

# MIPAV



MEDICAL IMAGE PROCESSING AND VISUALIZATION

<http://mipav.cit.nih.gov>





# Medical Image Processing, Analysis & Visualization in Clinical Research

**Justin Senseney**

SenseneyJ@mail.nih.gov

dcb.cit.nih.gov/~senseneyj

Biomedical Image Processing Research Services Section

Center for Information Technology

mipav.cit.nih.gov



# MIPAV Team



## Employees

Ruida Cheng

William Gandler

**Matthew McAuliffe**

Evan McCreedy

Justin Senseney

## Fellows

Sara Shen (Maryland)

## Contractors

Alexandra Bokinsky, Geometric Tools Inc. (Visualization)

Olga Vovk, SRA International Inc. (Technical Writing)

## Alumni

Paul Hemler (Hampden-Sydney), Agatha Monzon, Nishith Pandya (FITBIR),

Beth Tyrie (Kentucky), Hailong Wang (Heidelberg)



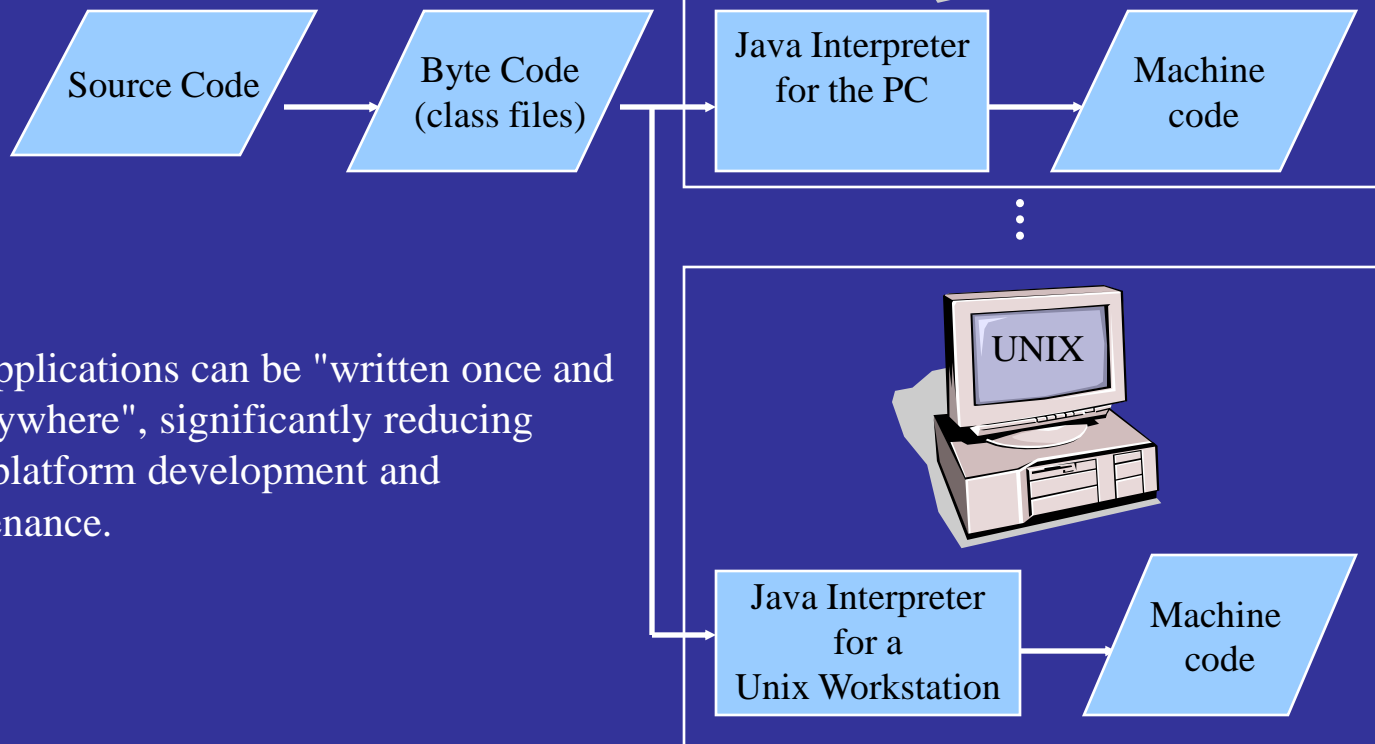
# Requirements for an Image Quantification and Visualization Application

- **Portability**
  - cross-platform or platform-independent execution
- **Data format independence**
  - access to images: DICOM, Analyze, TIFF, Raw, ...
- **Extensibility**
  - plugins and/or scripts
- **Scalability**
  - foundation to support the growth to larger and more intricate data structures
- **Usability**
  - coherent graphical user interface (GUI)



# Portability

## Java Primer



Java applications can be "written once and run anywhere", significantly reducing cross-platform development and maintenance.

## Data Independence

- DICOM file reader/writer
- DICOM Query/Retrieve and “Catcher”
- Comprehensive file format support/conversion
  - <http://mipav.cit.nih.gov/fileformat.html>
- MIPAV XML file format



# Extensibility

## Plugins and Scripts

- **Plugins**
  - Functions written in Java using the MIPAV API.
- **Scripts**
  - Use MIPAV to record and save function(s) applied to image dataset(s).
  - Apply the script to any number of image datasets using the script wizard.



# Scalability

- **Model Image is an n-dimensional structure.**
- **Algorithms can support up to 4D datasets.**
- **Viewers support 4D dataset with fusion.**

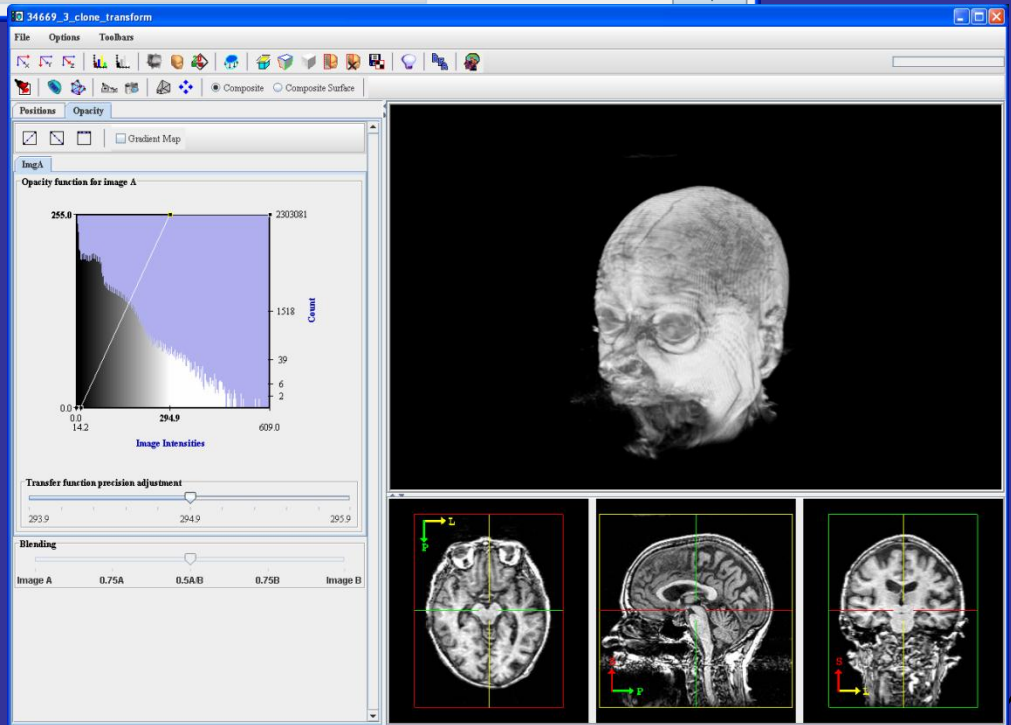
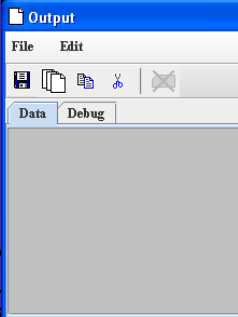
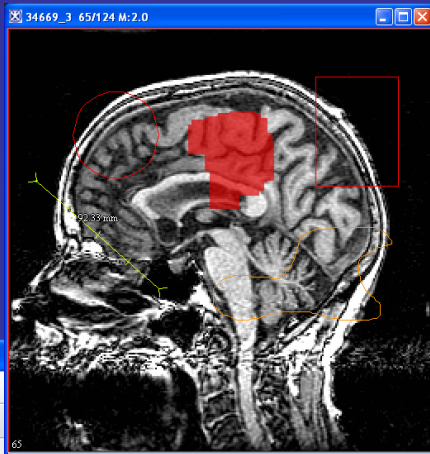
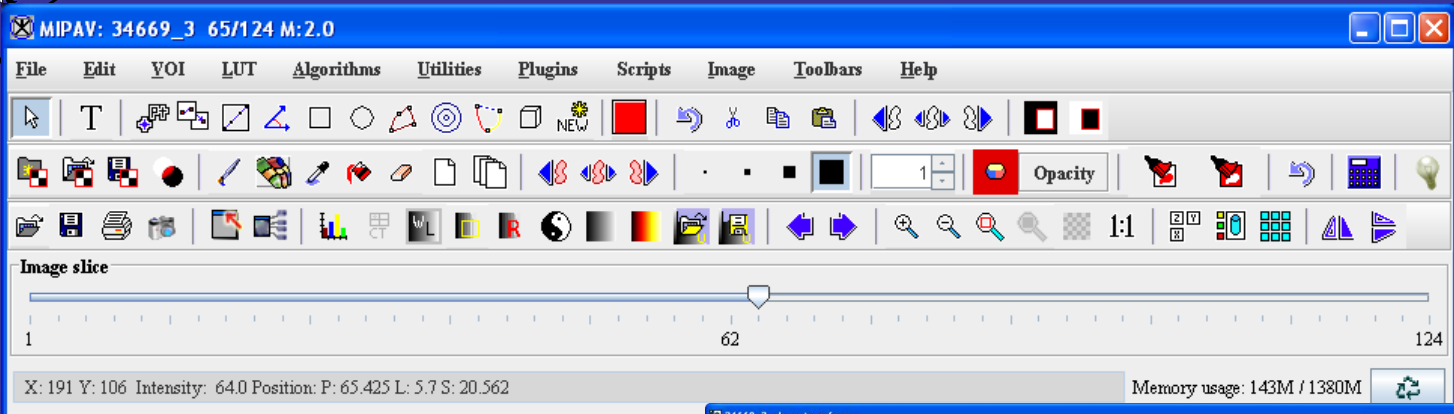




# Usability

- **GUI elements**
- **Scripting system**
- **Command-line tools**





# Functional Overview

## GUI

### Views – with data fusion

2D planar,  
 “Lightbox”,  
 Cine (movie),  
 Multi-planar,  
 3D tri-planar,  
 Surface render, (supports 3D texture  
 mapped volume rendering)  
 Volume render

### VOIs

32K  
 Manual and  
 automated  
 contouring

### Algorithms

Filtering  
 Segmentation/classification  
 Measurement/quantification  
 Registration/fusion  
 Utilities  
 Plugins

S  
c  
r  
i  
p  
t  
i  
n  
g

### Data (Image) types: n-dimensional structure

(boolean, byte, unsigned byte, short,  
 unsigned short, int, long, float, double, Complex, ARGB)

### PACS

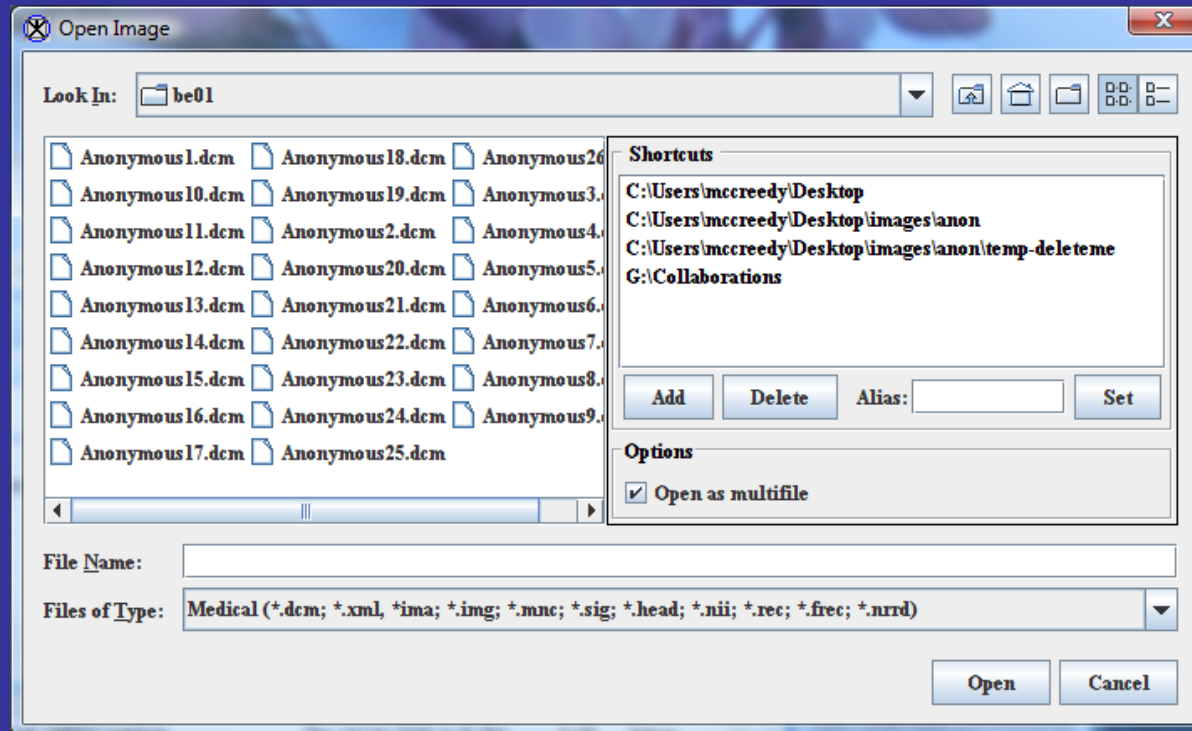
DICOM 3.0:  
 Query/Retrieve, Catcher

### File types

(Raw, Analyze, DICOM 3.0, GE, Siemens, Bruker, Interfile,  
 Micro cat, MINC, MRC, FITS, Cheshire, AFNI, TIFF, JPEG, GIF,  
 BMP, AVI, QuickTime, Biorad, Ziess LSM510, **XML**, and more)



