

Input/Output

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Input: Loading Data

Data can be loaded into or saved out of AnalyzePro using Input/Output. Input/Output can also be used to transform image data while loading into or saving out of AnalyzePro.

1. Loading a Data Set

- Open Input/Output.
- Navigate to the data **1** and select the data set you want to load. **2** See [Table 3.1](#) for supported file formats.

Note that the data will be displayed. **3**

- Click Load Volume **4** to load the data.
- Click Exit **5** to close Input/Output.

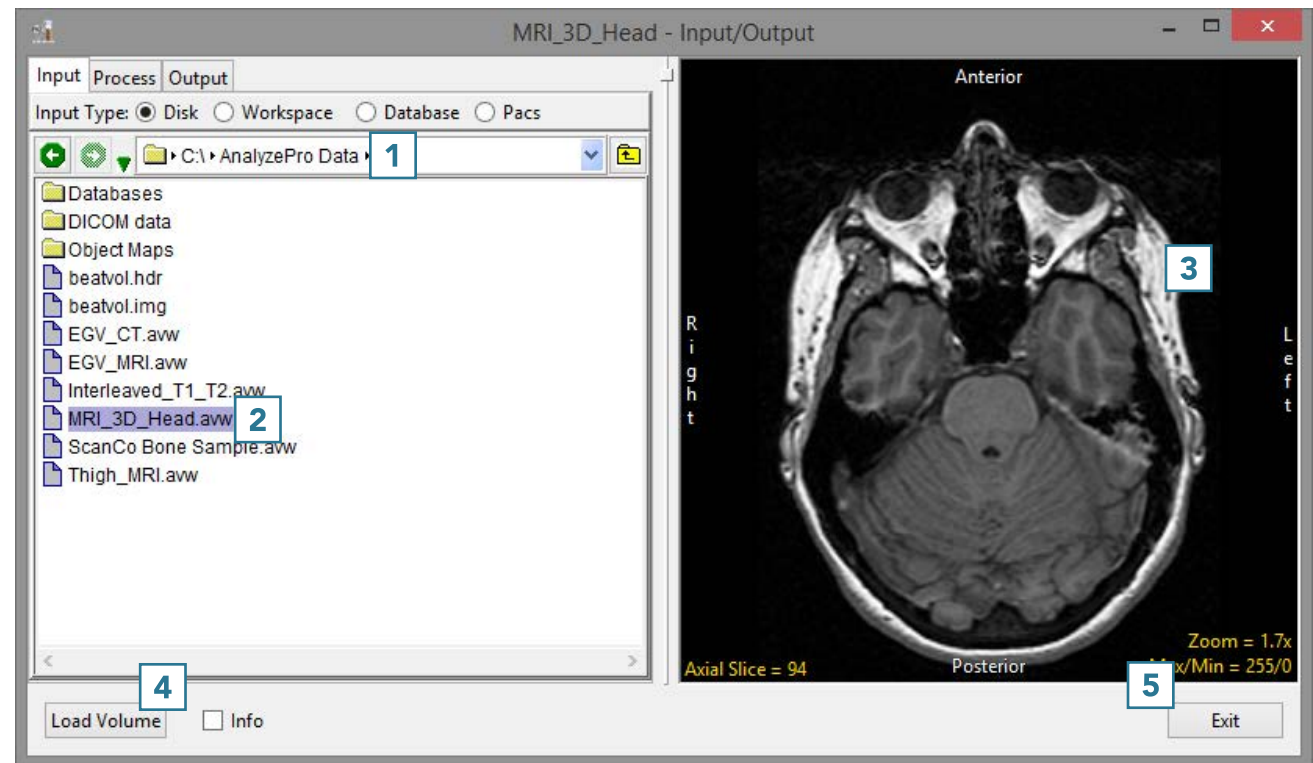




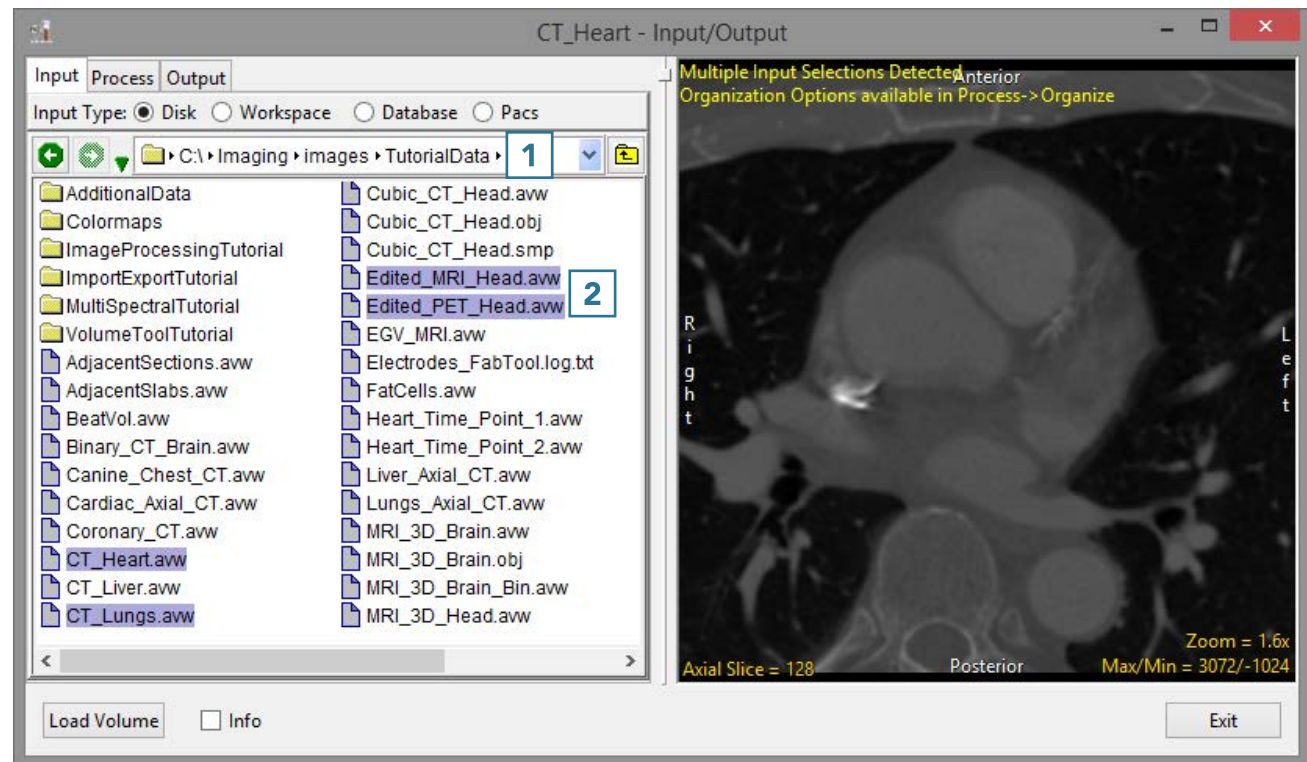
Table 3.1: File Formats and Attributes Supported by AnalyzePro

	Formats	AnalyzeAVW	OBJMAP	AVW_VolumeFile	AnalyzeImage(7.5)	AnalyzeScreen	UNKNOWN	DICOM	NIFTI	JPG	SunRaster	CTI	CTIECAT7	GE 9800	GEADVANCE	GE Advantage	GESigna	GESTARCAM	INTERFILE	TIFF	PBM	PGM	PPM	TARGA	XBM	PIC	PICKERMRI	SiemensCT	SIEMENSMAGVIS	YUV	ACRNEMA	GIF	ANIMATEDGIF	PAPYRUS2	PAPYRUS3	SGIrgb	SGIib	BMP	PostScript	SMIS	PNG	XWD	IMATRON	BIORAD	QUICKTIME	ITK	AVI	MPEG1	VARIANFDF	vox	VSI						
Read																																																									
Write																																																									
2D																																																									
3D																																																									
4D																																																									
Unsigned 8-bit																																																									
Signed 8-bit																																																									
Unsigned 16-bit																																																									
Signed 16-bit																																																									
Unsigned 32-bit																																																									
Signed 32-bit																																																									
Float																																																									
Double																																																									
Complex																																																									
RGB																																																									



