Image Import Parameters Dialog

After selecting 'Edit' in the open file dialog, the **Custom Import Parameters** dialog allows editing of image width, image height, bit length, and other image parameters necessary to open an image file not supported by Dr Razz (Fig. 26). Select the 'OK' button to accept the parameters in the dialog, and select 'Cancel' to reject the settings.

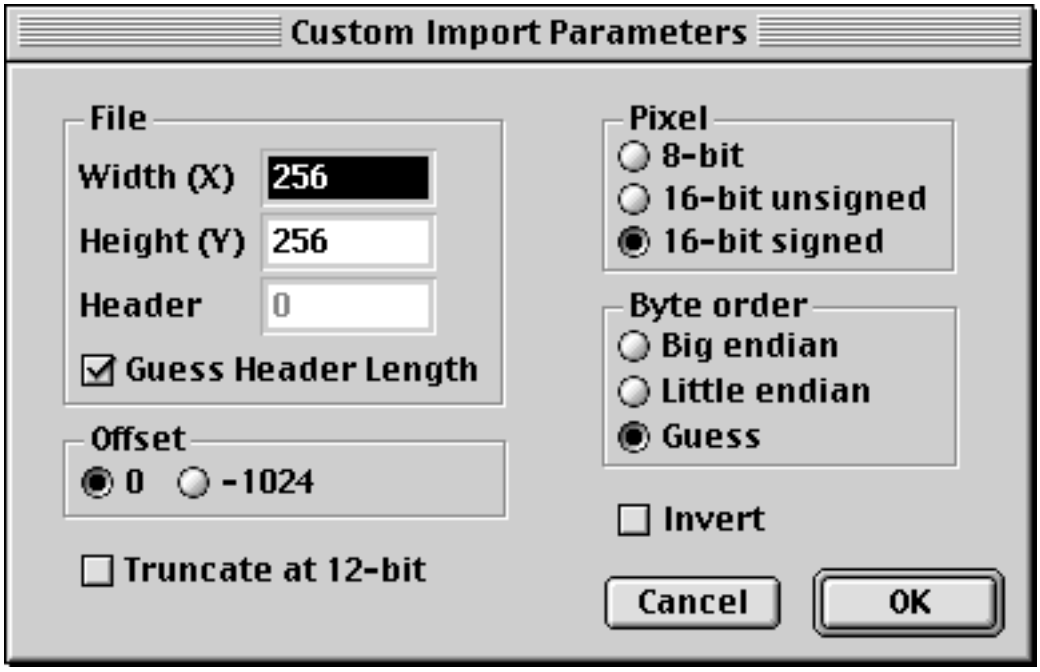



Figure 26. Custom Image Parameters dialog.

Image width and image height (in pixels), and header length (in bytes) are entered in the appropriate edit fields (Fig. 27). If the 'Guess Header Length' checkbox is selected, the image header size is automatically calculated based on the file size, the image dimensions and the 'bit length' of the image pixels. For 16-bit image pixels (2 bytes/pixel):

```
header size (bytes) = file size - [image width x image height x 2]
```

For 8-bit image pixels (1 byte/pixel):

```
header size = file size - [image width x image height]
```

When the 'Guess Header Length' checkbox is selected, the 'Header' edit field is inactive.

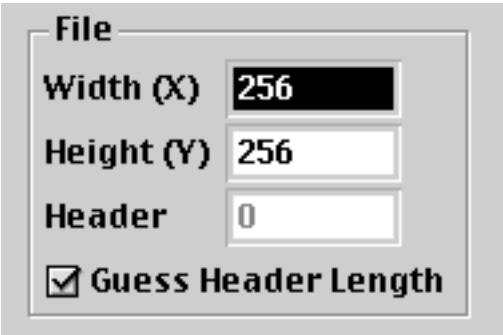



Figure 27. Image dimensions and header size edit fields.

Image pixel values in CT scans represent Hounsfield units (HU), which is related to density as follows:

$$HU = K\left(\frac{\mu_\rho - \mu_w}{\mu_w}\right)$$

where $\mu_\rho$ is the linear attenuation coefficient of the pixel, $\mu_w$ is the linear attenuation coefficient of water, and K is a constant that is equal to 1000. Thus the CT image pixel values range from -1000 for air to over 3000 for dense objects such as bone or metal. However, the pixel values in CT image files are often (but not invariably) stored as unsigned integers. To get the correct Hounsfield unit for such images, select the '-1024' radio button in the 'Offset' section (Fig. 28). The default is '0' (no data offset).