# Opening Images



# Opening Images

**Open image sequence**

Browse: D:\costes\Cell2\_0\_3D002.tif

**File list**

- Cell2\_0\_3D000.tif
- Cell2\_0\_3D001.tif
- Cell2\_0\_3D002.tif
- Cell2\_0\_3D003.tif
- Cell2\_0\_3D004.tif
- Cell2\_0\_3D005.tif
- Cell2\_0\_3D006.tif
- Cell2\_0\_3D007.tif
- Cell2\_0\_3D008.tif
- Cell2\_0\_3D009.tif**
- Cell2\_0\_3D010.tif
- Cell2\_0\_3D011.tif
- Cell2\_0\_3D012.tif
- Cell2\_0\_3D013.tif
- Cell2\_0\_3D014.tif
- Cell2\_0\_3D015.tif
- Cell2\_0\_3D016.tif
- Cell2\_0\_3D017.tif
- Cell2\_0\_3D018.tif
- Cell2\_0\_3D019.tif

**Dimensions**

5 Slices (Z)  
1 Channels (C)  
4 Time points (T)


**Sequences**

Z-C-T     Z-T-C  
 C-Z-T     C-T-Z  
 T-Z-C     T-C-Z

**Subsampling**

Enable  
Width:   
Height:   
 Force 8-bit

**Apply >>**

  
Image dimensions: 171x144

**Window**

0.1    1    10

**Level**

-255    0    255

Channel	Time point 1	Time point 2	Time point 3	Time point 4
1	Cell2_0_3D000.tif	Cell2_0_3D005.tif	Cell2_0_3D010.tif	Cell2_0_3D015.tif
	Cell2_0_3D001.tif	Cell2_0_3D006.tif	Cell2_0_3D011.tif	Cell2_0_3D016.tif
	Cell2_0_3D002.tif	Cell2_0_3D007.tif	Cell2_0_3D012.tif	Cell2_0_3D017.tif
	Cell2_0_3D003.tif	Cell2_0_3D008.tif	Cell2_0_3D013.tif	Cell2_0_3D018.tif
	Cell2_0_3D004.tif	Cell2_0_3D009.tif	Cell2_0_3D014.tif	Cell2_0_3D019.tif

**Crop**    **Remove**

**Open**    **Close**



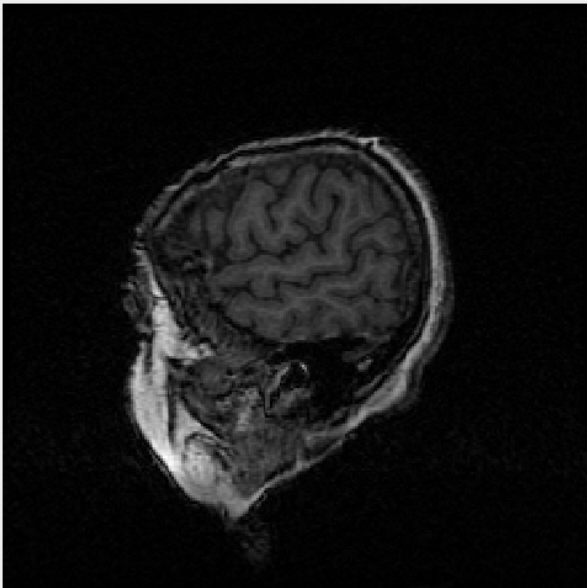
# Image Browser

Tree of images in selected directory

File

D:\alonde\Problem DICOMs

- 3086665
- 3117862
  - 3.SER
    - 1.ACQ
      - 1.IMA
      - 10.IMA
      - 100.IMA
      - 101.IMA
      - 102.IMA
      - 103.IMA
      - 104.IMA
      - 105.IMA
      - 106.IMA
      - 107.IMA
      - 108.IMA
      - 109.IMA
      - 11.IMA
      - 110.IMA
      - 111.IMA
      - 112.IMA
      - 113.IMA
      - 114.IMA
      - 115.IMA
      - 116.IMA
      - 117.IMA
      - 118.IMA
      - 119.IMA
      - 12.IMA
      - 120.IMA
      - 121.IMA
      - 122.IMA
      - 123.IMA
      - 124.IMA
      - 13.IMA
      - 14.IMA



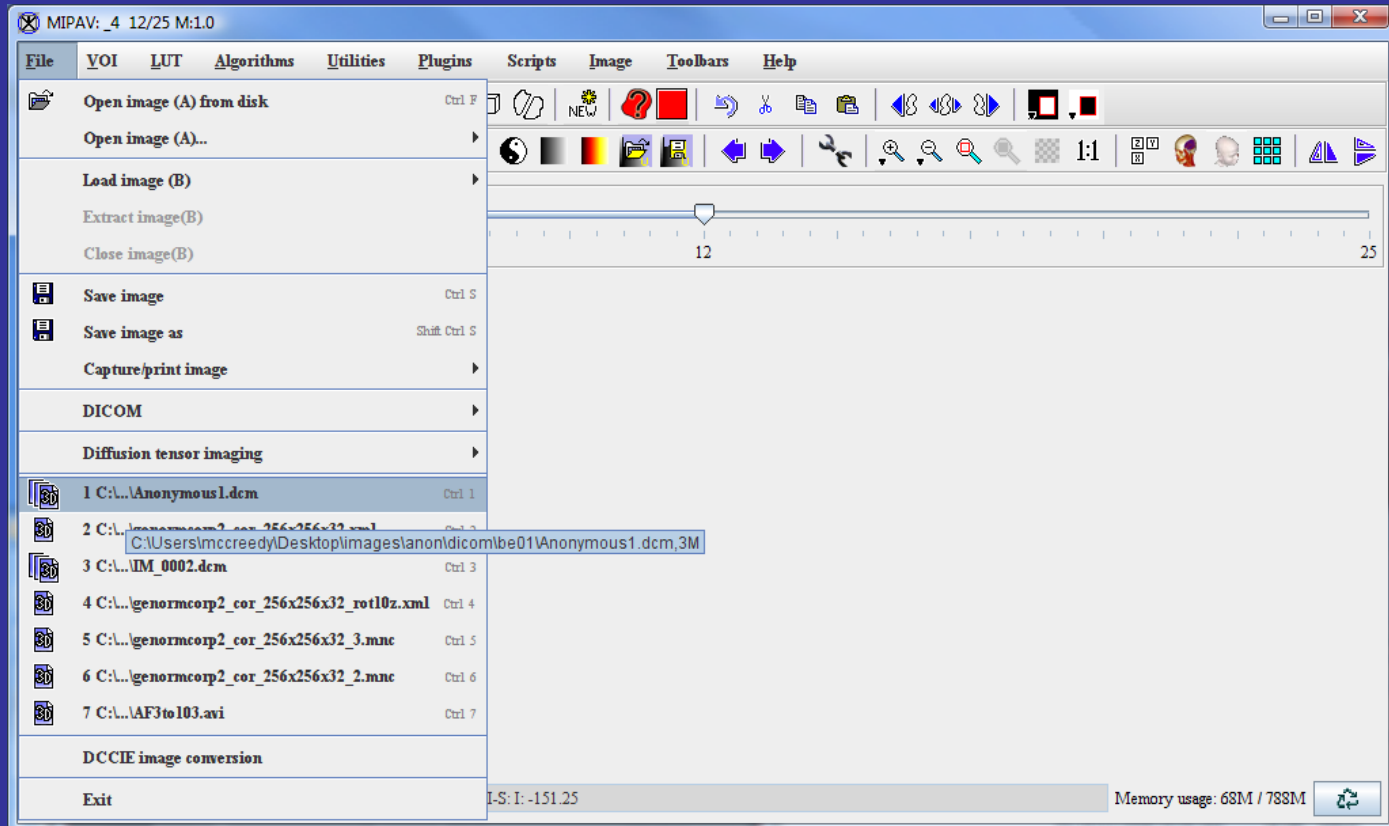
Window: 0.1 1 10

Level: -255 0 255

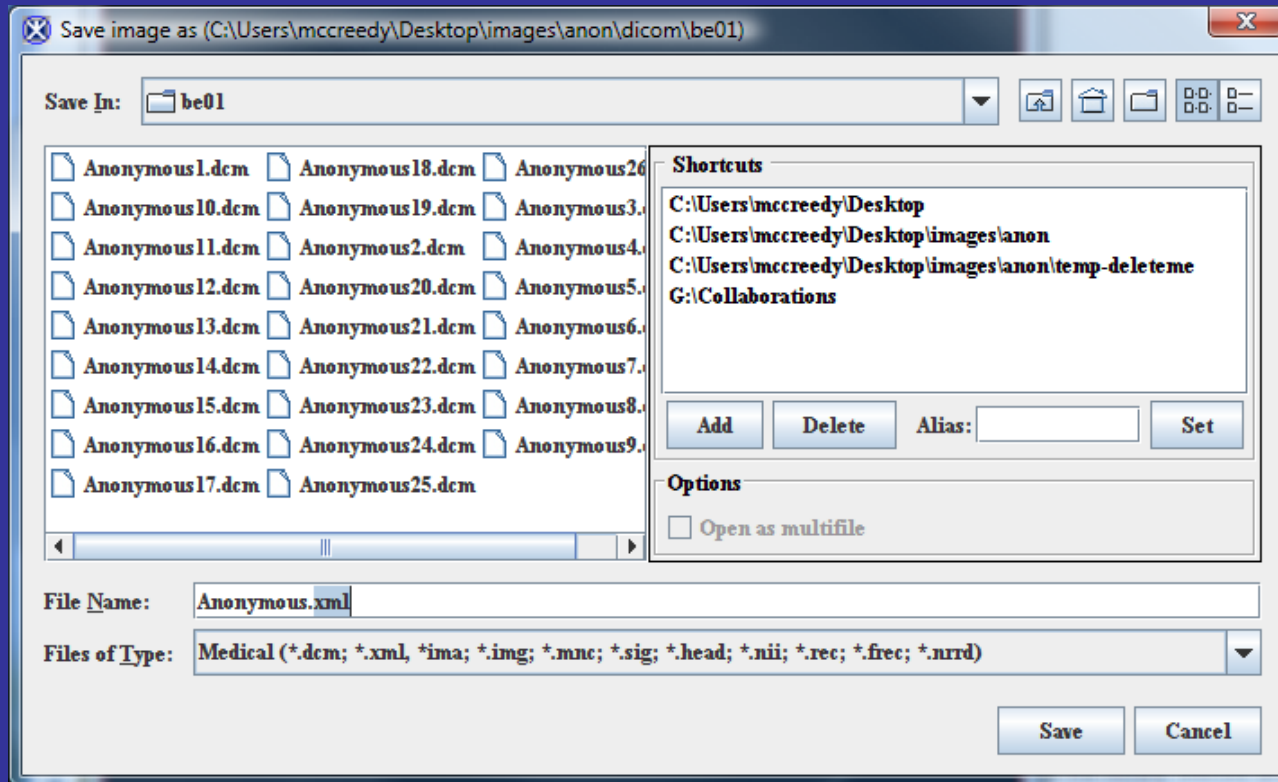
Image Information	
Dimension 0	256
Dimension 1	256
Type	Short
Max	279.0
Min	0.0
Modality	Magnetic Resonance
Orientation	Sagittal
Pixel resolution 0	0.9375 Millimeters
Pixel resolution 1	0.9375 Millimeters
Other Information	
(0002,0000) File Meta Information Group Length	192
(0002,0001) File Meta Information Version	256



# Opening Images



# Saving Image As (use suffix)





# Code Snapshot



```
int destExtents[] = new int[2];
destExtents[0] = image.getExtents()[0]; // X dim
destExtents[1] = image.getExtents()[1]; // Y dim

// Make a result image of Unsigned byte type
resultImage = new ModelImage(ModelStorageBase.UBYTE, destExtents, "Result Image", null);

int length = destExtents[0] * destExtents[1];
for (int i = 0; i < length; i++){
    destImage.set(i, i%256);
}

ViewJFrameImage imageFrame;
ModelLUT LUTa = new ModelLUT(ModelLUT.COOLHOT, 256, dimExtentsLUT);
imageFrame = new ViewJFrameImage(resultImage, LUTa, new Dimension(610,200), userInterface);
```

# Algorithms

- **Filters**
- **Calculation**
- **Registration**
- **Transformation**
- **Surface extraction**
- **Classification/Segmentation**



# Download and Setup

1. <http://mipav.cit.nih.gov/download>
2. Fill in form
3. Install (e.g. installMIPAV.exe)

\*\* Nightly download - latest changes but might have bugs.  
\*\* Archived releases also available.