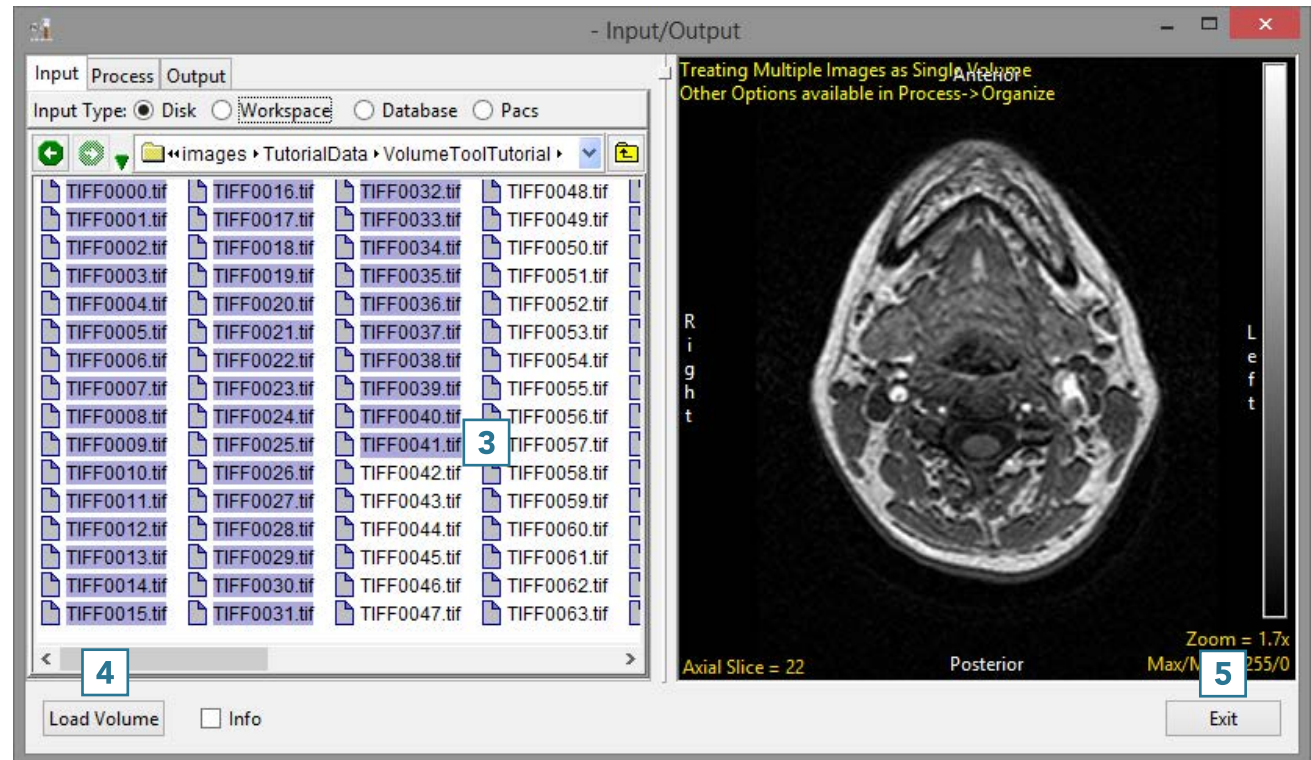
2. Loading Multiple Data Sets

- Open Input/Output.
- Navigate to the data sets. **1**
- To select multiple data sets, hold down the Ctrl key and select each data set to load. **2**



Alternatively, to select a range of data:

- Choose the first data set, then press the Shift key and finally select the last data set in the range. **3**
- Click Load Volume **4** to load the data.
- Click Exit **5** to close Input/Output.

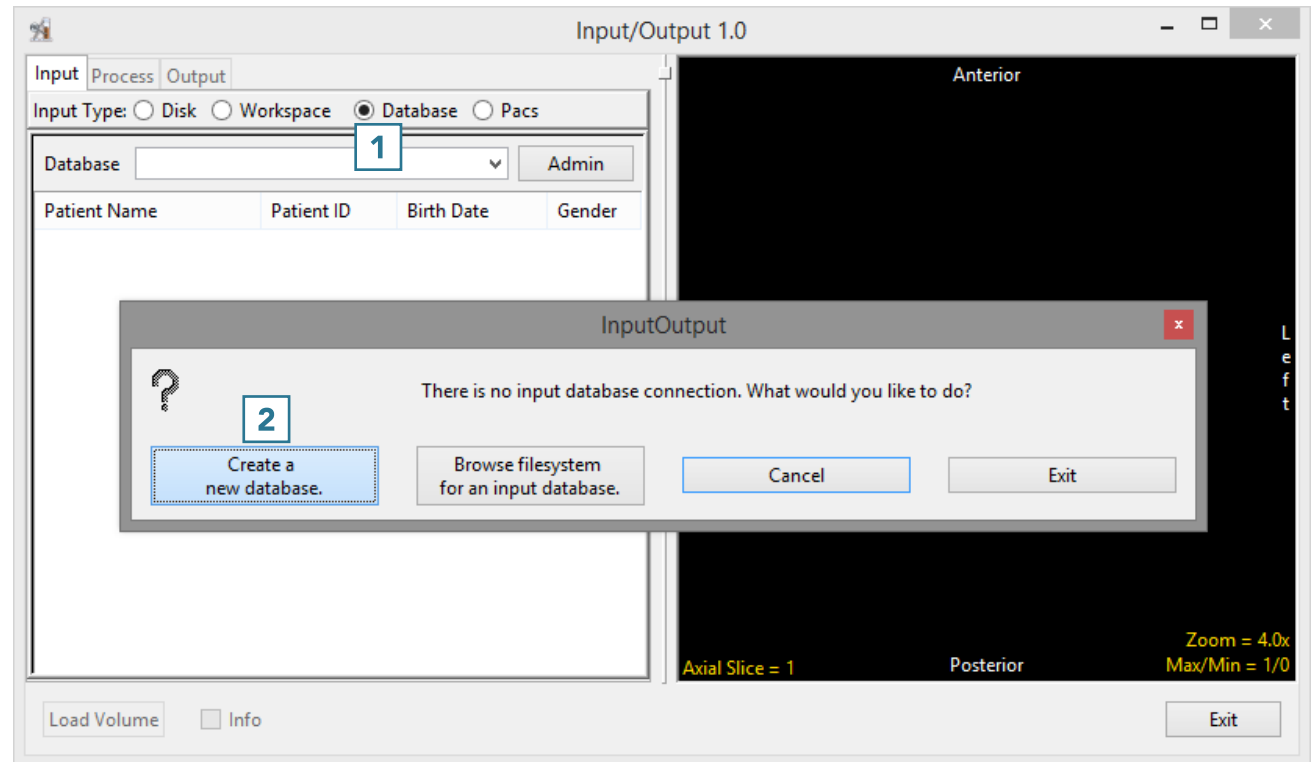




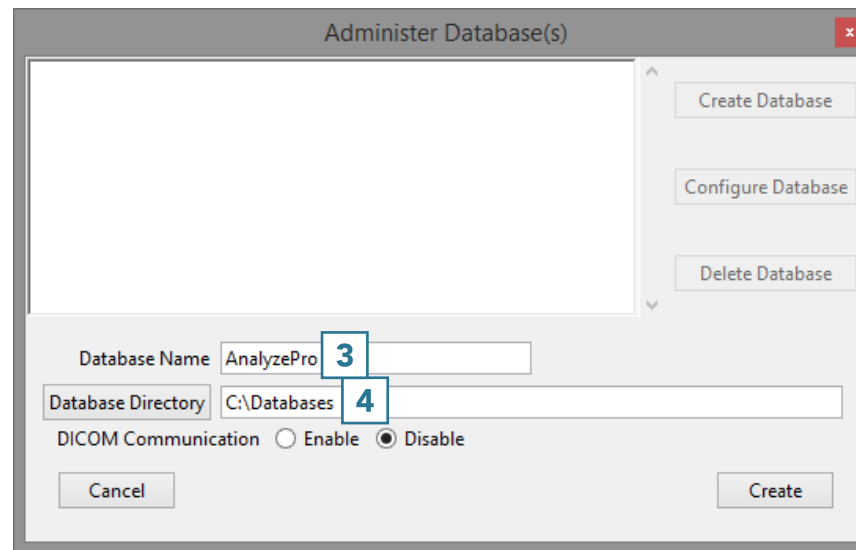
3. Importing DICOM Data

Creating a Database

- Open Input/Output.
- Set Input Type to Database. **1**
- The first time the Database option is selected, a window will be displayed, asking:
'There is no input database connection. What would you like to do?'
- Select Create a new database. **2**



- The Administer Database(s) window will open.
- Name the database **3** and set the location where the database will be saved. **4**





Enabling DICOM Communications (optional)