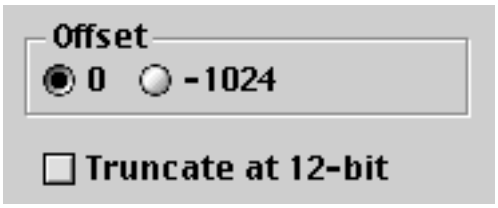



Figure 28. Data offset and truncate options.

If the 'Truncate at 12-bit' option is selected, the image pixel values will be truncated (limited) to 12-bit contrast range (4096 values). This option can be useful if the image contains large spurious values not related to the actual image data.

Pixel parameters important for opening an image file include the size of a pixel integer (8-bit or 16-bit) and (for 16-bit images) whether the pixel is signed or unsigned (Fig. 29). For 16-bit pixels, the 'Byte order' options include 'Big endian' (Motorola), 'Little endian' (Intel) or 'Guess'. The 'Guess' option attempts to determine byte order based on the image pixel values.

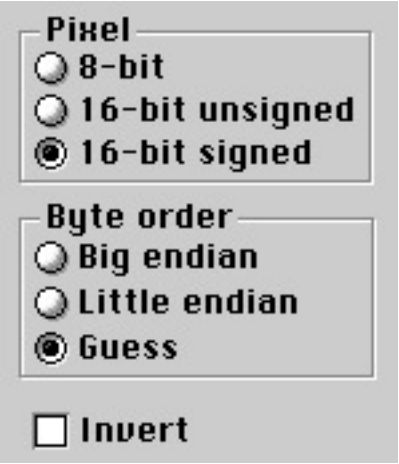



Figure 29. Pixel parameters.

The image grayscale values can be inverted by selecting the 'Invert' option (Fig. 29).

# Saving a File

## Save

The ‘Save’ menu item under the ‘File’ menu is active if any alteration of the image has occurred. Alterations include any image processing operation, image flip or rotate, and invert. Selecting the ‘Save’ menu item, or pressing the <Cmd-S> key combination saves the current image. Saving an image replaces the contents of the file associated with the frontmost image window with the image pixels in the image display window.

## Save As

The ‘Save As…’ menu item is active whenever an image display window is open. The 'Save As...' dialog (Fig. 30) appears if the 'Save As...' menu item is selected from the 'File' menu, or the 'Save' menu item is selected but the original image file is a stationery document or does not have a supported save file type. The ‘Save As’ operation saves the image pixels in the frontmost image display window into the new file named in the edit text box below the ‘Save As’ label. The new file is associated with the image display window, and the original image file is not altered if the new file does not have the same name as the original file.

The keyboard shortcut for 'Save As' is <Cmd-Shift-S>.

## Save A Copy As

The ‘Save A Copy As’ menu item is active whenever an image display window is open. The ‘Save A Copy As’ operation saves the image pixels in the frontmost image display window into the new file named in the text edit box. However, unlike the ‘Save As’ operation, the new file is **not** associated with the image display window. This operation is useful in saving multiple versions of an image without altering the original.

The keyboard shortcut for 'Save A Copy As' is <Cmd-Option-S>.