The screenshot shows the MIPAV download page on the CIT website. The page header includes the CIT logo and the text "CENTER FOR INFORMATION TECHNOLOGY NATIONAL INSTITUTES OF HEALTH". A search bar is located in the top right corner. The main navigation menu includes links for CIT Home, Products & Services, Information Security, Support, Science, IT Policies, and About CIT. The breadcrumb trail reads: Back to: CIT Home > Science > Collaborative Research > Biomedical Imaging > MIPAV. The page title is "SCIENCE" and the main heading is "Download MIPAV".

Two versions of MIPAV can be downloaded for each platform:

- A release version
- A nightly test-build

**What's the difference?**

The release version of MIPAV is tested to ensure that it installs and runs. We make new release versions available when we feel a significant number of changes have accumulated. A nightly built, test version is released nightly and it incorporates changes made to MIPAV during the course of the day.

**Which to download?**

Most users will find that the release version fits their needs; the group has deemed that added functionality does not have any noticable errors. However, because the nightly-built, test version will track recent changes, a user seeking a solution to a known problem may be able to find it corrected before we are ready to make a new release. Any temporary errors may prevent the MIPAV project software from even installing.

**MIPAV releases**

The latest release is version: 4.1.3 (2008-10-15)  
The latest nightly build is version: 4.1.3-2008-10-16 (2008-10-16)

Previous versions of MIPAV are also available below.

Please fill out the form below and click on the button for your particular operating system to download MIPAV.

**Note to users:** The beta GPU volume renderer in MIPAV currently only works on systems with Nvidia graphics cards that support the Cg shader language. We are currently working to add support for ATI graphics cards through the use of the GLSL shader system.

[View the MIPAV Installation Guide](#)

**JHU Medic**

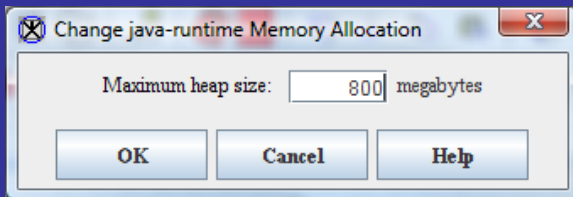
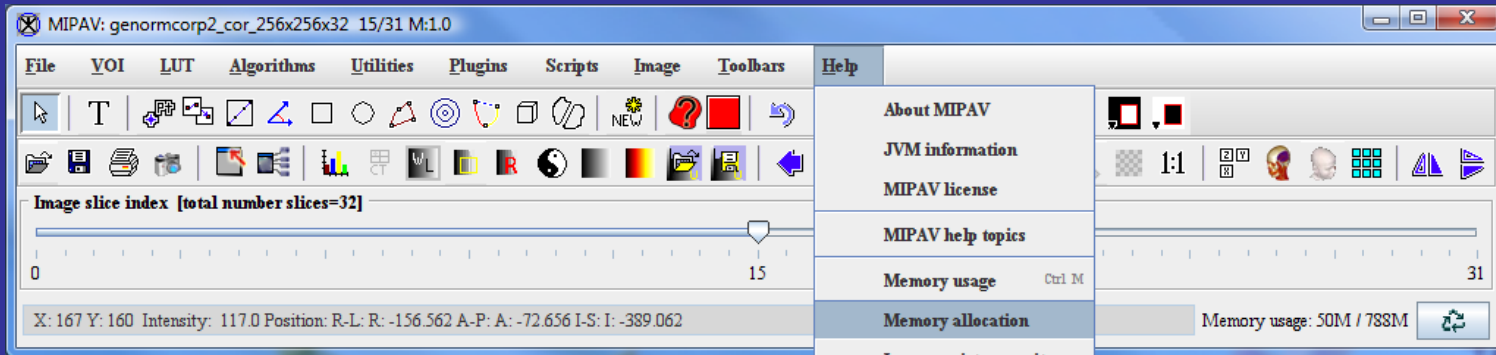
**MEDIC**

Johns Hopkins University Medic have built plug-ins for MIPAV, focusing on modifying images to use Talairach co-ordinates.

Name (required)	<input type="text"/>
Email (required)	<input type="text"/>
Institute or Center	Not at the National Institutes of Health, Maryland, USA. ▾
Interest in MIPAV	<input type="text"/>



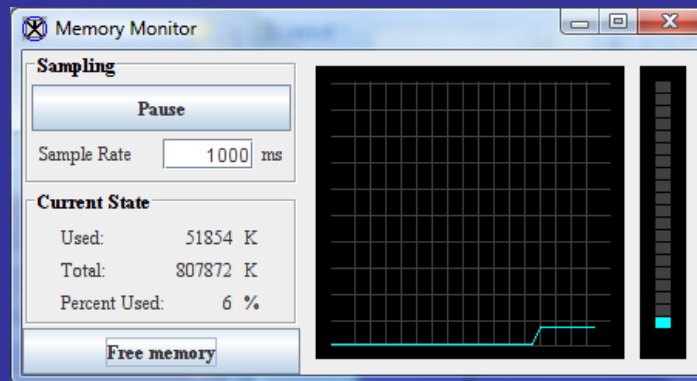
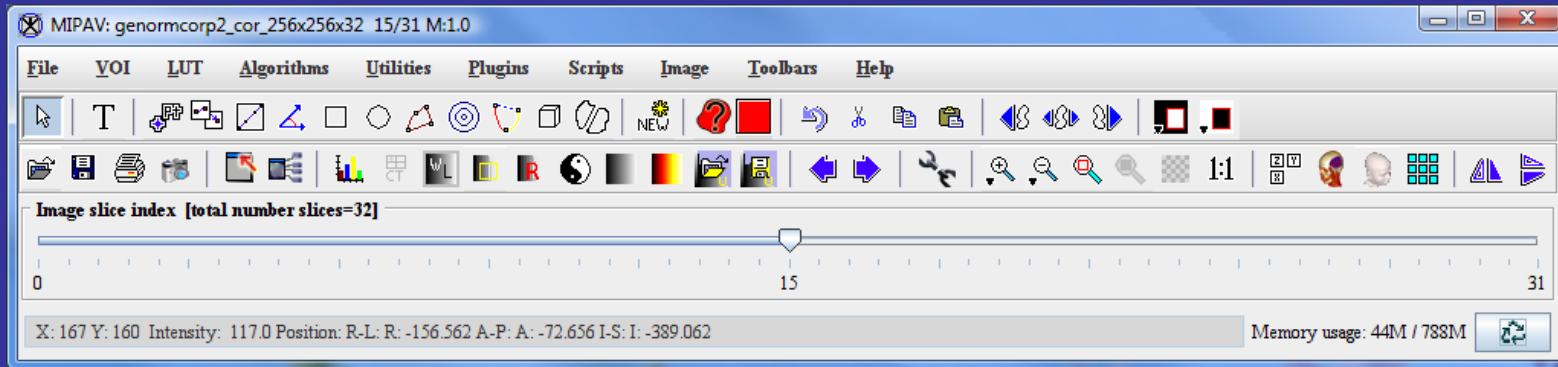
# Memory Allocation



## General Rules

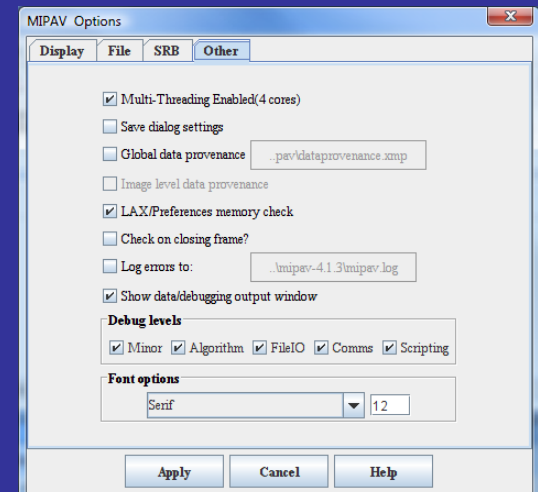
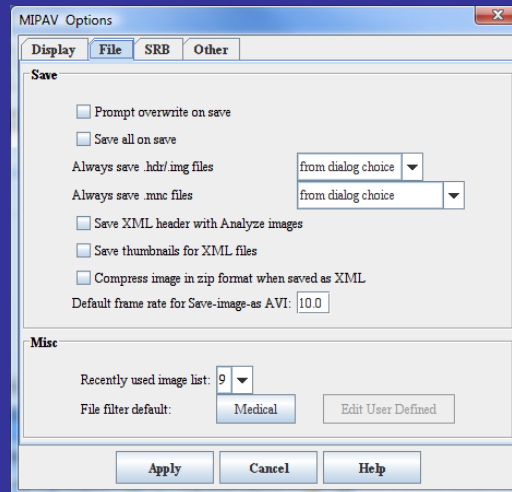
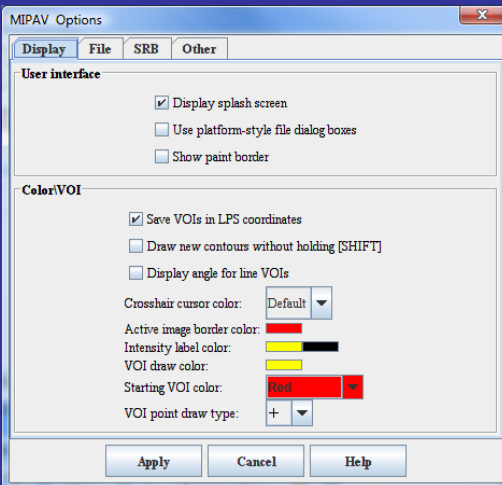
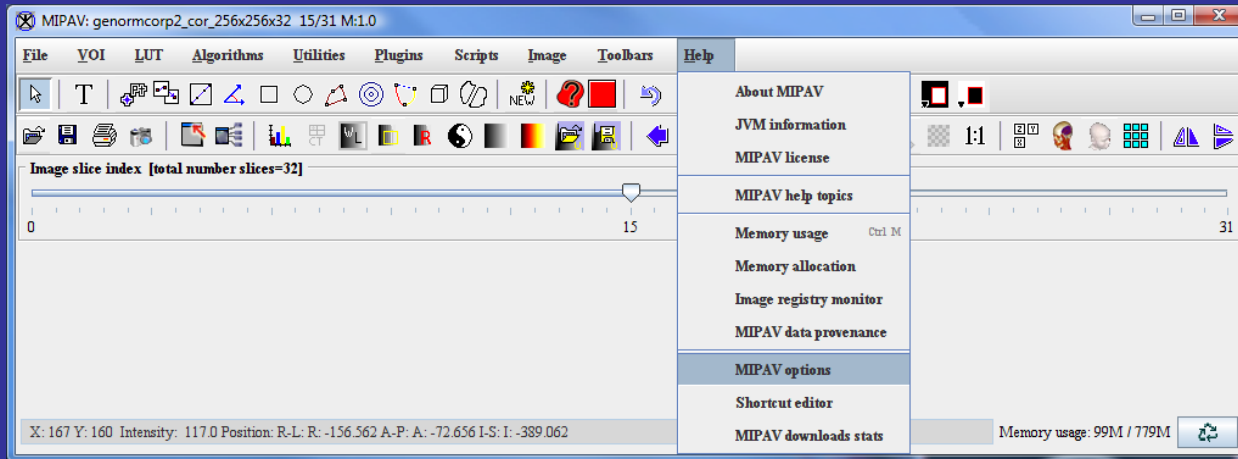
- Do not exceed the computer's physical RAM. For example if the computer has 1GB do not exceed approx 800MB.
- For 32-bit Windows systems do not exceed 1,400MB