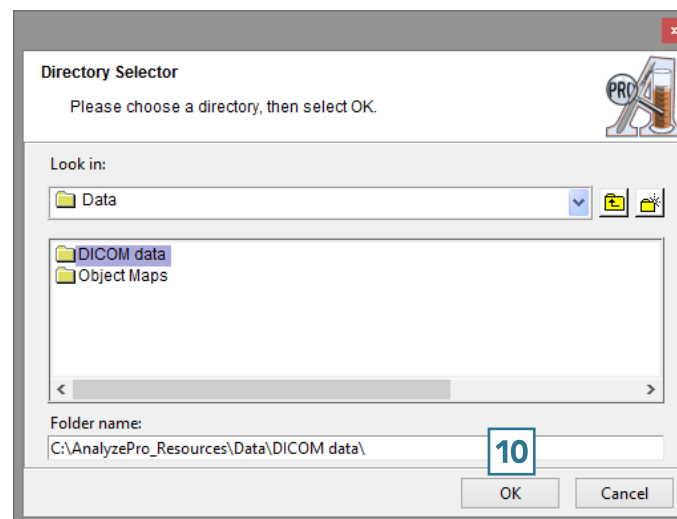
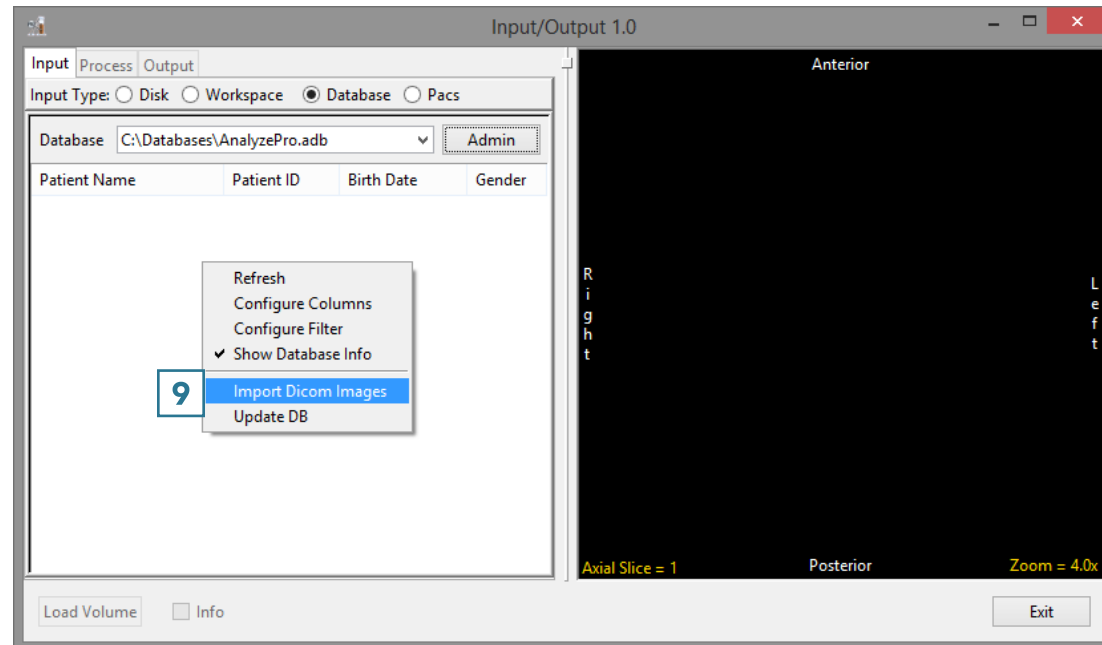
Setting up a receiver for the database will allow DICOM image data to be pushed from a PACS server to AnalyzePro. To set up a DICOM receiver:

- Set the DICOM Communication to Enable. **5**
- Set the Port number **6** and Application Entity Title (AET) Name. **7**
 - Note that the AET Name should not go over 16 alphanumeric characters.
 - Make a note of the Port number and AET Name. Your PACS administrator will need this information along with the systems IP address to configure DICOM push from PACS.
- Click Create. **8**



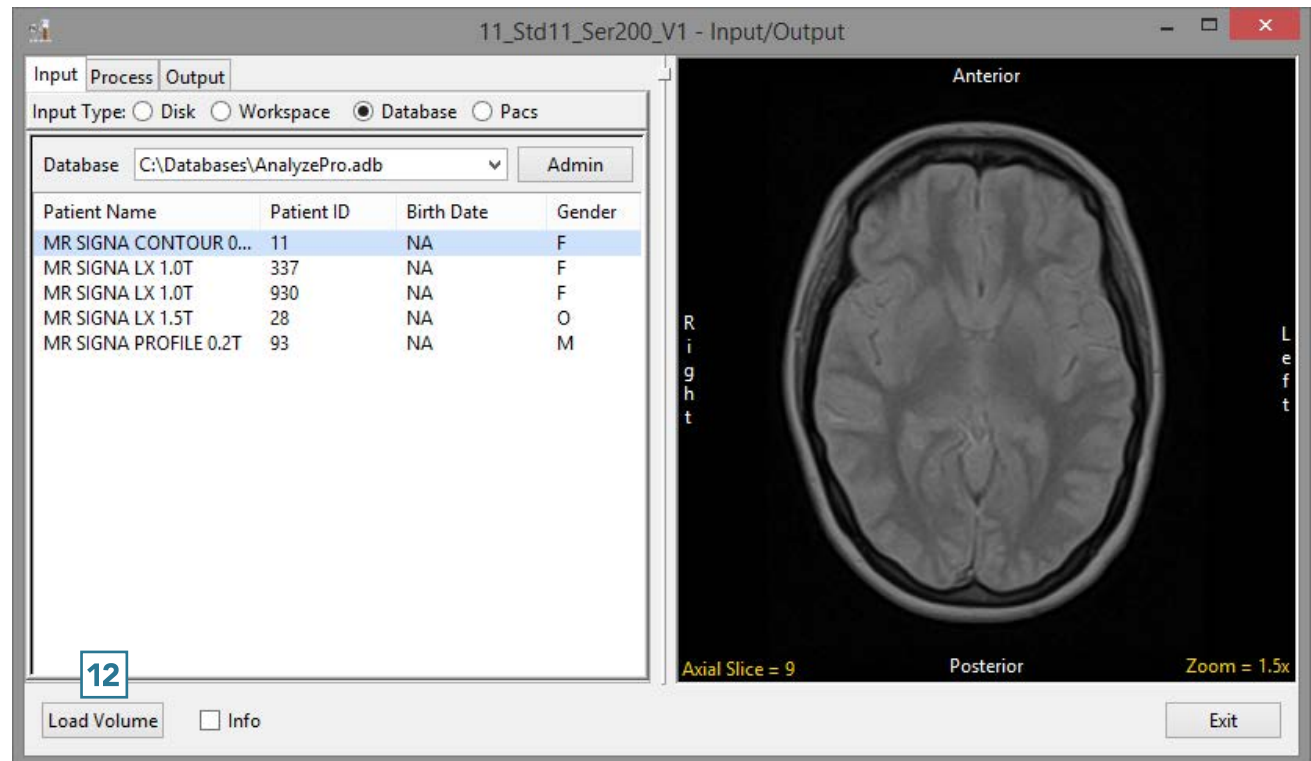
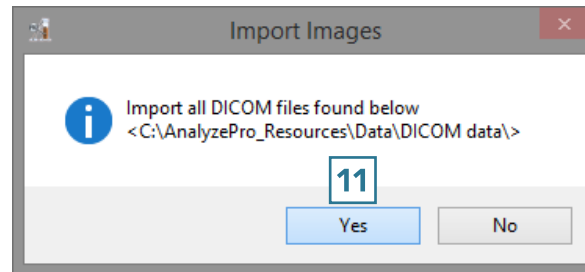
Importing Images

- Right-click in the window and select Import DICOM Images. **9**
- Use the Directory Selector to navigate to the location of the DICOM images to import and click OK. **10**





- A window will open stating Import all DICOM files found below <the specified folder>; click Yes. **11**
- Once import is complete, the image data will be available in the database.
- To load a data set into AnalyzePro, select a data set and then click Load Volume. **12**

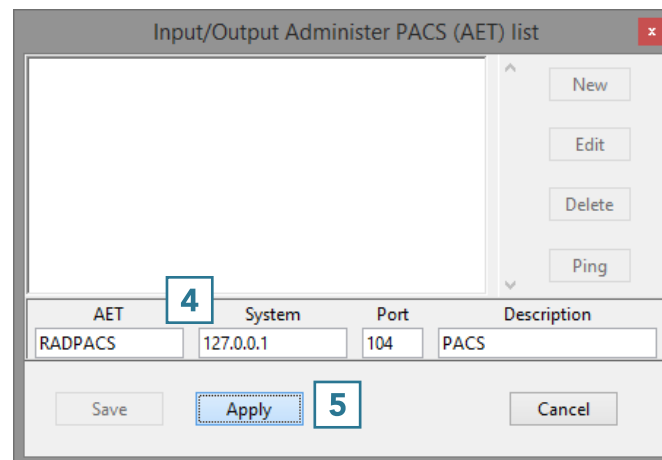
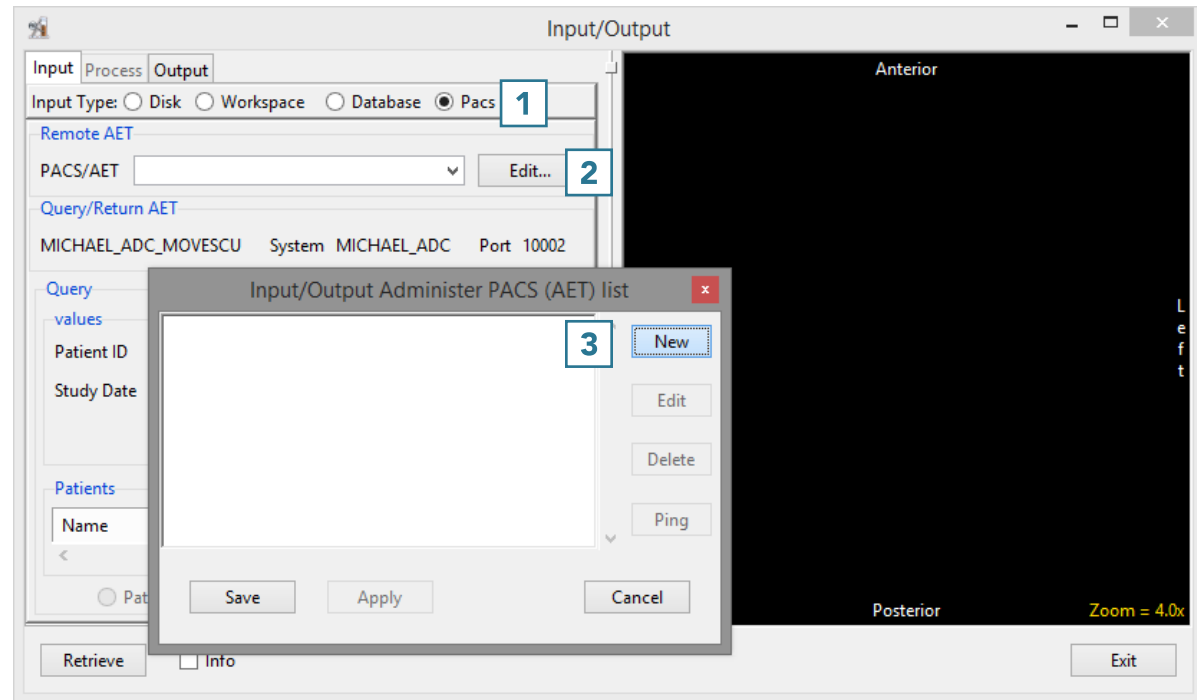


4. Configuring PACS Communications

To set up communications to allow Query and Retrieval of DICOM data from PACS, first create a database (see Creating a DICOM database), then open Input/Output.