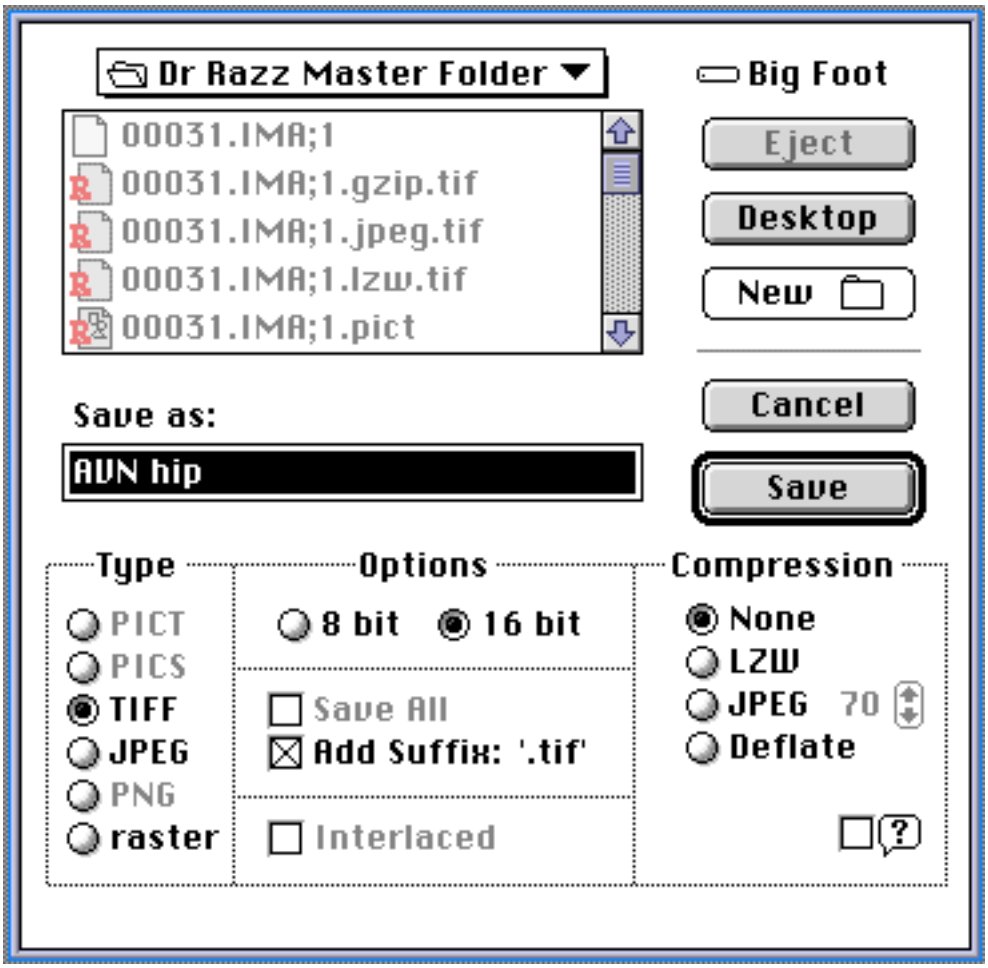



Figure 30. The Save As and Save A Copy As dialog.

## Save Options

Images can be saved as PICT, PICS, TIFF, JPEG JFIF, *PNG* or raster (image pixels without a header) files (Table 2). The file types available depend on whether the 16-bit or 8-bit option is selected. The file format options are listed in Table 2. The 'Add Suffix:' option adds an appropriate suffix to the saved file name. The suffix is displayed to the right of the checkbox label. *JPEG* files are interlaced if the 'Interlaced' checkbox is selected. If there are multiple image display windows opened, the 'Save All' checkbox is active, and selecting the check box saves all the open images in the selected file format.

The 'PICS' file format option is only enabled if the front most image display window is an image series. PICS files are easily converted to QuickTime movies with utilities distributed by Apple Computer and other companies.

JPEG compression quality is adjusted by selecting the small arrows to the right of the JPEG compression button (Fig. 31). A higher number is associated with higher image quality, but a lower the compression ratio. A compression quality number of 40 or more often results in little visible degradation of the image at normal magnification.

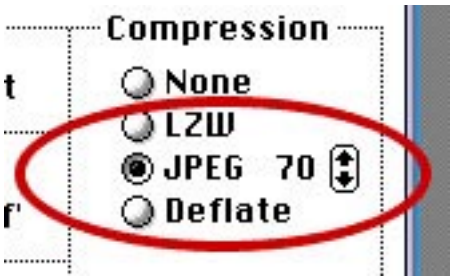



Figure 31. JPEG compression quality.

Table 2. Image File Format Options for Saving Files.

| File Format | 8-bit | 16-bit | Compression | Interlaced |
|---|---|---|---|---|
| raster | yes | yes | none | no |
| PICT | yes | no | (default) | n/a |
| PICS | yes | no | same as PICT | n/a |
| TIFF | yes | yes | none, LZW, deflate | no |
| JFIF/JPEG | yes | yes | JPEG | no |
| *PNG* | *yes* | *yes* | *deflate* | *yes* |

## Saving JPEG Files

JPEG files can be saved in either 8-bit (1 byte/pixel) or 16-bit (2 bytes/pixel) format (Table 2). However, 16-bit JPEG files cannot have a contrast resolution greater than 12-bit (image values from 0 to 4095). When saving a 16-bit JPEG image with greater than 12-bit contrast resolution, a dialog asks whether to remap the image to 12-bit contrast resolution (Fig. 32).