# Memory Usage



Press to recover memory

# MIPAV Program Options



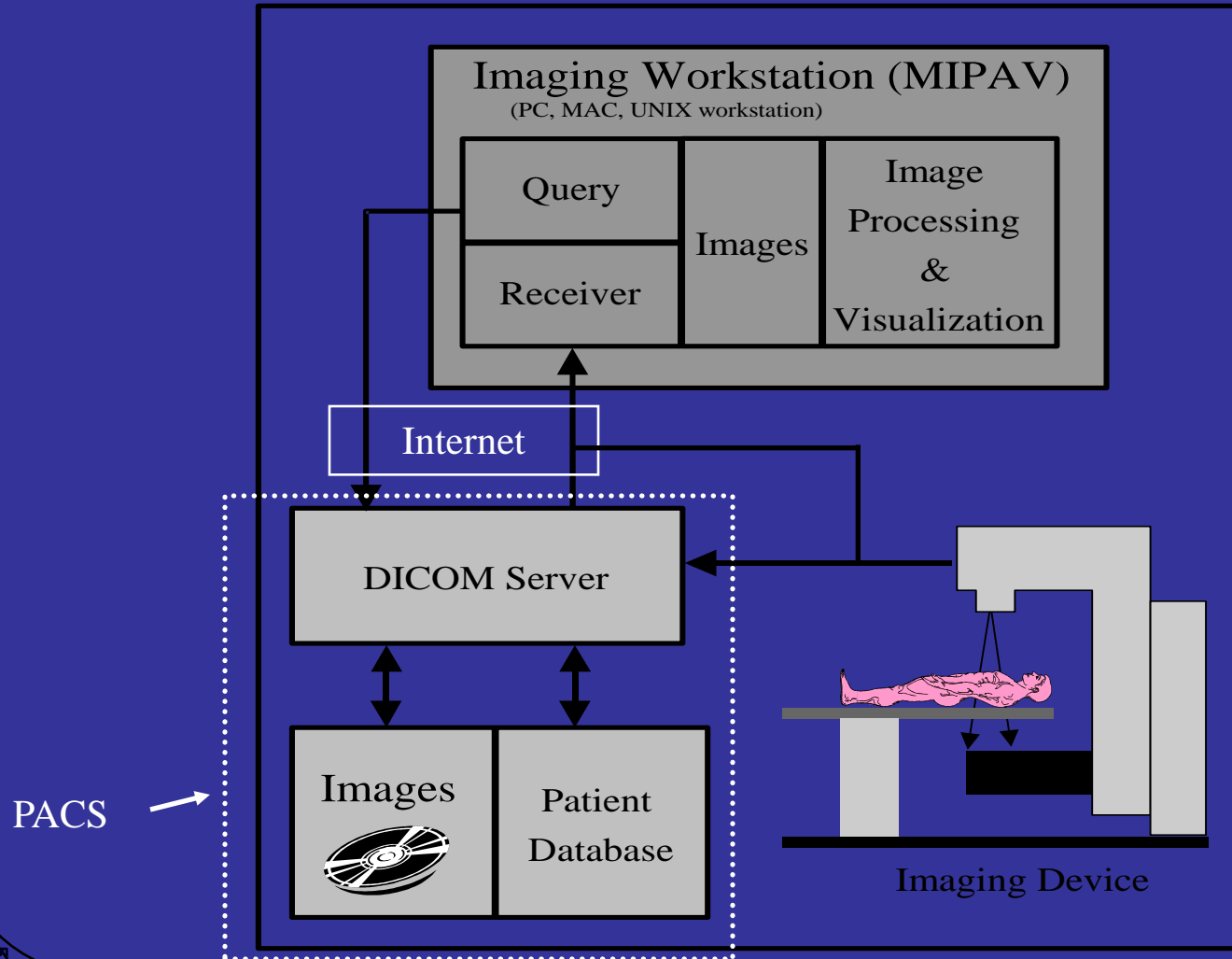
# Digital Image Communication in Medicine (DICOM).

American College of Radiology (ACR) and the National Electrical Manufacturers Association (NEMA) formed a joint committee in 1983 to develop a standard in Digital Image Communication in Medicine (DICOM).

1. Promote communication of digital image information, regardless of device manufacturer
2. Facilitate the development and expansion of picture archiving and communication systems (PACS) that can also interface with other systems of hospital information
3. Allow the creation of diagnostic information databases that can be interrogated by a wide variety of devices distributed geographically.



# DICOM Model





DICOM Communication Panel - IP address = 165.112.92.46

QR Client Send Hosts Help

**Patient Query Information**

Patient Name:   
Patient ID:   
Study Number:   
Physician:

**Query Duration**

Today  One Week  One Month  
 Three Month  Six Month  One Year

Start Date: Oct 17 2008  
End Date: Oct 17 2008  
Today's Date: Oct-17-2008

**Query Result**

Query Level: Patient

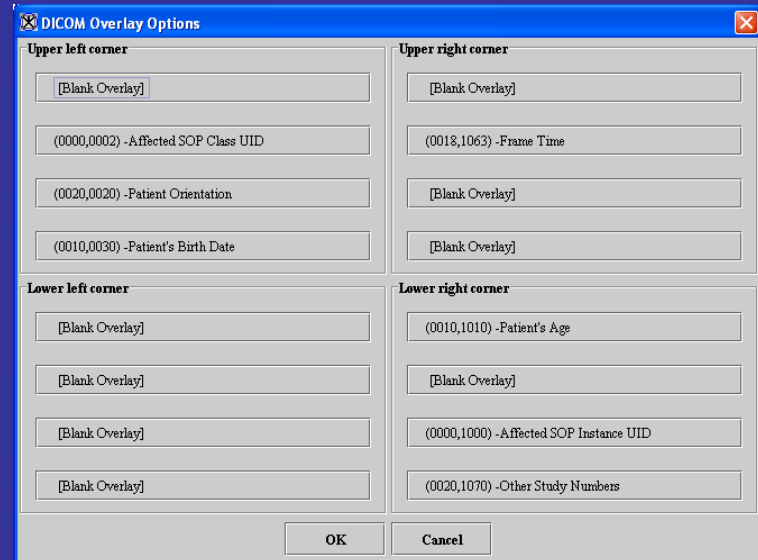
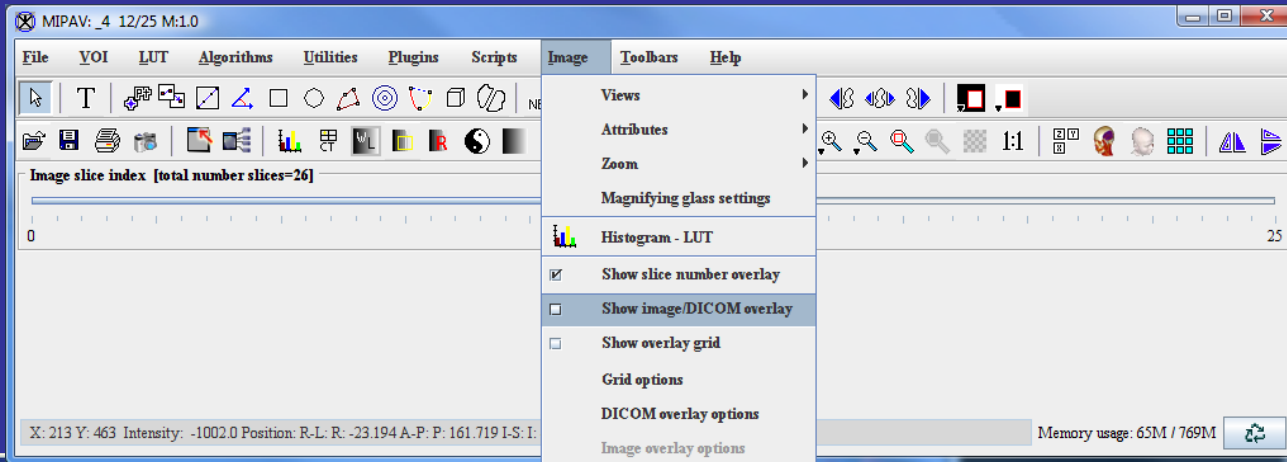
Pat. Name	Pat. ID	Referring Physician
-----------	---------	---------------------

**Query Retrieval Information**

Status	#	Source	Destination	Error	ID
--------	---	--------	-------------	-------	----

# DICOM communication interface

# DICOM



# DICOM

Access to image header information

Tag	Name	Value
512		
512		
26		
Short		
-1024.0		
3071.0		
Axial		
0.78125		
0.78125		
1.25		
Millimeters per pixel		
1.0000 0.0000 0.0000 0.0000		
0.0000 1.0000 0.0000 0.0000		
0.0000 0.0000 1.0000 0.0000		
0.0000 0.0000 0.0000 1.0000		
Other Image Information		
<input type="checkbox"/> (0002,0000)	File Meta Information Group Length	220
<input type="checkbox"/> (0002,0001)	File Meta Information Version	257
<input type="checkbox"/> (0002,0002)	Media Storage SOP Class UID	1.2.840.10008.5.1.4.1.1.2
<input type="checkbox"/> (0002,0003)	Media Storage SOP Instance UID	1.2.840.113619.2.55.1.1762528037.1957.104695...
<input type="checkbox"/> (0002,0010)	Transfer Syntax UID	1.2.840.10008.1.2
<input type="checkbox"/> (0002,0012)	Implementation Class UID	1.2.276.0.7230010.3.0.3.5.1
<input type="checkbox"/> (0002,0013)	Implementation Version Name	OFFIS_DCMTK_351
<input type="checkbox"/> (0002,0016)	Source Application Entity Title	
<input type="checkbox"/> (0008,0005)	Specific Character Set	ISO_IR 100
<input type="checkbox"/> (0008,0008)	Image Type	ORIGINAL, PRIMARY, AXIAL
<input type="checkbox"/> (0008,0012)	Instance Creation Date	20030306
<input type="checkbox"/> (0008,0013)	Instance Creation Time	162730
<input type="checkbox"/> (0008,0016)	SOP Class UID	1.2.840.10008.5.1.4.1.1.2
<input type="checkbox"/> (0008,0018)	SOP Instance UID	
<input type="checkbox"/> (0008,0020)	Study Date	20030306
<input type="checkbox"/> (0008,0021)	Series Date	20030306
<input type="checkbox"/> (0008,0022)	Acquisition Date	20030306
<input type="checkbox"/> (0008,0023)	Content (formerly Image) Date	20030306
<input type="checkbox"/> (0008,0030)	Study Time	161210.000000
<input type="checkbox"/> (0008,0031)	Series Time	161925.000000
<input type="checkbox"/> (0008,0032)	Acquisition Time	162138
<input type="checkbox"/> (0008,0033)	Content (formerly Image) Time	162730
<input type="checkbox"/> (0008,0050)	Accession Number	
<input type="checkbox"/> (0008,0060)	Modality	COMPUTED_TOMOGRAPHY
<input type="checkbox"/> (0008,0064)	Conversion Type	Workstation
<input type="checkbox"/> (0008,0070)	Manufacturer	GE MEDICAL SYSTEMS
<input type="checkbox"/> (0008,0080)	Institution Name	
<input type="checkbox"/> (0008,0090)	Referring Physician's Name	



# DICOM Anonymization

The screenshot displays the MIPAV software interface with the 'Anonymize DICOM directory' dialog box open. The main window shows a menu with 'DICOM' and 'Anonymize DICOM directory' options. The dialog box has the following fields and options:

- Image source directory:** C:\Users\mccreedy\Desktop\images\anon\dicom
- Image destination directory:** C:\Users\mccreedy
- Translation/Key file destination directory:** C:\Users\mccreedy
- Other options:**
  - Recursive anonymization
  - Anonymize filename
- Directory name anonymization:**
  - Selected directory
  - Subdirectory
  - No directory name change

Buttons at the bottom of the dialog include Run, Close, Stop, and Help.