- Set Input Type to PACS. **1**
- Under Remote AET, click Edit. **2**
- In the Input/Output Administer PACS (AET) list window that opens, click New. **3**
- The window will update showing AET, System, Port, and Description fields. Enter the PACS information into these fields **4** and click Apply. **5**

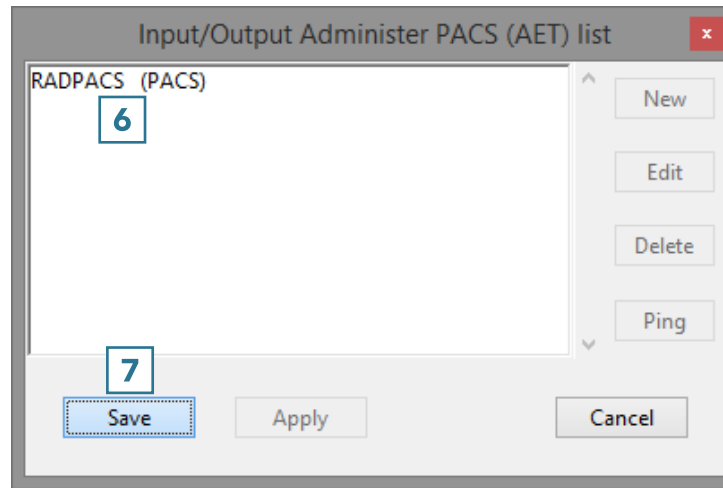
Note that you will need to contact your PACS administrator to obtain the relevant PACS information.



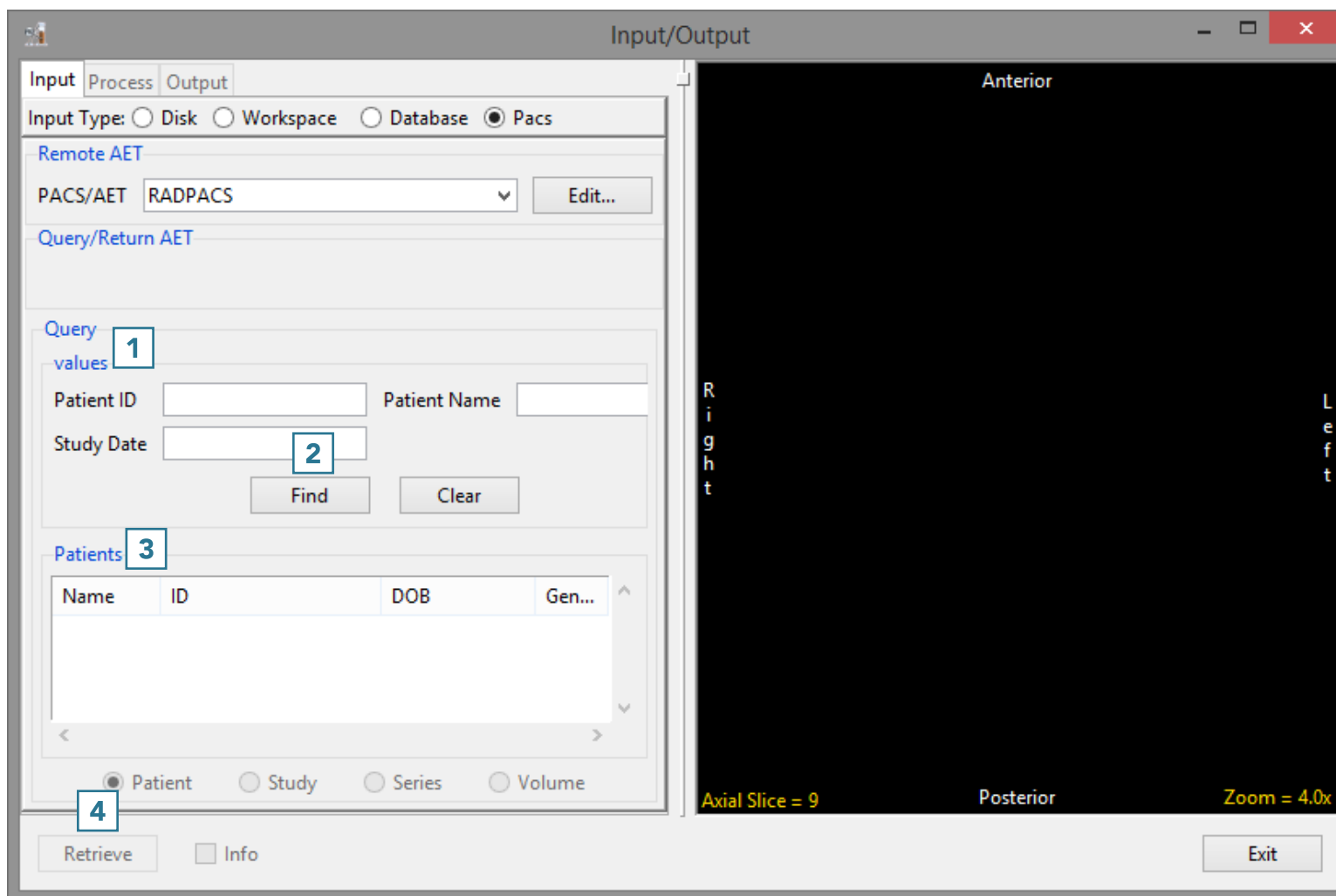


- The window will update and the PACS information will be available in the main window. **6**
- Click Save to close the window. **7**
- The PACS is now configured on the AnalyzePro side.

Note that there may be additional configuration required on the PACS side by your PACS admin.



- To Query the PACS, enter the Patient ID, Patient Name or Study Date **1** and click Find **2** or press [Enter].
- The relevant patient data will displayed under Patients. **3**
- Select the patient and click Retrieve **4** to merge into the current database.





Process: Transforming Data

Spatial- and intensity-based transformations can be applied to the data while loading to or saving from AnalyzePro. These transformation options are available from Input/Output > Process, once a data set is selected.

5. Organize

MultiVolume Override

Sometimes image data may not be organized as expected. For example, two 3D data sets may be concatenated into a single 3D data set, requiring the data to be split into two volumes. Furthermore, the data may be interleaved. The MultiVolume Override options provide a utility to efficiently reorganize such problematic data while loading.

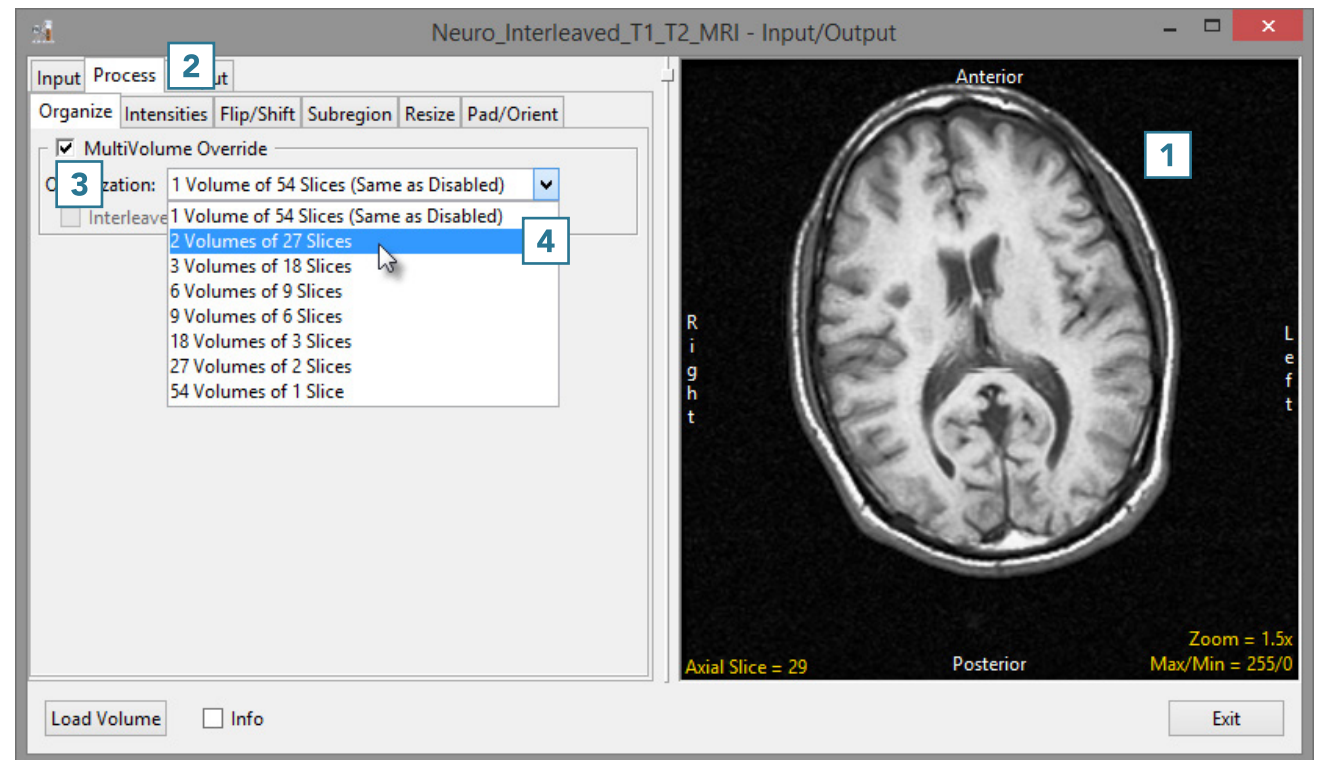


- Open the Input/Output module.
- Navigate to the data and select the data set you want to load and transform.
- Note that the data will be displayed. **1**
- Select the Process tab. **2**
- Under Organize, check the MultiVolume Override option. **3**
All possible data reorganization options will be available from the drop-down menu.