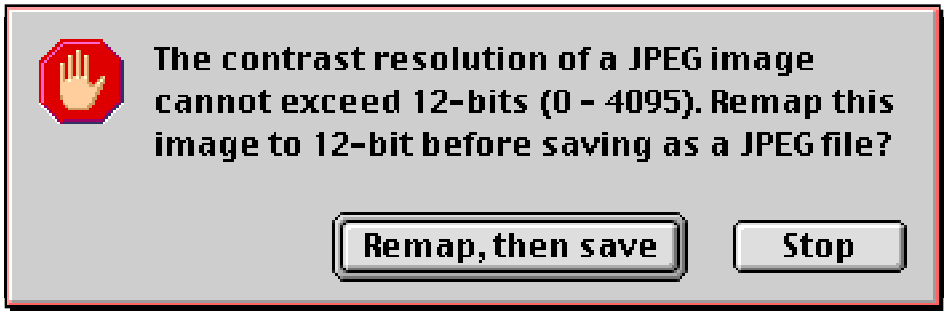



Figure 32. Saving JPEG image.

Selecting the 'Remap, then save' button will remap the current image to 12-bit contrast resolution before the image is saved. Selecting the 'Stop' button cancels the save operation, and leaves the image unchanged. Additionally, selecting the 'Remap to 12-bit' menu item of the 'Options' menu will also remap the current image to 12-bit contrast resolution.

# User Preferences

Selecting the 'Preferences' menu item under the 'File' menu opens the **Preferences dialog** (Fig. 33). User preferences are stored in a file titled 'Dr Razz Prefs' in the 'Preferences' Folder in the 'System Folder'.