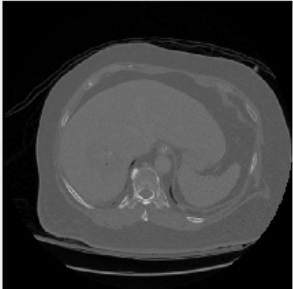
# DICOM File Browser

DICOM browser

File

C:\Users\smcreech\Desktop\images  
be01

Patient Name	Patient ID	Study ID	Study Date	Description
			03/06/2003	



Window  
0.1 1 10

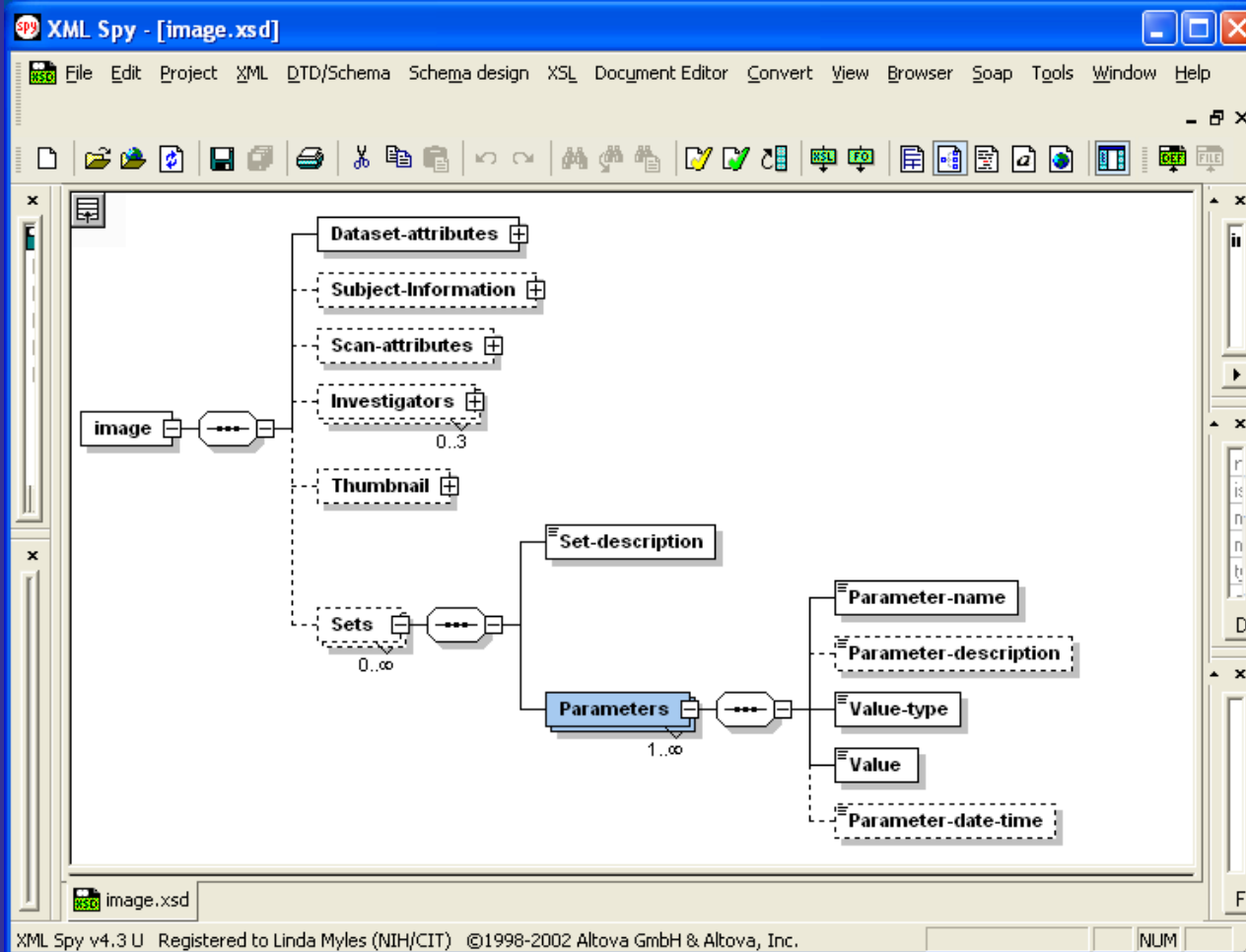
Level  
-255 0 255

Series	Type	# Images	Time	Mod	Description	StudyID
4		26	16:19:25.000000	CT		

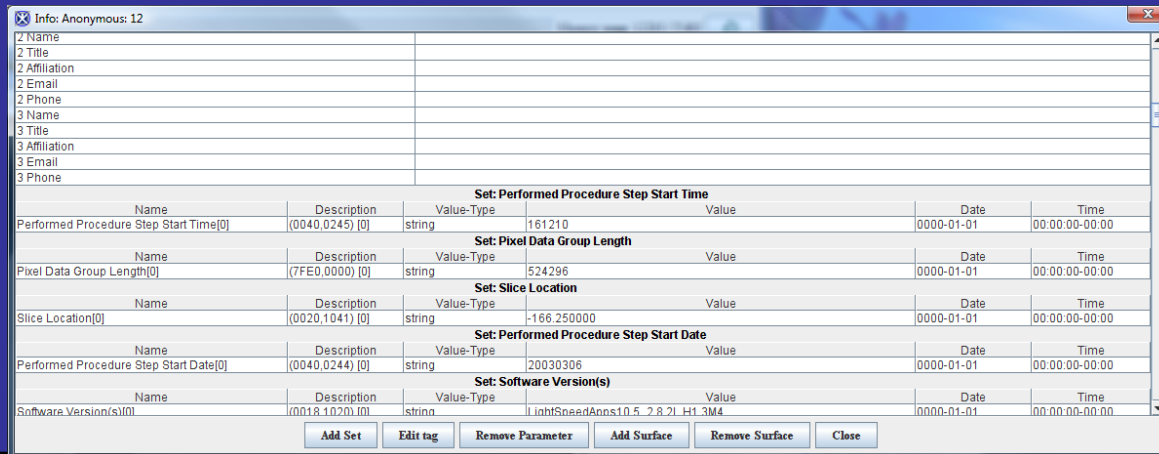
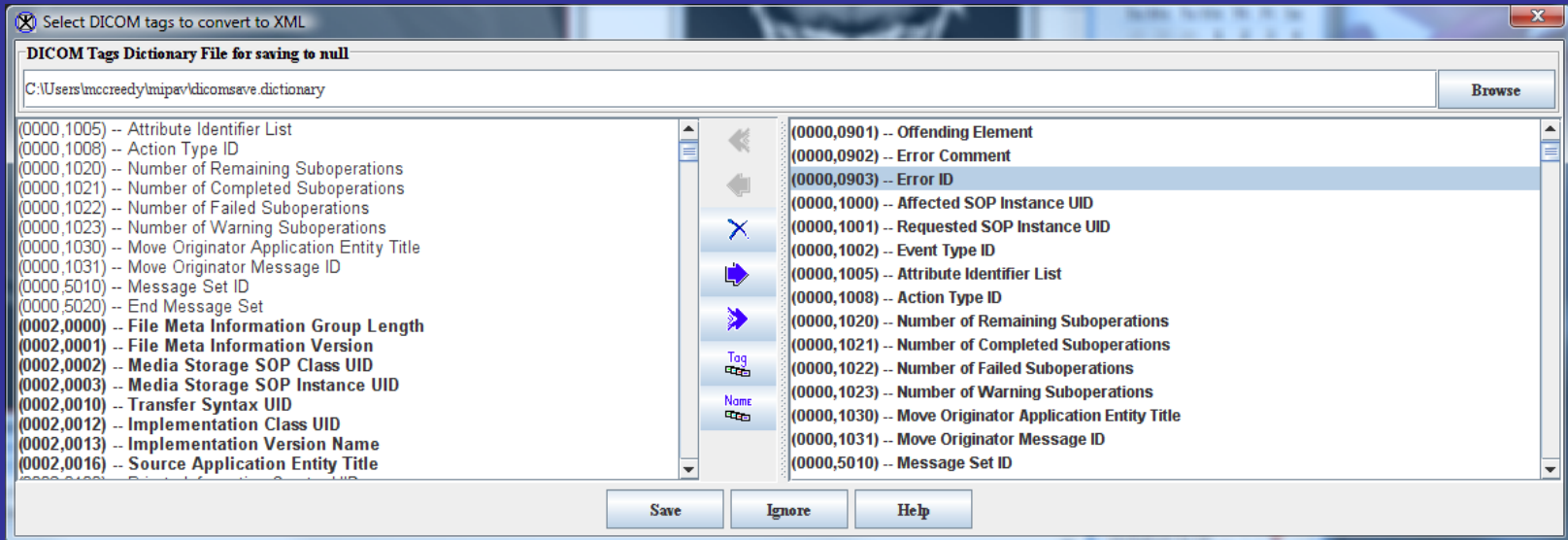
Instance (formerly I... ▾	Acquisition Time	X-position	Y-position	Z-position
26	16:21:38	-189.6	-200	-135
25	16:21:38	-189.6	-200	-136.25
24	16:21:38	-189.6	-200	-137.5
23	16:21:38	-189.6	-200	-138.75
22	16:21:38	-189.6	-200	-140
21	16:21:38	-189.6	-200	-141.25
20	16:21:38	-189.6	-200	-142.5
19	16:21:38	-189.6	-200	-143.75
18	16:21:38	-189.6	-200	-145
17	16:21:38	-189.6	-200	-146.25
16	16:21:38	-189.6	-200	-147.5
15	16:21:38	-189.6	-200	-148.75



# XML Schema File Format



# XML Schema File Format



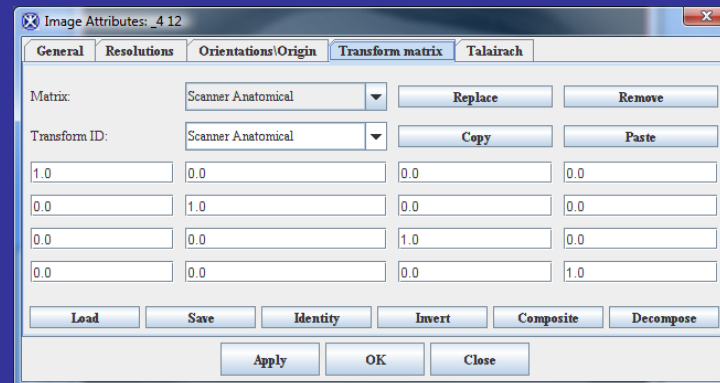
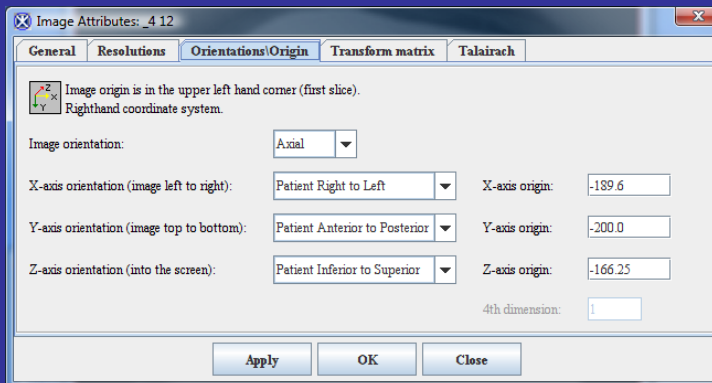
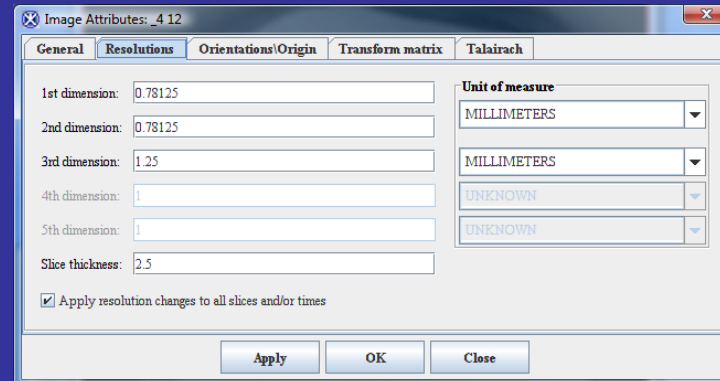
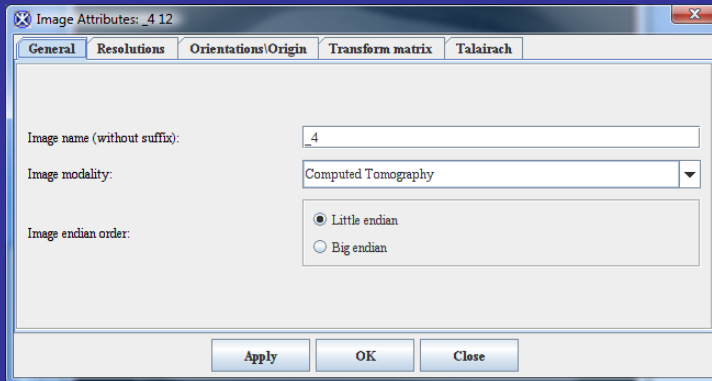
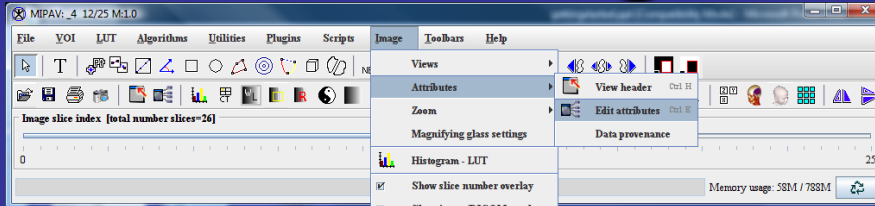
# XML Schema File Format

```
<?xml version="1.0" encoding="UTF-8" ?>
<!-- MIPAV header file -->
- <image xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  filename="junk.raw" nDimensions="3">
- <Dataset-attributes>
  <Image-offset>0</Image-offset>
  <Data-type>Short</Data-type>
  <Endianness>Little</Endianness>
  <Extents>512</Extents>
  <Extents>512</Extents>
  <Extents>55</Extents>
  <Resolutions>0.703125</Resolutions>
  <Resolutions>0.703125</Resolutions>
  <Resolutions>10.0</Resolutions>
  <Slice-spacing>0.0</Slice-spacing>
  <Units>Millimeters</Units>
  <Units>Millimeters</Units>
  <Units>Millimeters</Units>
  <Compression>zipped</Compression>
  <Orientation>Axial</Orientation>
  <Subject-axis-orientation>Right to Left</Subject-axis-orientation>
  <Subject-axis-orientation>Anterior to Posterior</Subject-axis-orientation>
  <Subject-axis-orientation>Inferior to Superior</Subject-axis-orientation>
  <Origin>-171.5</Origin>
  <Origin>-180.0</Origin>
  <Origin>-315.0</Origin>
  <Modality>Computed Tomography</Modality>
```