We know that in this example the 54-slice data set is comprised of a T1 and a T2 data set, each containing 27 slices. Select the appropriate option from the drop-down menu: 2 Volumes of 27 Slices. **4**

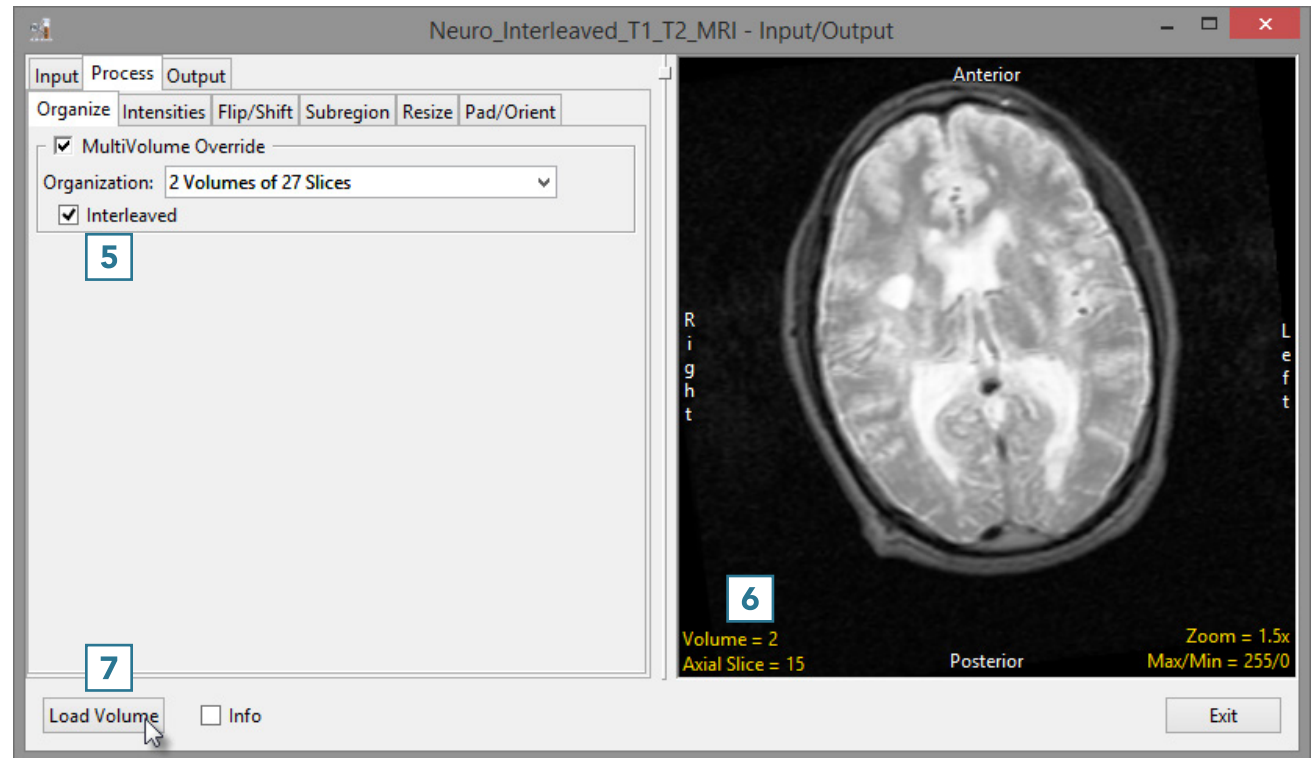


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- The data has now been changed from a single 3D data set containing 54 slices to a 4D multivolume made up of two 3D data sets, each containing 27 slices. Hold the cursor over the image and use the middle mouse wheel to scroll through the data. Note that in this example, the T1 and T2 image data is interleaved so the current volume will alternate between T1 and T2 slices.
- To correct for the interleaved image data, check the Interleaved option. **5**
- Scroll through the image data for volume 1. This will now display only the T1 image data.
- Use the Volume option **6** to change to volume 2 and scroll through the data. Only T2 image data will be displayed.
- Click Load Volume **7** to load the corrected image data.





6. Intensities

The Intensities option allows for intensity scaling or threshold-based manipulations to be applied to the data.

Intensity Scaling

Intensity scaling allows for the adjustment of the voxel value information in the data. Image data can be scaled by adjusting the output Data Type. Values can also be linearly scaled using the Input Maximum and Minimum scale options.

Modifying Image Data Type

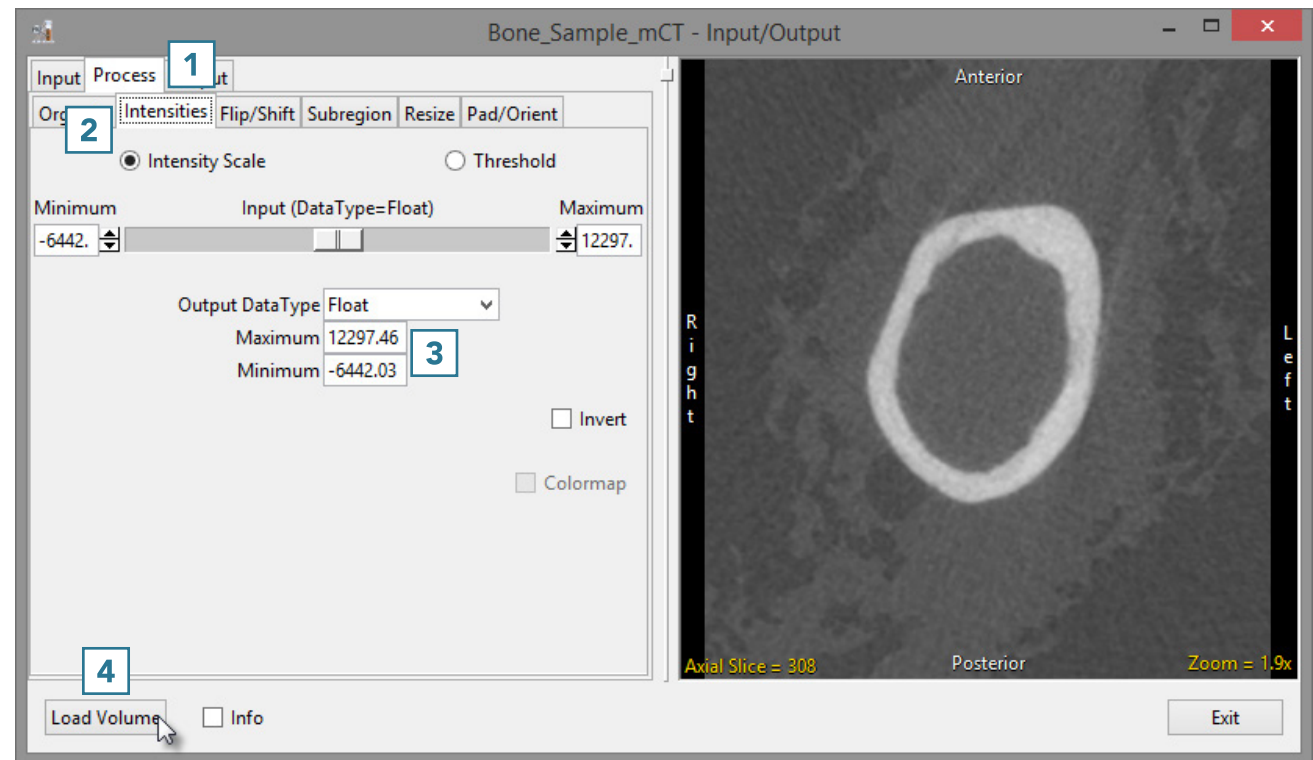
Changing the image data type can reduce the size of the data on disk. In this example, a microCT data set has a data type of Float. The size of the image data when loaded into AnalyzePro is 92.71 MB. Changing the data type to Signed 16-bit reduces the size of the data set by about 50% to 46.35 MB when loaded.



- Open Input/Output.
- Navigate to and select the data set you wish to load and transform.
- Select Process **1** and Intensities. **2**
- Make a note of the Input Maximum and Minimum values. **3**
- Select Load Volume. **4** This will load the volume to the workspace as a Float data set.