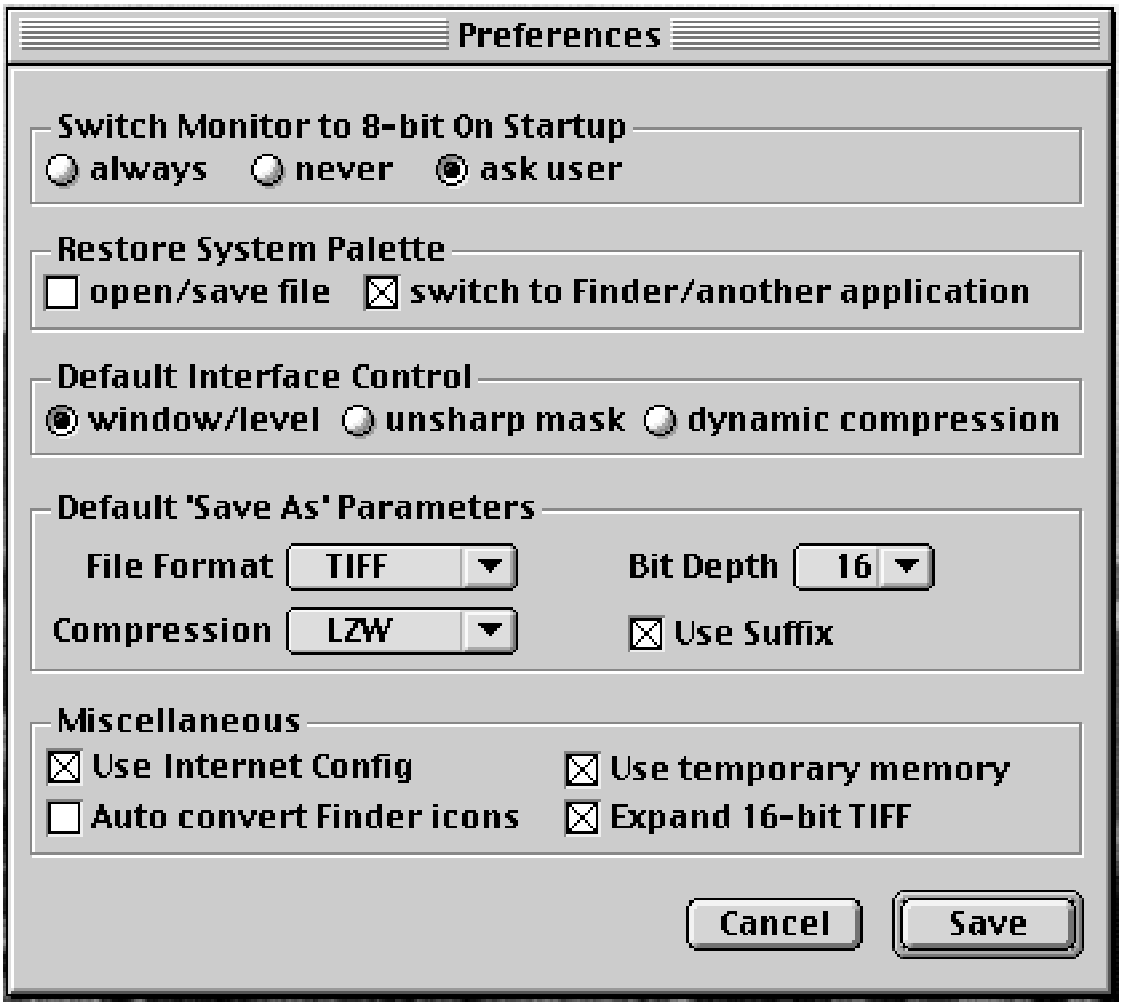



Figure 33. Preferences Dialog.

## Switch Monitor To 8-bit On Startup

Dr Razz grayscale images look best when the monitor display depth is set to 8-bit. The **always** preference will automatically change the monitor to 8-bit when Dr Razz is started. The **never** preference does not change the monitor setting to 8-bit, and the **ask user** preference displays a dialog on startup asking if the user wants the monitor changed to 8-bit (Fig. 34). The monitor

display depth is always restored to the original setting when the Dr Razz application terminates.


Figure 34. The "ask user" dialog.

## Restore System Palette

Dr Razz grayscale images use a grayscale palette that also converts the desktop and other application windows to grayscale display mode. The **open/save file** preference restores the original System palette for the open file and save file dialogs. The **switch to Finder/another application** preference restores the System palette when the Finder or another application is selected. The advantage of switching to the System palette is the original color display is restored, but the disadvantage is an annoying monitor "flash" (which can take tens of seconds to complete) while the monitor restores the System palette.

## Default Interface Control

These preference settings determine the default interface control when an image is opened: **window/level**, **unsharp mask**, or **dynamic compression**.

## Default 'Save As' Parameters

These preference settings determine the default **file format** (PICT, TIFF, JPEG, etc.), **compression** (none, JPEG, LZW, deflate), **bit depth** (8 or 16-bit) and the **use suffix** option when the 'Save As' command is selected. However, if the 16-bit option is selected and an 8-bit image is saved, the parameters will default to 8-bit TIFF with no compression.

## Miscellaneous

The **Use Internet Config** preference uses the 'Internet Config' extension for the 'Internet' menu items. The document "Installing Internet Config" explains the 'Internet Config' extension is more detail.

The **Use temporary memory** preference uses System "temporary" memory outside of the Dr Razz application memory partition for loading image data: deselecting this preference will force all memory allocation to occur within the Dr Razz memory partition. Most users should select this preference. However, the temporary memory option should probably be deselected if virtual memory is enabled.

The **Auto convert Finder icons** preference automatically converts image Finder icons to the appropriate Dr Razz icon (see Table 1, below).

The **Expand 16-bit TIFF** preference expands the contrast resolution of 16-bit TIFF files to the entire 16-bits. This option is helpful if the TIFF file is subsequently opened with PhotoShop.

# About Dr Razz Dialog

Selecting the 'About Dr Razz…' menu item under the Apple men, or pressing the <F15> function key, displays the About Dr Razz dialog (Fig. 35). Clicking the mouse anywhere within the dialog will close the dialog.