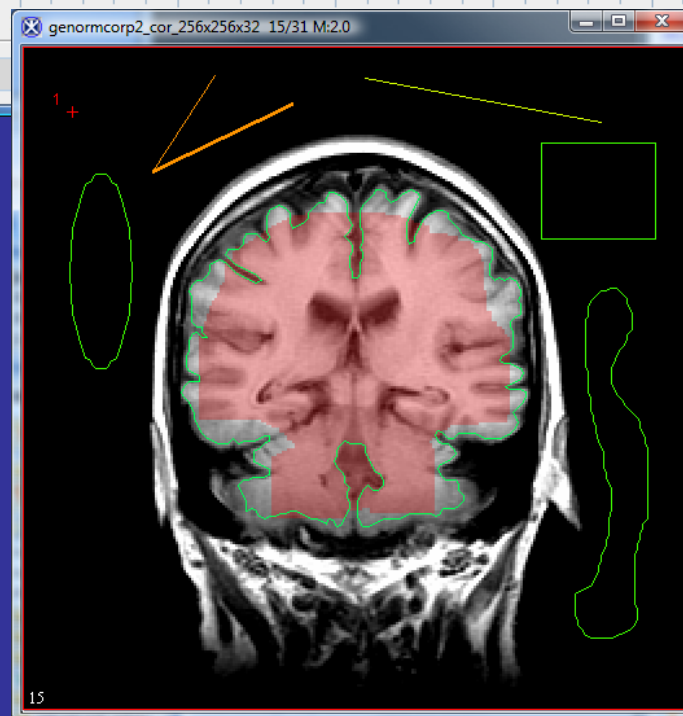
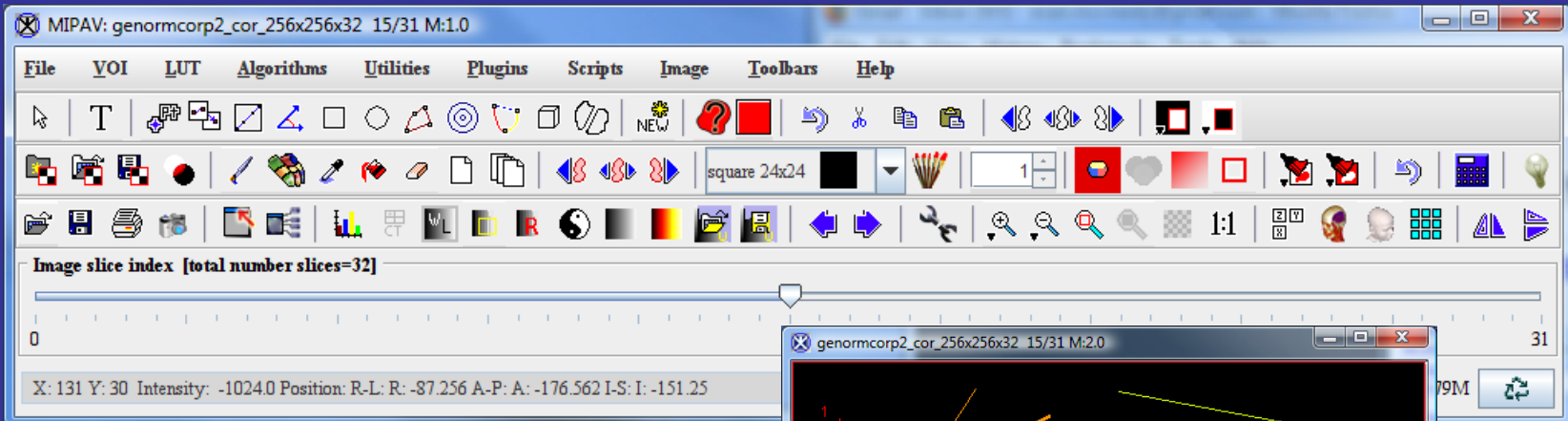




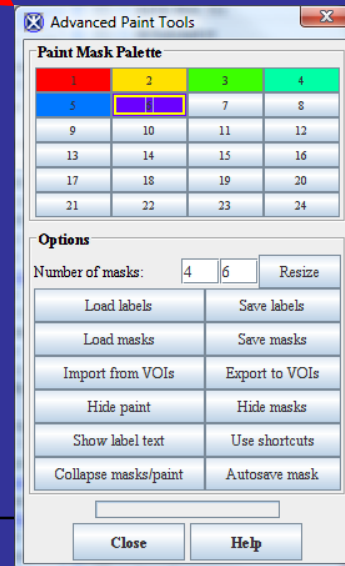
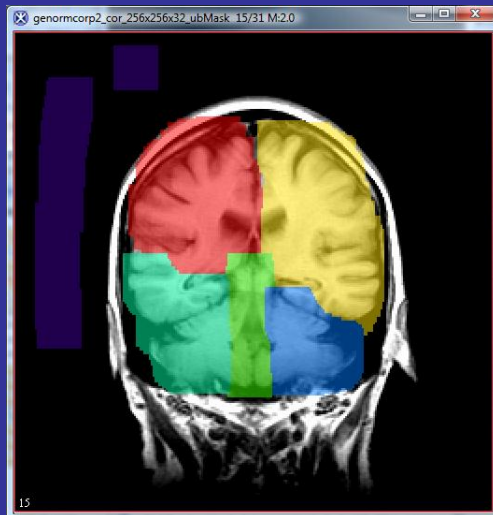
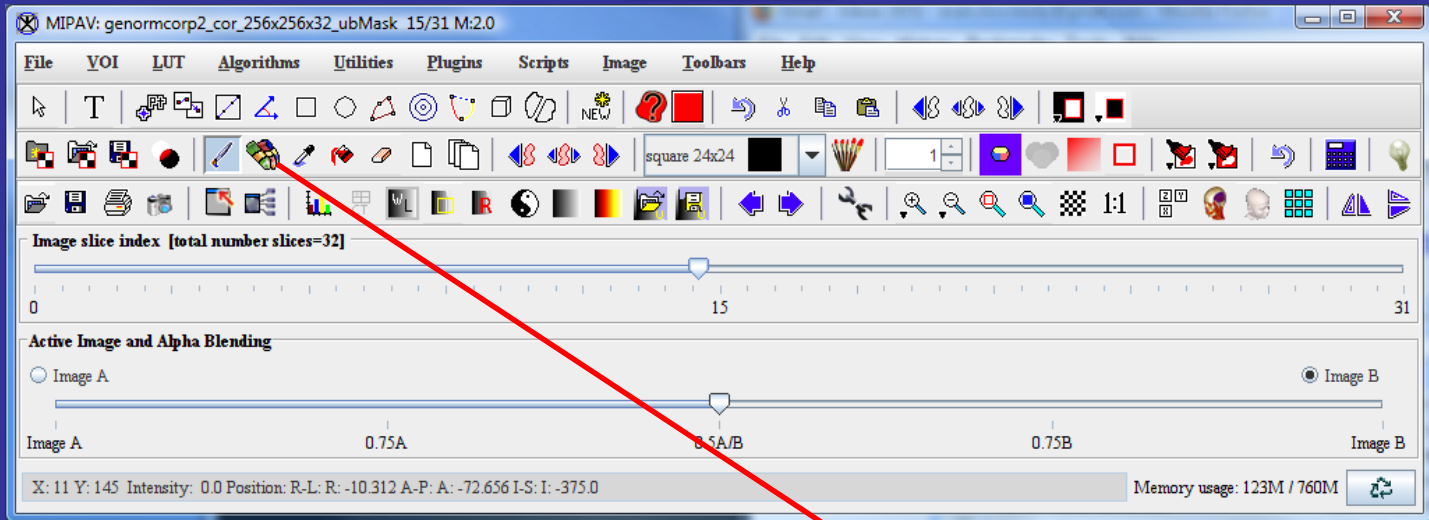
# Image Attributes



# Volume of Interest (VOI)



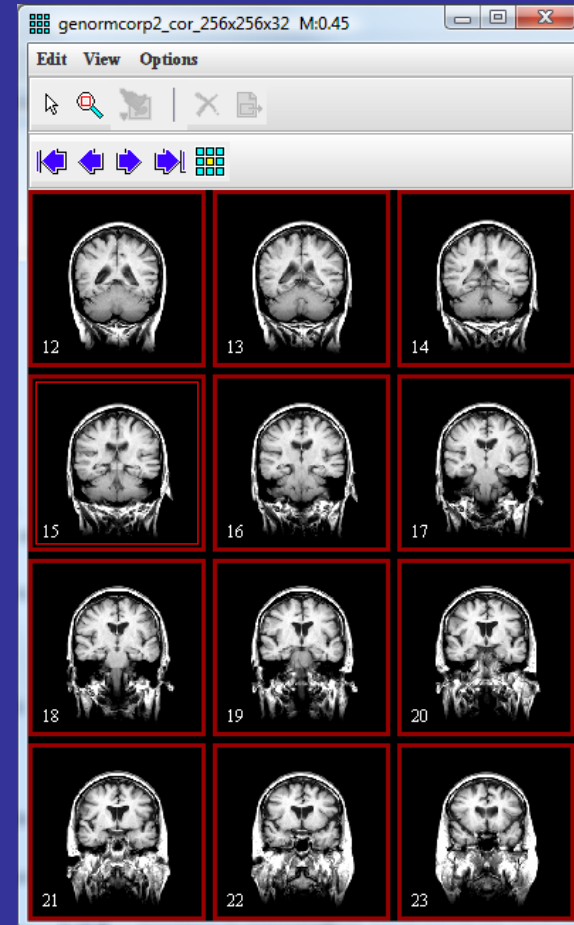
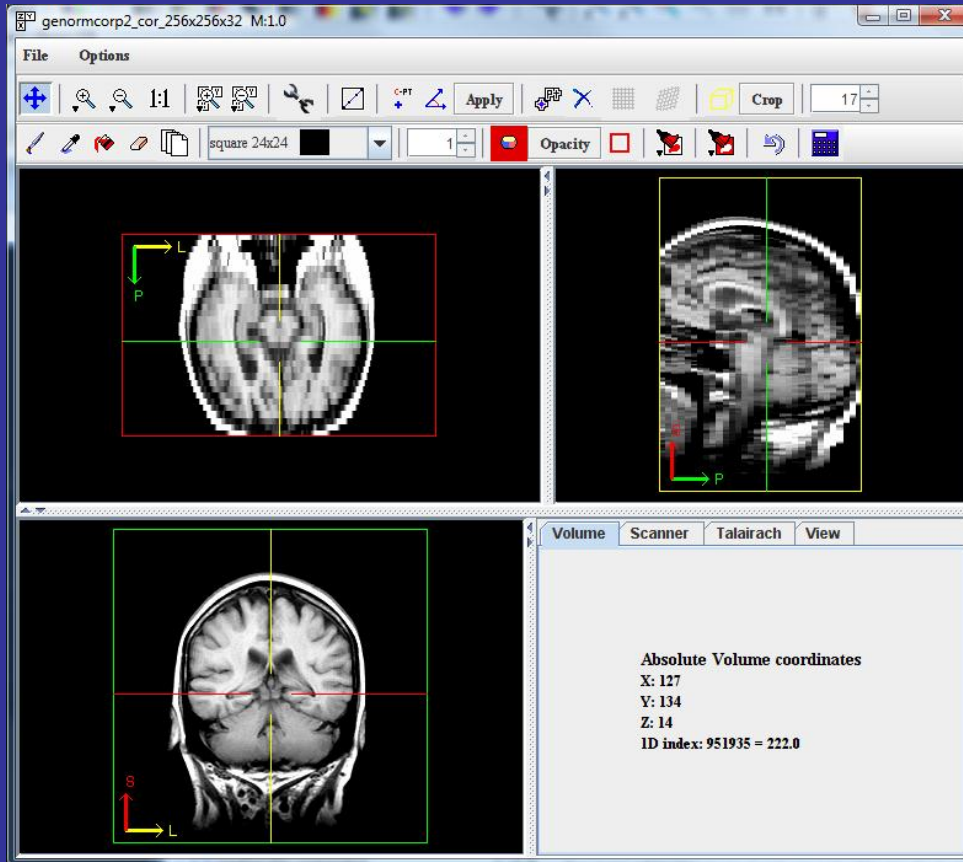
# VOI