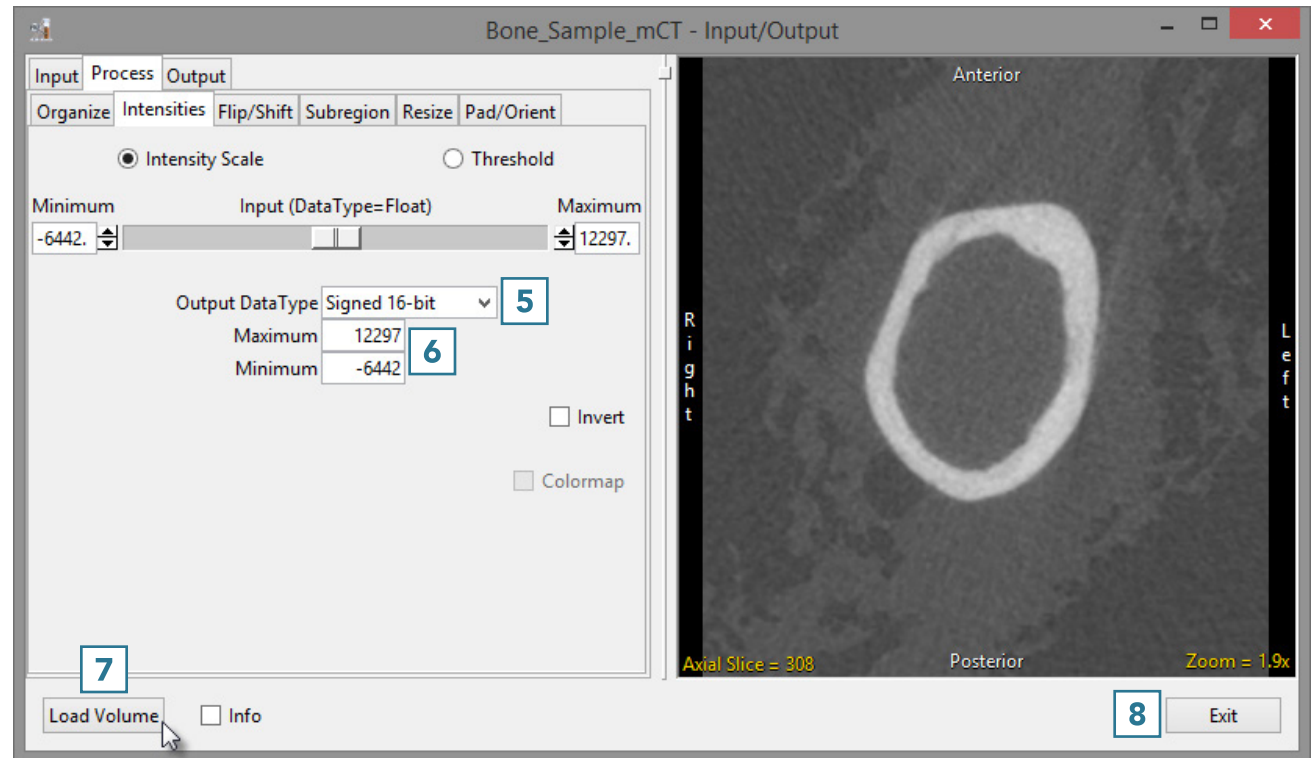


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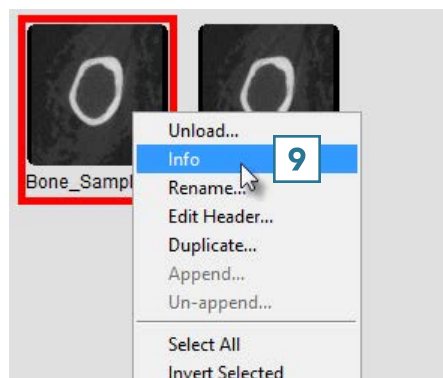


- Set the Output DataType to Signed 16-bit. **5**
- Enter the Output Maximum and Minimum values **6** by copying the input maximum and minimum values and rounding to the nearest whole number.
- Select Load Volume **7** and select Create New when prompted.
- Exit Input/Output. **8**





- In the AnalyzePro window, right-click on the first data set and select Info. **9** Repeat for the second data set.
- In the info panel beneath the data, note the size of the original and scaled data set.



Bone_Sample_mCT	Bone_Sample_mCT0	Bone_Sample_mCT	Bone_Sample_mCT0
FileName=C:\temp\APRO\Michael\Bone_Sample_mCT.mmap DataType=AVW_FLOAT (32-bit float) Width=190 Height=208 Depth=615 NumVols=1 Size=92.71 Mb Info: 0002 0002="1.2.840.10008.5.1.4.1.1.2" 0002 0003="2.16.756.5.23.5050.67.3003.3.2014" 0002 0010="1.2.840.10008.1.2.1" 0002 0012="2.16.756.5.23.1.2" 0002 0013="SCANCO_V1.2a" 0008 0008="ORIGINAL\PRIMARY\AXIAL" 0008 0016="1.2.840.10008.5.1.4.1.1.2" 0008 0018="2.16.756.5.23.5050.67.3003.3.2014" 0008 0020="20140107" 0008 0021="20140107" 0008 0023="20140107"		FileName=C:\temp\APRO\Michael\Bone_Sample_mCT0.mmap DataType=AVW_SIGNED_SHORT (16-bit signed) Width=190 Height=208 Depth=615 NumVols=1 Size=46.35 Mb Info: 0002 0002="1.2.840.10008.5.1.4.1.1.2" 0002 0003="2.16.756.5.23.5050.67.3003.3.2014" 0002 0010="1.2.840.10008.1.2.1" 0002 0012="2.16.756.5.23.1.2" 0002 0013="SCANCO_V1.2a" 0008 0008="ORIGINAL\PRIMARY\AXIAL" 0008 0016="1.2.840.10008.5.1.4.1.1.2" 0008 0018="2.16.756.5.23.5050.67.3003.3.2014" 0008 0020="20140107" 0008 0021="20140107" 0008 0023="20140107"	



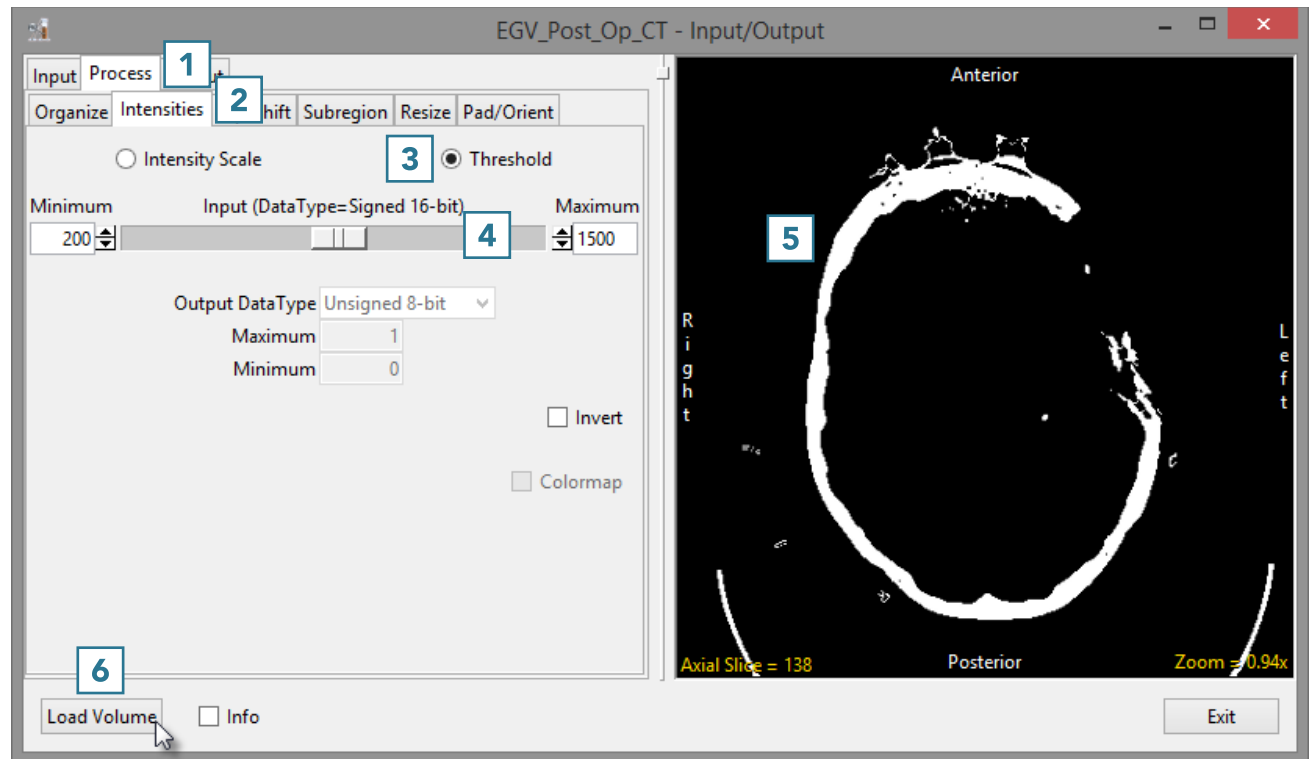
Threshold Scaling

Threshold scaling allows a range of voxels from the input volume to be loaded as a binary data set. All voxels greater than or equal to the Input Minimum and less than or equal to the Input Maximum are set to 1. All other voxels are set to 0.