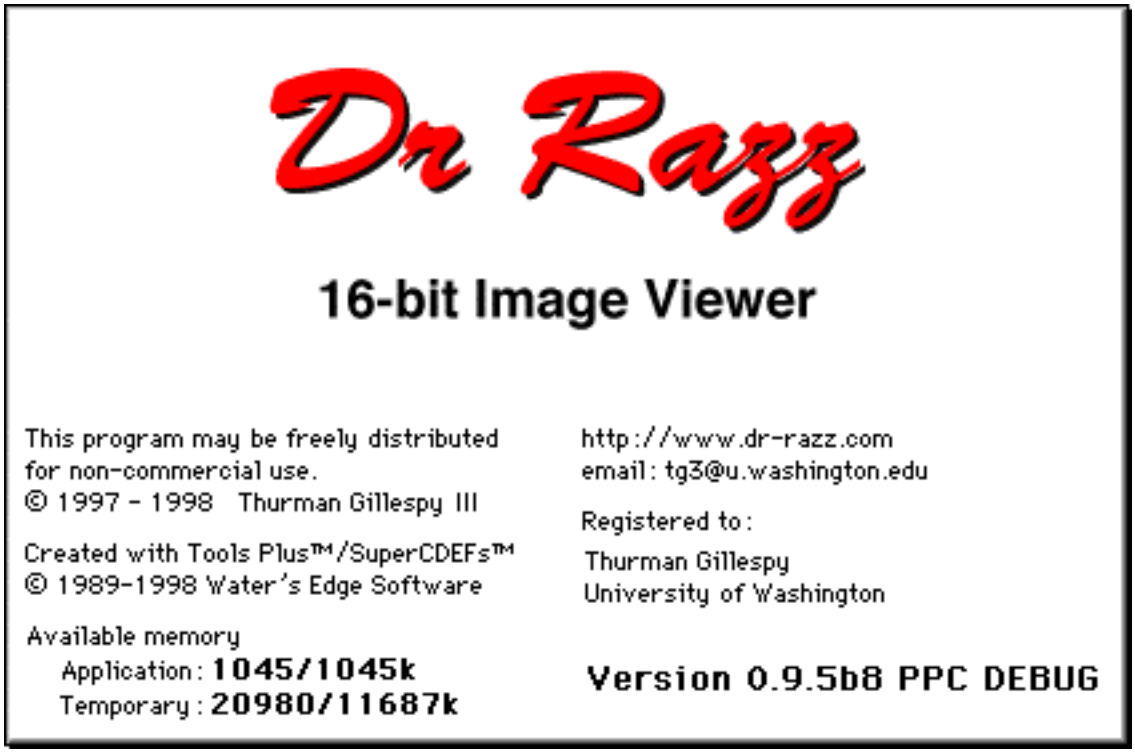



Figure 35. About Dr Razz dialog.

The dialog displays information about permissible program distribution, copyright, contact information, amount of available memory, registration information, and the version of the program. The **available memory: application** section displays the amount of memory available in the application memory partition. The **available memory: temporary** section displays the amount of available memory in System temporary memory. Dr Razz can use System temporary memory if that option is selected as a user preference (see 'User Preferences', page 32).

# Info Window

The **Info window** (Fig. 36) displays information about the image, including the file name, width and height of the image, minimum and maximum image pixel values, and the size of the image (not the size of the image file).


Figure 36. Info window.

The info window is opened by selecting the 'Get Info' menu item under the 'File' menu. The info window can be closed by either clicking the close box, or by pressing the <Delete> key.

# Finder Icons

The following table illustrates the Finder icons associated with the Dr Razz application.

Table 1. Dr Razz Finder icons.

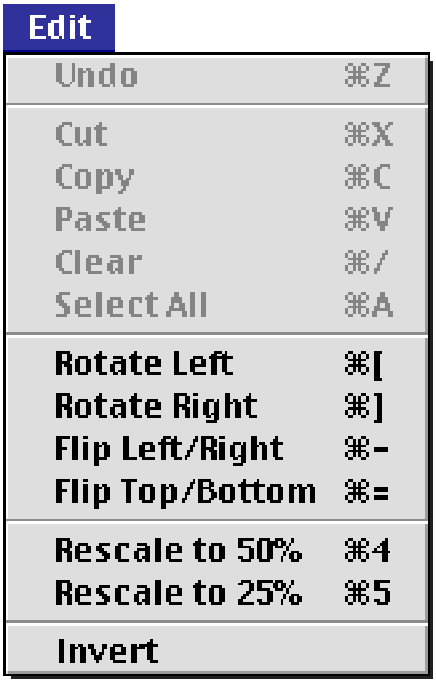
| Finder Icon | Stationary Document | Explanation |
|---|---|---|
|  | **n/a** | The Dr Razz application |
|  | **n/a** | Preference file (Preferences Folder, System Folder) |
|  |  | Raster image file (pixels with no header) |
|  |  | Binary image file (image and header) |
|  |  | PICT file. |
|  |  | TIFF file. |
|  |  | JPEG (JFIF format) file |
|  |  | ACR/NEMA, DICOM 3.0 file |

If the Finder icon of an open document does not match the image file format, the ‘Convert Finder Icons’ menu item is enabled under the 'File' menu. Selecting this menu item changes the Finder icon to match the image file type. Selecting the 'Auto convert Finder icons' user preference will automatically convert the Finder icon to the appropriate Dr Razz icon.