# Lookup Table (LUT)

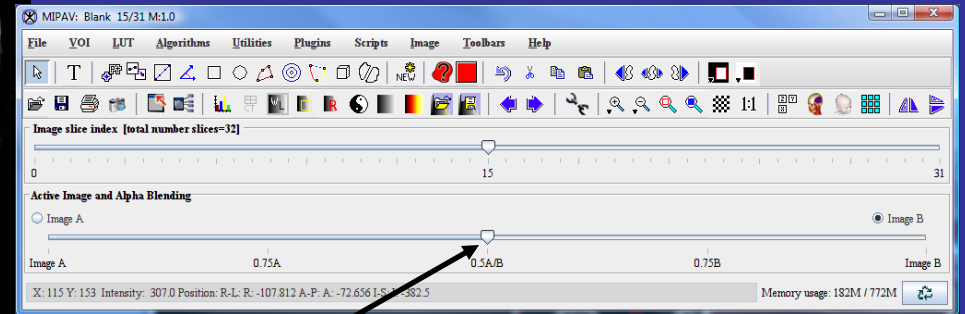
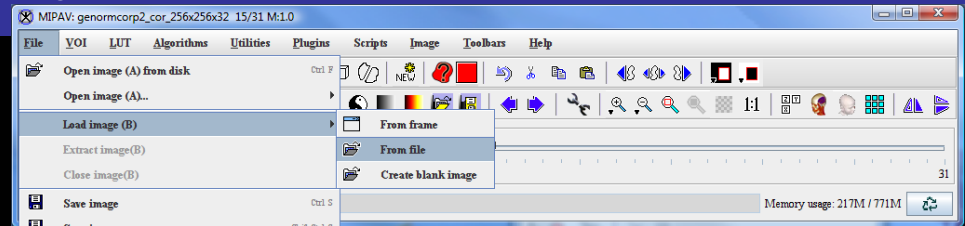
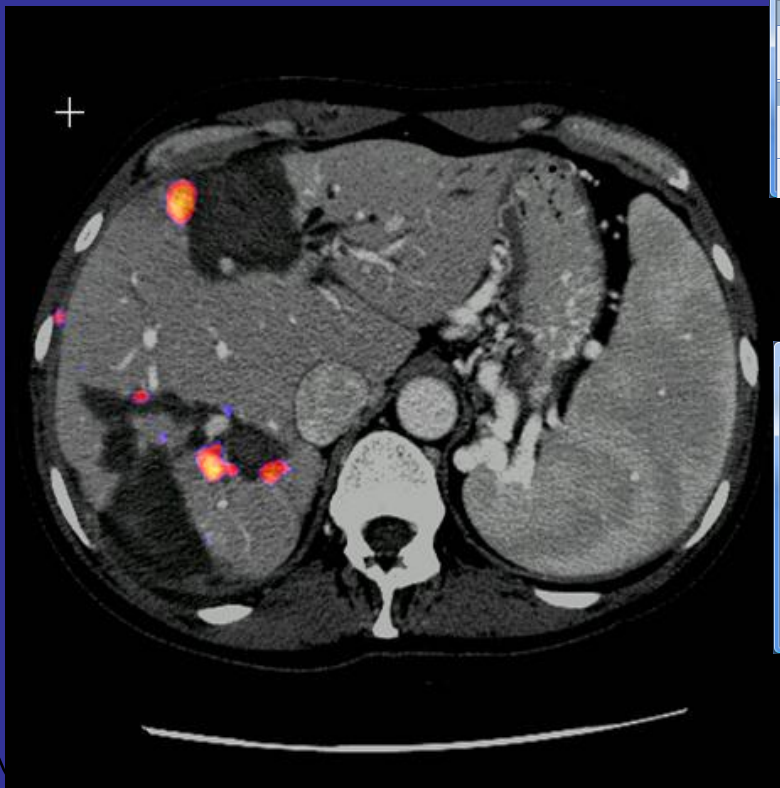
The screenshot displays two windows from a medical software application. The top window, titled "Lookup Table: genormcorp2\_cor\_256x256x32", shows a toolbar with various icons. A red box highlights a specific icon in the toolbar, and a red arrow points from this icon to the "Hot Metal LUT" selected in the "BlackBody" section of the window. Below the toolbar, there is a slider for "Image slice index [total number slices=32]" with a value of 15. The bottom window, titled "genormcorp2\_cor\_256x2...", displays a coronal MRI slice of a brain. The slice is labeled "15" in the bottom-left corner. The histogram window shows a plot of "Image Intensities" with a y-axis labeled "Count" ranging from 0 to 645758 and an x-axis ranging from 0.0 to 1242.0. A color bar on the left of the histogram indicates the mapping of intensities to colors. The histogram shows a distribution of intensities with a peak around 113.0 and a secondary peak around 401.0. The "ImageA" section of the software interface includes options for "Update (real-time)", "Log scale (Histogram)", and "Interpolate image". The "Number of colors" is set to 256. The "LUT" section includes fields for "Upper threshold", "Lower threshold", and "Fill value (non-red)". The "X Range" is set to 0 and the "Y Range" is set to 0. The "X Scale" is set to 4.

# Multi-planar and Lightbox



# Image Fusion

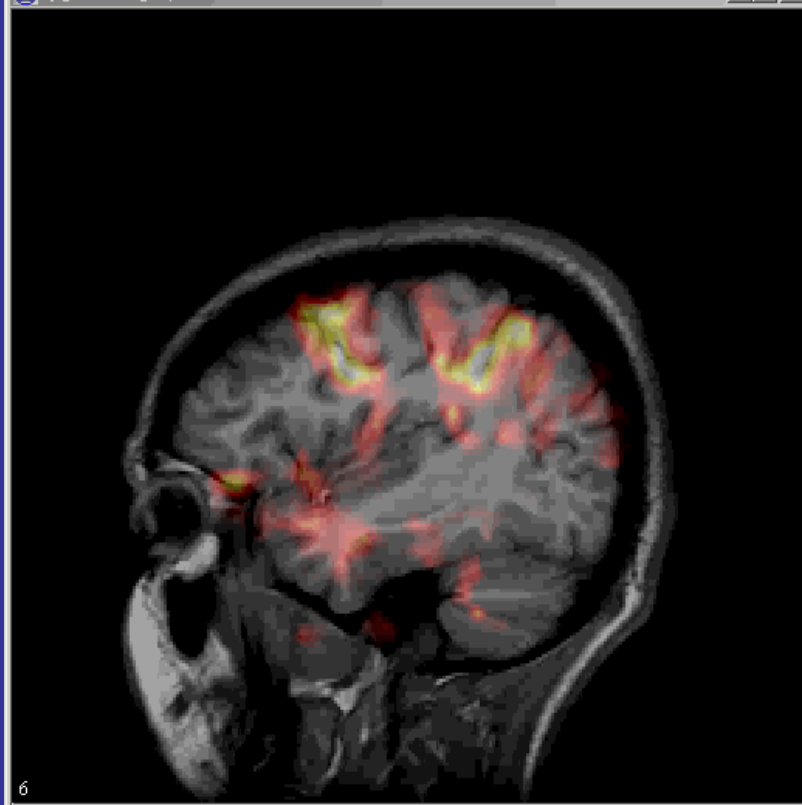
The **loading** of two images into the same frame



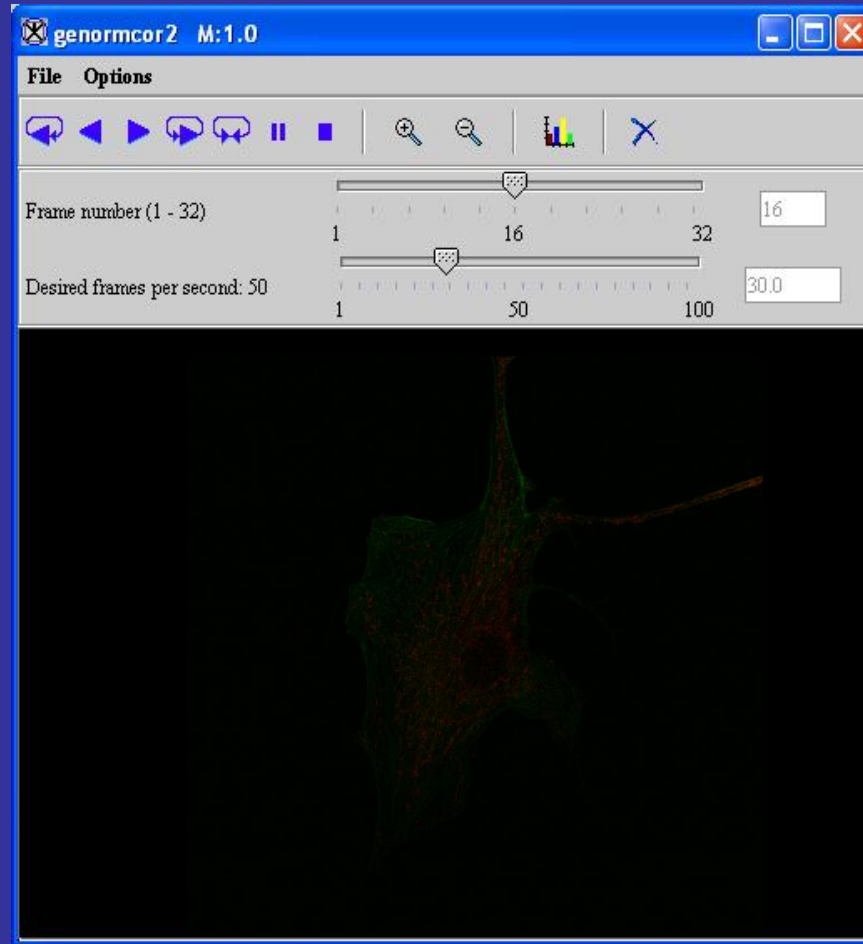
Controls blending between the two images



# Structural MRI and Functional MRI

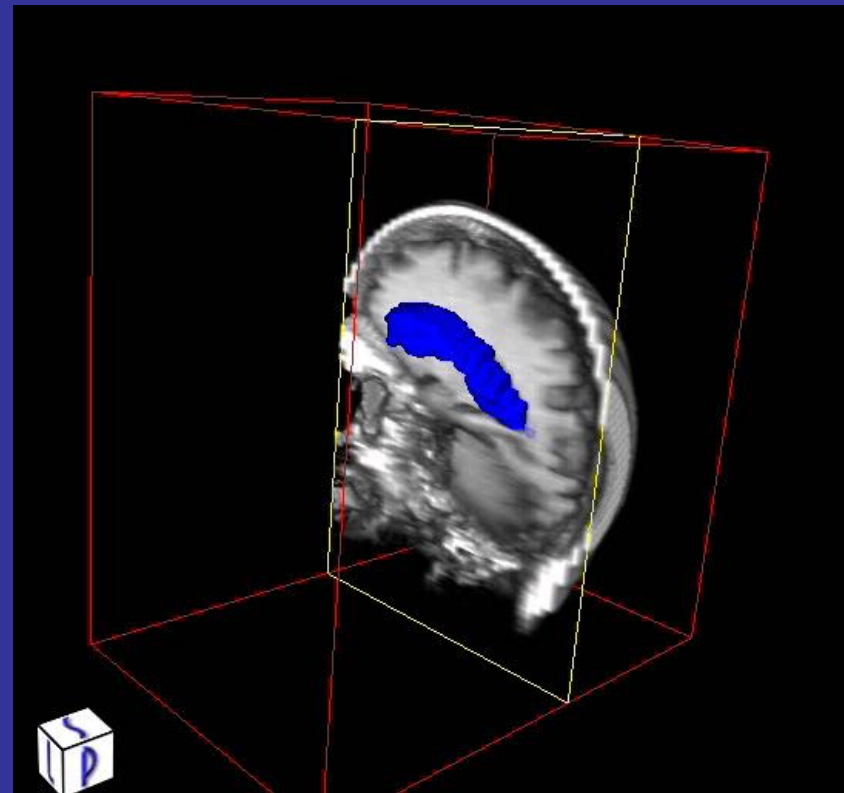
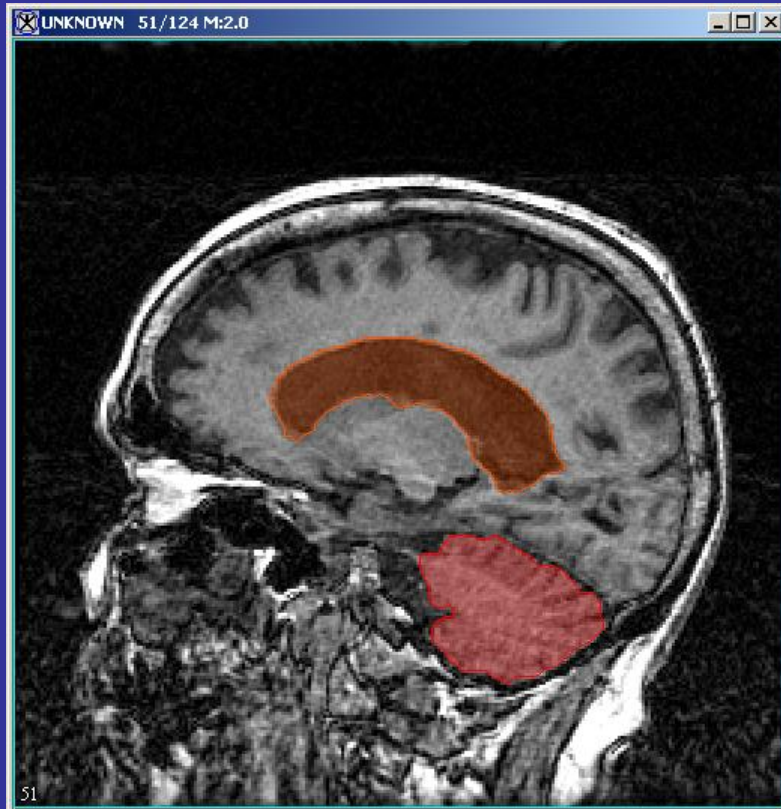