- Open Input/Output.
- Navigate to and select the data set to which you want to apply a threshold scaling.
- Select Process **1** and Intensities. **2**
- Check the Threshold option. **3**
- Use the Input sliders to set the threshold minimum and maximum. **4**
- Note the image display will update, showing a binary image for the selected voxels. **5**
- Click Load Volume **6** to load the binary volume.



Download the EGV_Post_Op_CT data set to follow along
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Inverting Data

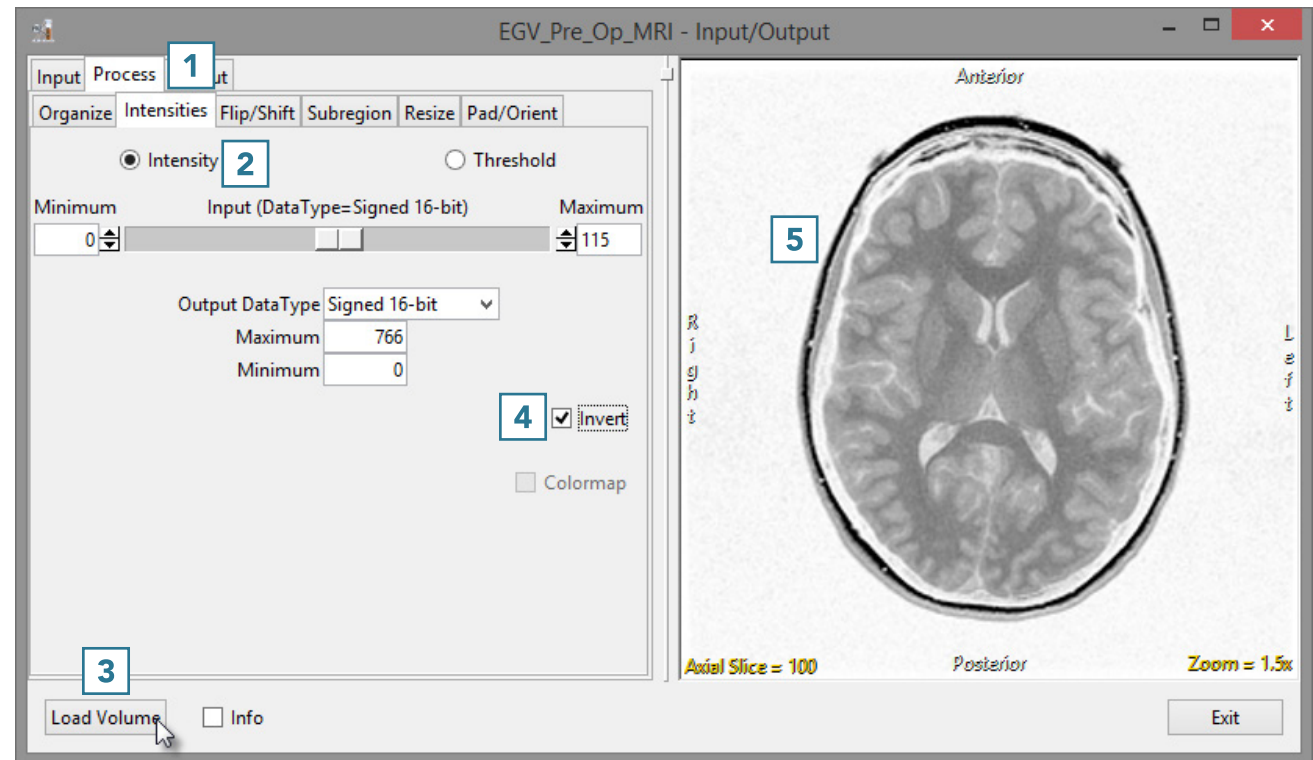
For certain applications, such as the [segmentation of the thalamus](#), it is beneficial to view an inverted copy of the image data alongside the original grayscale data to improve visualization of the thalamus. Reviewing the original and inverted image data aids with manual delineation of the structure.

- Open Input/Output.
- Navigate to and select the data set you want to invert.
- Select Process **1** and Intensity. **2**
- Select Load Volume **3** to load the data into AnalyzePro.
- Next, check the Invert option. **4**
Note that the display of the data will update. **5**
- Click Load Volume **3** and select Create New.

A grayscale and inverted version of the data are now available for use within the program. These two data sets can be simultaneously loaded into Segment.



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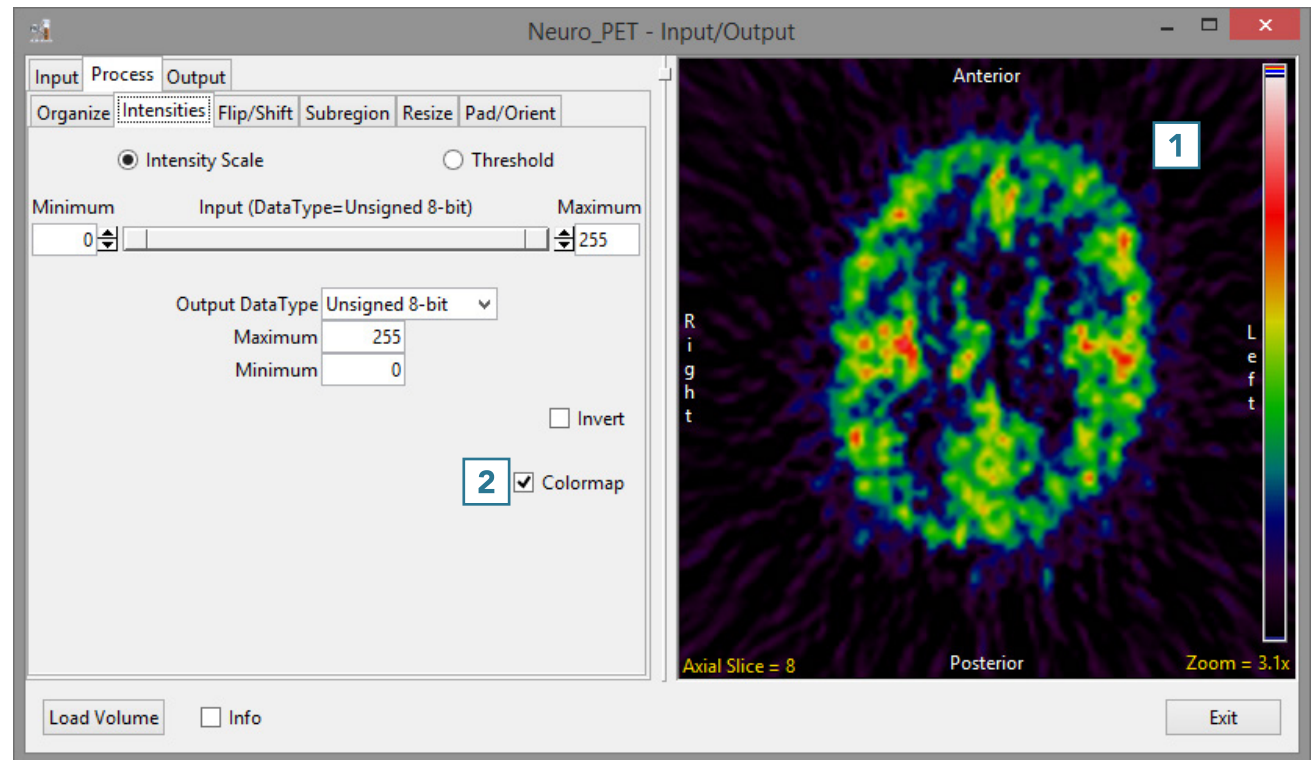


Colormaps

When loading a data set that has an associated colormap, **1** the Colormap checkbox will be selected. **2**