# Image Processing

The 'Edit', 'Options' and 'Enhance' menus offer a variety of image processing operations. Operations that change image orientation can be performed on 8-bit and 16-bit images, but operations that change the appearance of an image can only be performed on 16-bit images.

## Edit Menu

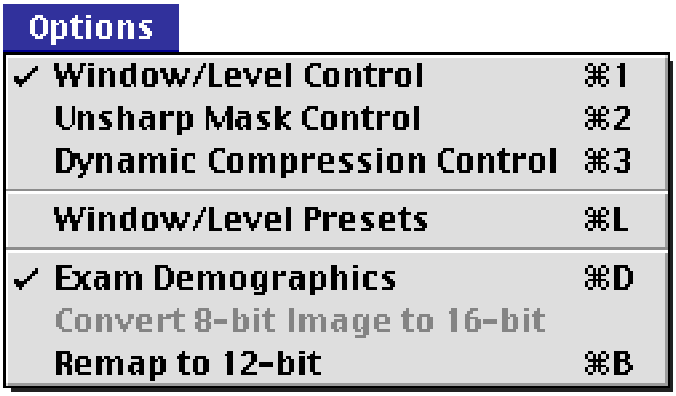



Images can be rotated 90° counterclockwise with the **Rotate Left** operation, and 90° clockwise rotation with the **Rotate Right** operation. The **Flip Left/Right** command performs a 180° horizontal rotation, and the **Flip Top/Bottom** command performs a 180° vertical rotation.

Images can be reduced in size by 50% by the **Rescale to 50%** operation, and can be reduced to 25% of original size by the **Resize to 25%** operation.

The **Invert** operation inverts the image grayscale.

## Options Menu

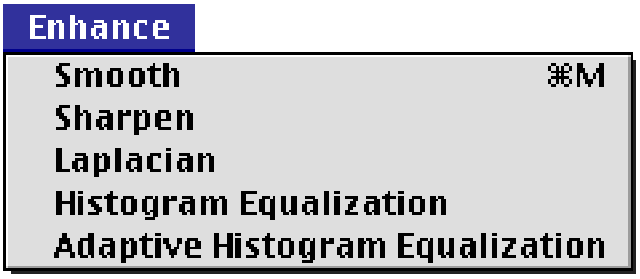



The interactive **Window/Level Control**, **Unsharp Mask Control** and **Dynamic Compression Control** (Figs. 5, 17, 19) are described in previous sections.

An 8-bit (1 byte/pixel) image can be converted to a 16-bit (2 bytes/pixel) by the **Convert 8-bit Image to 16-bit** operation. The operation also expands the contrast resolution from 8 to 10 bits. An 8-bit image must be converted to a 16-bit image before most image processing operations can be performed.

The contrast resolution of a 16-bit image can be expanded or compressed to 12-bit by the **Remap to 12-bit** operation.

## Enhance Menu




The **Smooth** operation blurs the image using a 3x3 blurring convolution kernel.

```
1  1  1
1  1  1
1  1  1
```

Holding the <Option> key while selecting the menu item will increase the amount of smoothing by using a 7x7 kernel.

The **Sharpen** operation enhances the high frequencies ("sharpens") in the image using an unsharp mask operation with the following convolution kernel.

```
 0 -1  0
-1  5 -1
 0 -1  0
```

Holding the <Option> key while selecting the menu item will increase the amount of sharpening with the following convolution kernel:

```
-1 -1 -1
-1  9 -1
-1 -1 -1
```

The **Laplacian** operation enhances the edges in the image, with the following kernel:

```
 0 -1  0
-1  4 -1
 0 -1  0
```

The **Histogram Equalization** operation redistributes the image pixel values based on the grayscale histogram so that the number of pixels at any one grayscale is about the same. Although the operation is often useful in image enhancement and restoration, the effect on many medical images is unsatisfactory.

The **Adaptive Histogram Equalization** performs a histogram equalization on each pixel based on an NxN local neighborhood (i.e., surrounding pixels). The technique is impractical without significant hardware or software optimization. An article that describes the adaptive histogram equalization algorithm used by Dr Razz is listed in the 'References' section.

# Internet Options

For computers connected to the internet, the 'Internet' menu allows quick and easy access to a variety of Dr Razz related internet functions. For this menu to work correctly, the Internet Config system extension, which is included with the Dr Razz distribution, should be installed. The Internet Config extension determines which web browser and other internet programs perform the internet functions.