# Animation Tool

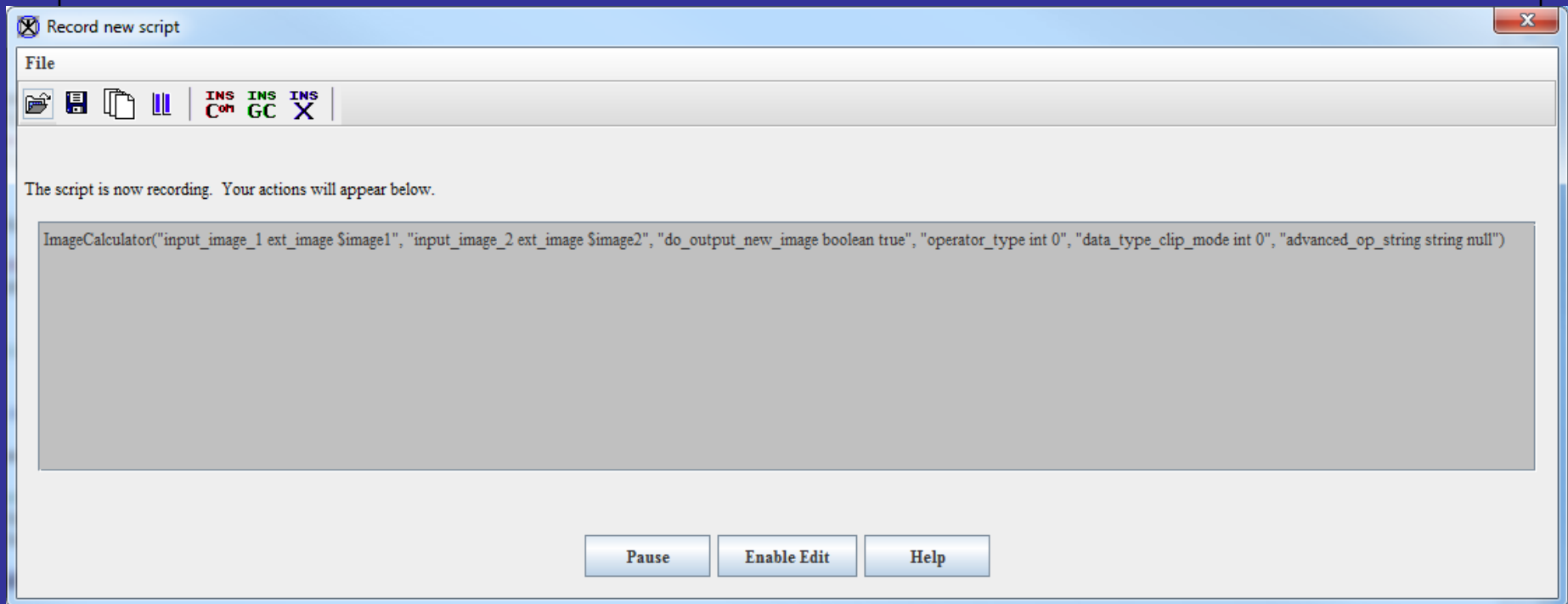




# Masks and Surfaces



# Scripting - Record



# Scripting - Run

The screenshot displays the MIPAV Script Tool interface for running a script. The window title is "MIPAV Script Tool: F:\my\Documents\temp.sct".

**Script Execution Setup**

- Script Executer
  - Simage1 (ImageCalculator -- input\_image\_1)
    - (run-1) 1481\_5313
  - Simage2 (ImageCalculator -- input\_image\_2)
    - (run-1) 3559\_5328

**Images**

- 1481\_5313
- 3559\_5328\_calc
- 3559\_5328

**VOIs from selected image**

Buttons: "Add image from file", "Run Script", "Add VOI from file"





# Help

The screenshot shows the MIPAV software interface. The title bar reads "MIPAV: v5.4.4 3559\_5328\_calc 8/17 M:1.0". The menu bar includes "File", "VOI", "LUT", "Algorithms", "Utilities", "Systems analysis", "Plugins", "Scripts", "Image", "Toolbars", and "Help". The Help menu is open, showing options: "About MIPAV", "JVM information", "MIPAV license", "MIPAV help topics" (highlighted), "Report a bug", "Memory usage" (with a keyboard shortcut "Ctrl M"), and "Memory allocation". Below the menu bar is a toolbar with various icons. A slider labeled "Image slice index [total number slices=18]" is set to 8. The status bar at the bottom displays: "X: 115 Y: 72 Intensity: -1997.0 Position: R-L: R: -140.695 A-P: A: -178.988 I-S: I: -304.75".

The screenshot shows the MIPAV Help web page. The browser address bar shows "mipav.cit.nih.gov/pubwiki/index.php/MIPAV\_Help". The page title is "MIPAV Help". The page content includes a "Contents" section with a list of links: "1 Preface", "2 Getting Started Quickly with MIPAV", "3 MIPAV Basics", "4 MIPAV Algorithms", "5 Glossary", "6 Appendices", "7 Talairach", "8 Using FRET in MIPAV", "9 Frequently Asked Questions (FAQs)", "10 Videos", "11 Publications", and "12 Presentations and Classes". The "Preface" section is partially visible, starting with "Scope of this guide". The page also features a navigation sidebar with links to "Main page", "Community portal", "Current events", "Recent changes", "Random page", and "Help". A search box and a toolbox are also present.





# Bug Report

MIPAV: v5.4.4 3559\_5328\_calc 8/17 M:1.0

File VOI LUT Algorithms Utilities Systems analysis Plugins Scripts Image Toolbars Help

Image slice index [total number slices=18]

X: 115 Y: 72 Intensity: -1997.0 Position: R-L: R: -140.695 A-P: A: -178.988 I-S: I: -304.75

U: Memory: 372M

Help menu items: About MIPAV, JVM information, MIPAV license, MIPAV help topics, Report a bug, Memory usage (Ctrl M), Memory allocation

Report a Bug

**Information**

Your name:

Your email address:

Version of MIPAV you are running: 5.4.4

Platform you are operating (ex. PC):

Operating System you are using: Windows 7

How urgent is this bug? When do you need it fixed by?:

**Bug Description**

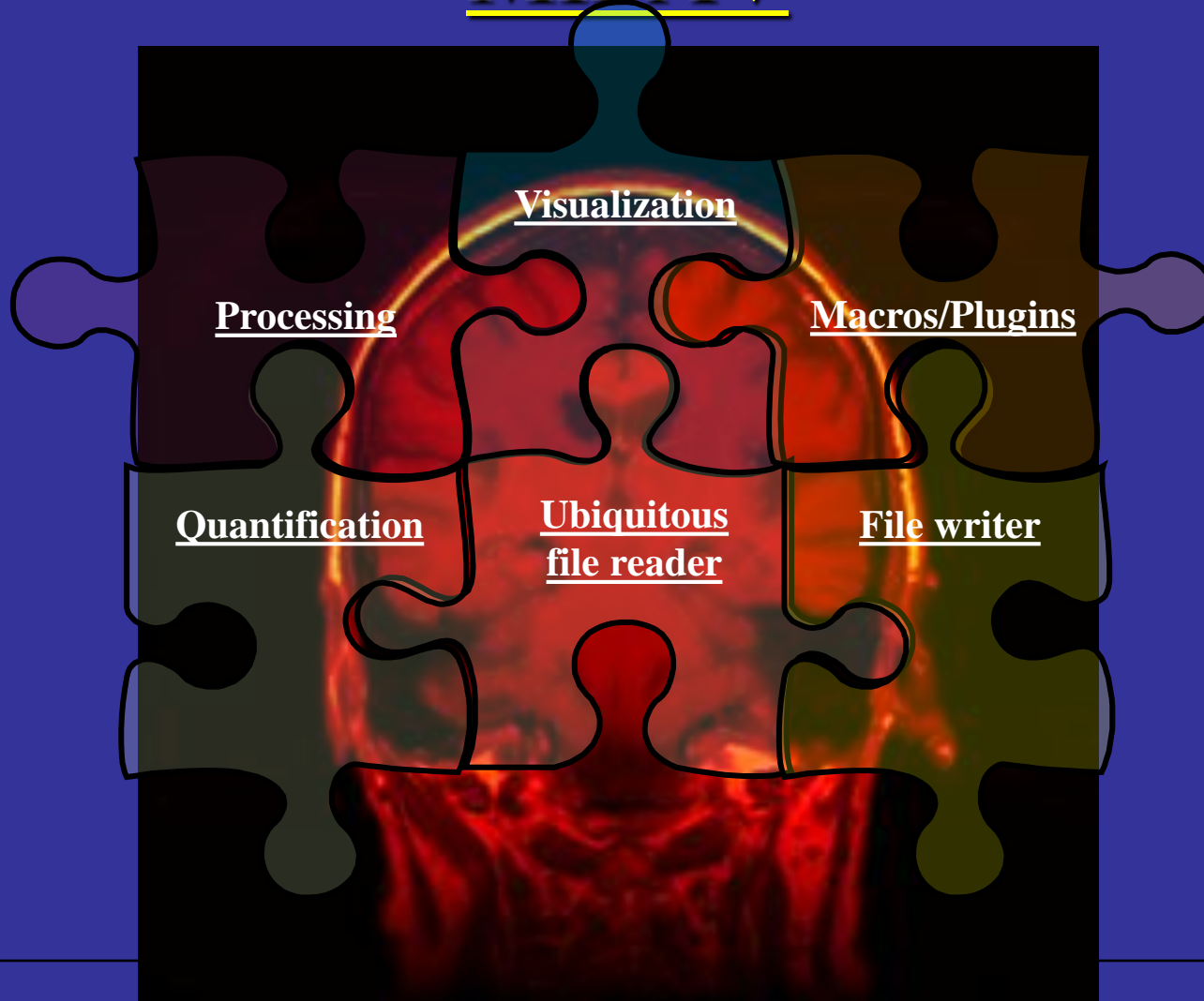
Title: Unexpected Output

Please give a detailed description of the bug encountered

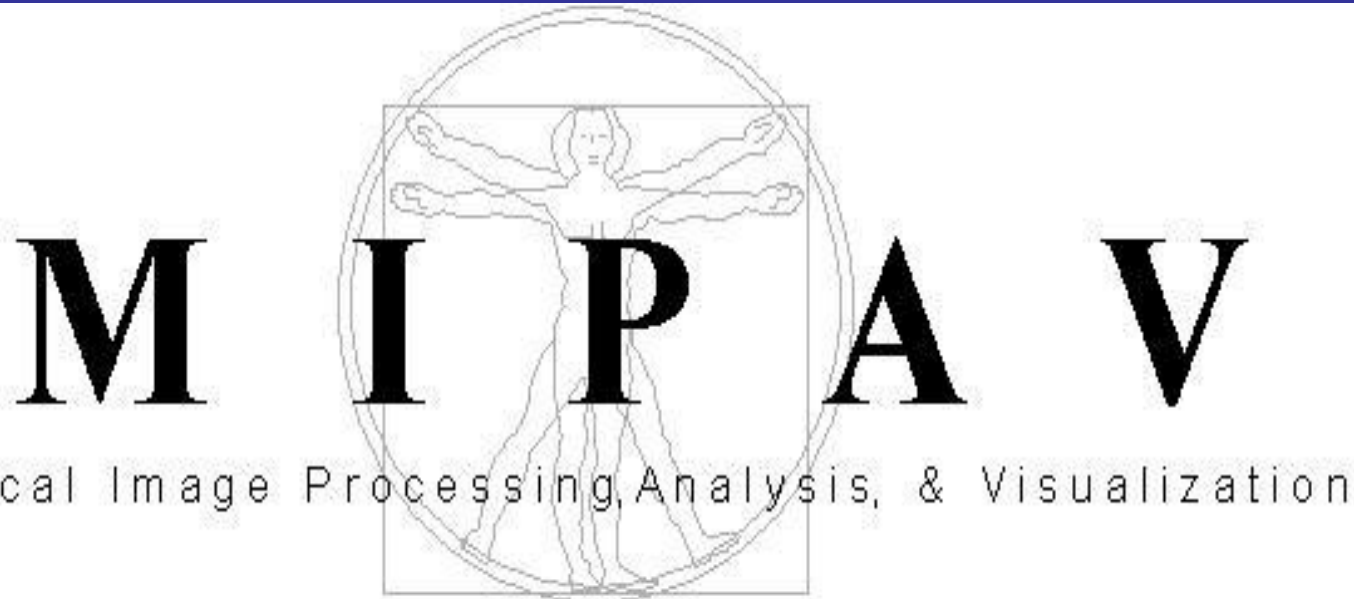
**Attachments**



# MIPAV



<http://mipav.cit.nih.gov>



[SenseneyJ@mail.nih.gov](mailto:SenseneyJ@mail.nih.gov)