- **Dr Razz Web Site** - go to the Dr Razz web site.
- **Comments and Suggestions** - submit comments about the program.
- **Submit a Bug Report** - report any problems with Dr Razz.
- **Download Latest Version** - FTP the latest version.
- **Email the Author** - send an email message to the author of Dr Razz.
- **Register** - register your copy of the program.

# Keyboard Shortcuts

• Window/Level control: left and right arrow keys change the window setting, and the up and down arrows change the level setting. When the window setting is below 200, the window and level settings are changed more slowly with finer resolution. Pressing the <Option> key increases magnitude of change with arrow keys.

• Image series : '<' and '>' keys (without command key) go to next and previous image. On extended keyboards, <Home> and <End> go to first and last image, while <Page Up> and <Page Down> keys go to next and previous image.

• Nearly all of the controls in the 'Open' and 'Save' dialogs have keyboard shortcuts. Most are obvious in context.

• The <~> or <F15> keys on the extended keyboard open the 'About Dr Razz' dialog. Clicking the mouse will close the dialog.

• Holding the <space bar> while the cursor is in an image display window will change the cursor to the grabber tool.

• Menu shortcuts: <Cmd-Shift-S> opens the 'Save As' dialog; <Cmd-Option-S> opens the 'Save A Copy As' dialog; <Cmd-Shift-I> *opens the 'Import' dialog*.

• The image info window can be closed by pressing the <Delete> key.

# Miscellaneous

## Acknowledgments

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- TIFF support (libtiff), by Sam Leffler, release 3.4.
- JPEG code by the Independent JPEG Group, release 6b.
- deflate compression (zlib) by Jean-loup Gailly and Mark Adler, release 1.1.3.
- More Files 1.4.8, by Jim Luther.
- Jim's CDEFs, by Jim Stout, release 1.5.
- Infinity Windoid 3.0, by Troy Gaul.
- libmoto (optimized math and string library), Motorola, Inc.

The Dr Razz user interface was designed with the ToolsPlus™ and SuperCDEFs™ development system. "Portions of this application © 1989-1998 Water's Edge Software. All rights reserved." Additional information is available at `<http://www.interlog.com/~wateredg/>`.

## Copyright Notice and Disclaimer of Warranty

## Contact Information

General comments about the program and inquiries to the author can be emailed to:

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## Where To Get Dr Razz

- **Dr Razz Web Site**

  <http://www.dr-razz.com>

## About That Name

“Razz” is a pun on the word “raster.” The proper spelling is “Dr Razz”, without any punctuation (no period after 'Dr').

## Related Publications

Here is a list of publications related to the Dr Razz project.

1. Gillespy T 3rd. Optimized algorithms for displaying 16-bit gray scale images on 8-bit computer graphic systems. J Digit Imaging 1993; 6:25-29.

2. Gillespy T 3rd, Rowberg AH. Displaying radiological images on personal computers: introduction and fundamental principles of digital images. J Digit Imaging 1993; 6:81-87.

3. Gillespy T 3rd, Rowberg AH. Displaying radiological images on personal computers. J Digit Imaging 1993; 6:151-163.

4. Gillespy T 3rd, Rowberg AH. Dual lookup table algorithm: an enhanced method of displaying 16-bit gray-scale images on 8-bit RGB graphic systems. J Digit Imaging 1993; 7:13-17.

5. Gillespy T 3rd, Rowberg AH. Displaying images on personal computers: image storage and compression - part 1. J Digit Imaging 1993; 6:197-204.

6. Gillespy T 3rd, Rowberg AH. Displaying images on personal computers: image storage and compression - part 2. J Digit Imaging 1993; 7:1-12.

7. Gillespy T 3rd, Rowberg AH. Displaying images on personal computers: image processing. J Digit Imaging 1994; 7:51 - 60.

8. Gillespy T 3rd, Richardson ML, Rowberg AH. Displaying images on personal computers: practical applications and uses. J Digit Imaging 1994; 7: 101-106.

9. Gillespy T 3rd. Optimized algorithm for adaptive histogram equalization. 3308-104. Medical Imaging 98. San Diego, California, February 21 - 26, 1998.

More information about the Journal of Digital Imaging can be found at:

```
<http://www.scar.rad.washington.edu/SCAR/publications.html>
```

# Index