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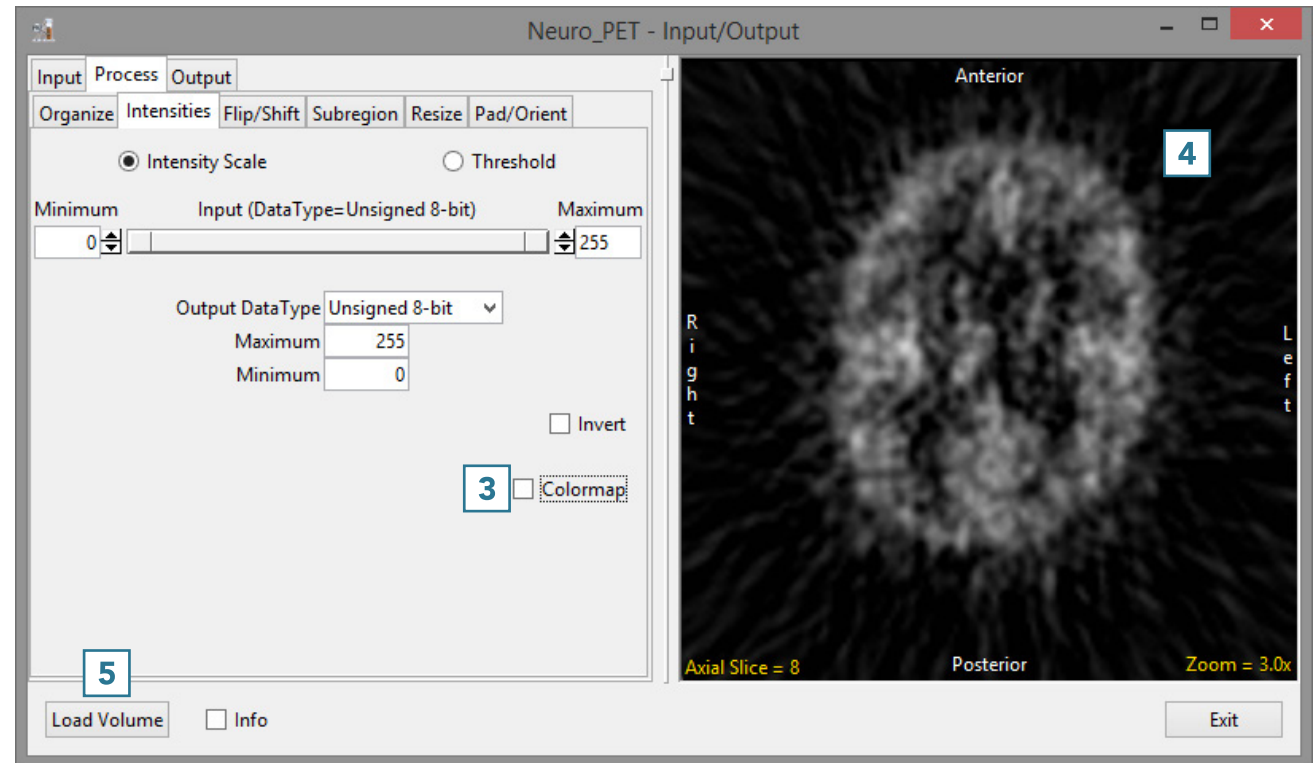




- To load the grayscale data without the associated .lkup colormap file, uncheck the Colormap checkbox. **3**

Note that the image display will update to show the grayscale data. **4**

- To load the data, click Load Volume. **5**





7. Flip/Shift

Data Flipping

It may be necessary to flip data in order to orient it correctly. The Flip/Shift > Flip options allow users to flip data along any single axis or combination of axes.

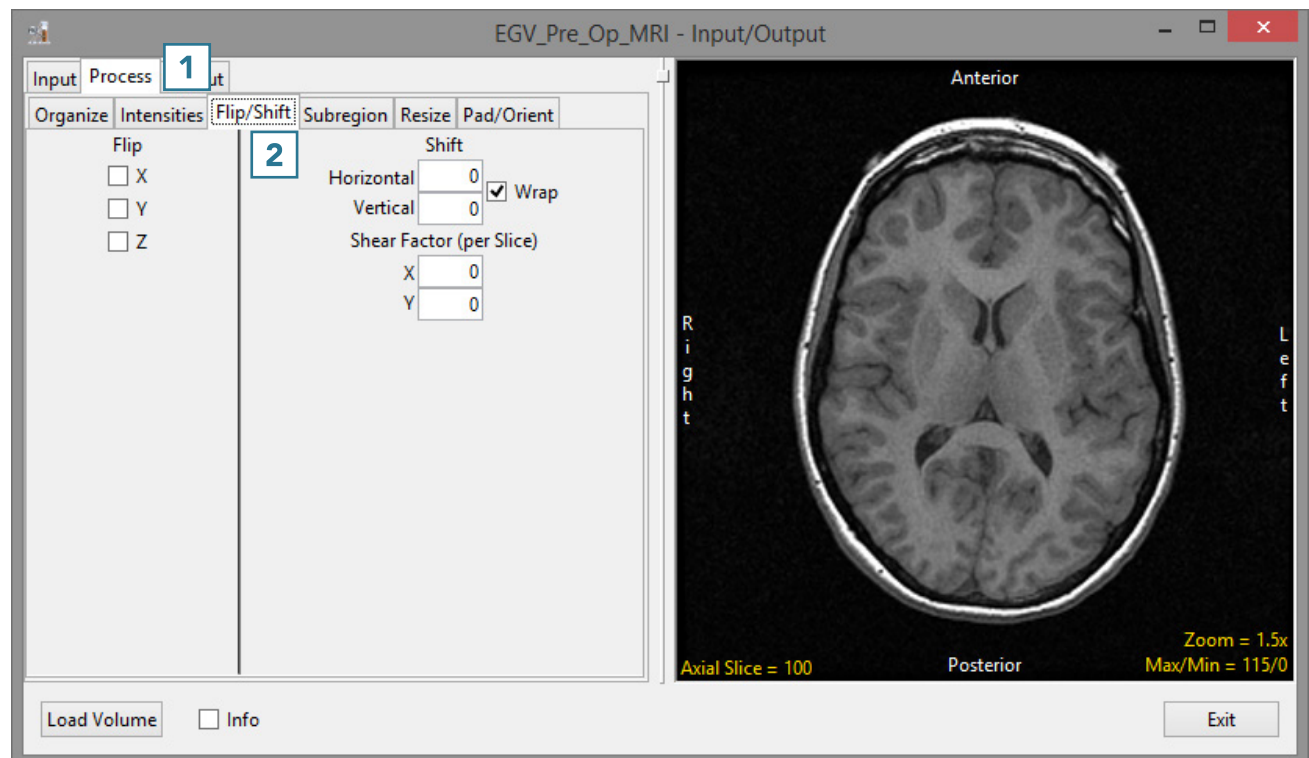
Once a flip checkbox is selected, the flip will be applied to the data and the display panel can be used to review. Unchecking the option will undo the flip. Flipping the data in only the X or Y direction will create a mirror image. If this is not the desired result, the data can be flipped in both the X and Y directions at once to prevent a mirror image from being created. To apply a flip:

- Open Input/Output.
- Navigate to and select the data set to be flipped and loaded.
- Select Process **1** and Flip/Shift. **2**



Download the EGV_Pre_Op_MRI data set to follow along
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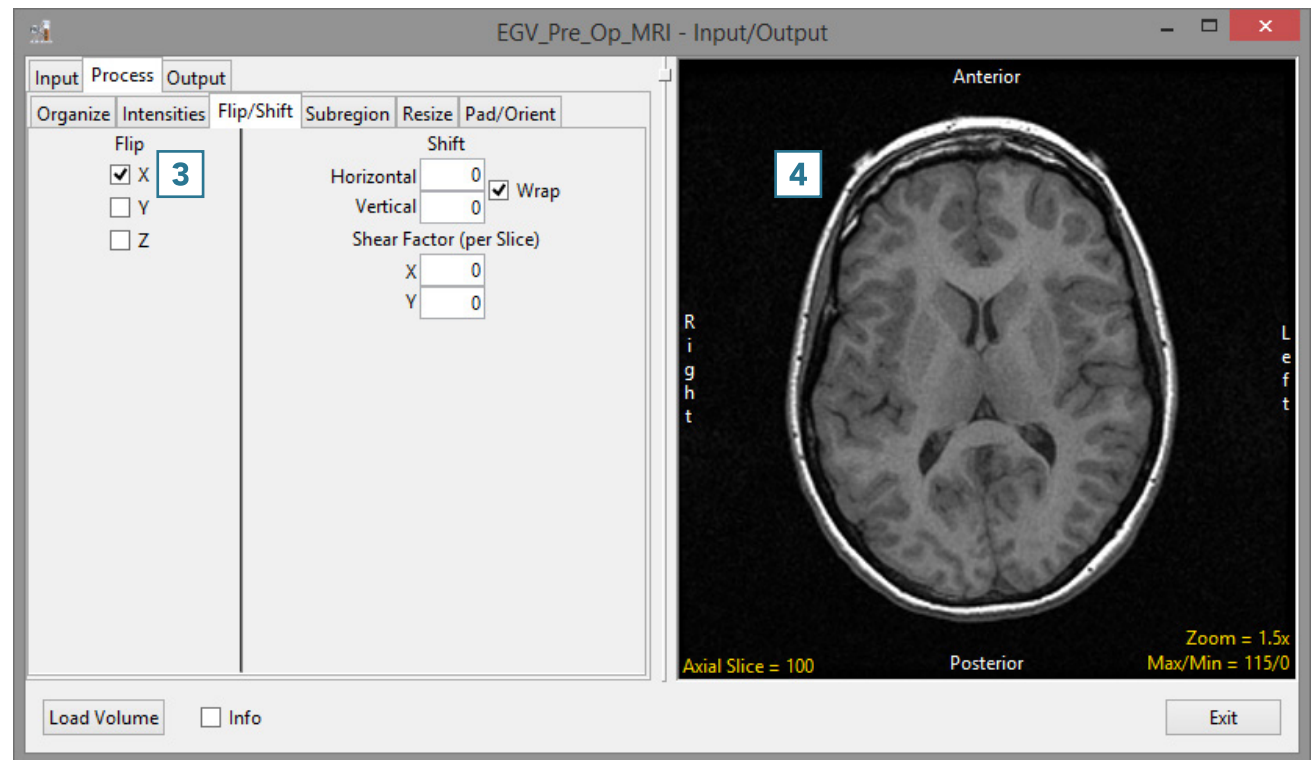
Axis	OUTCOME
X	Flips data horizontally, rotating about the vertical (Y) axis.
Y	Flips data vertically, rotating about the horizontal (X) axis.
Z	Changes the order of the slice data.





- Check the X Flip option. **3**

Note the update to the data. **4**





- Check the Y Flip option. **5**

Note the update to the data. **6**

- To load the data, click the Load Volume button. **7**

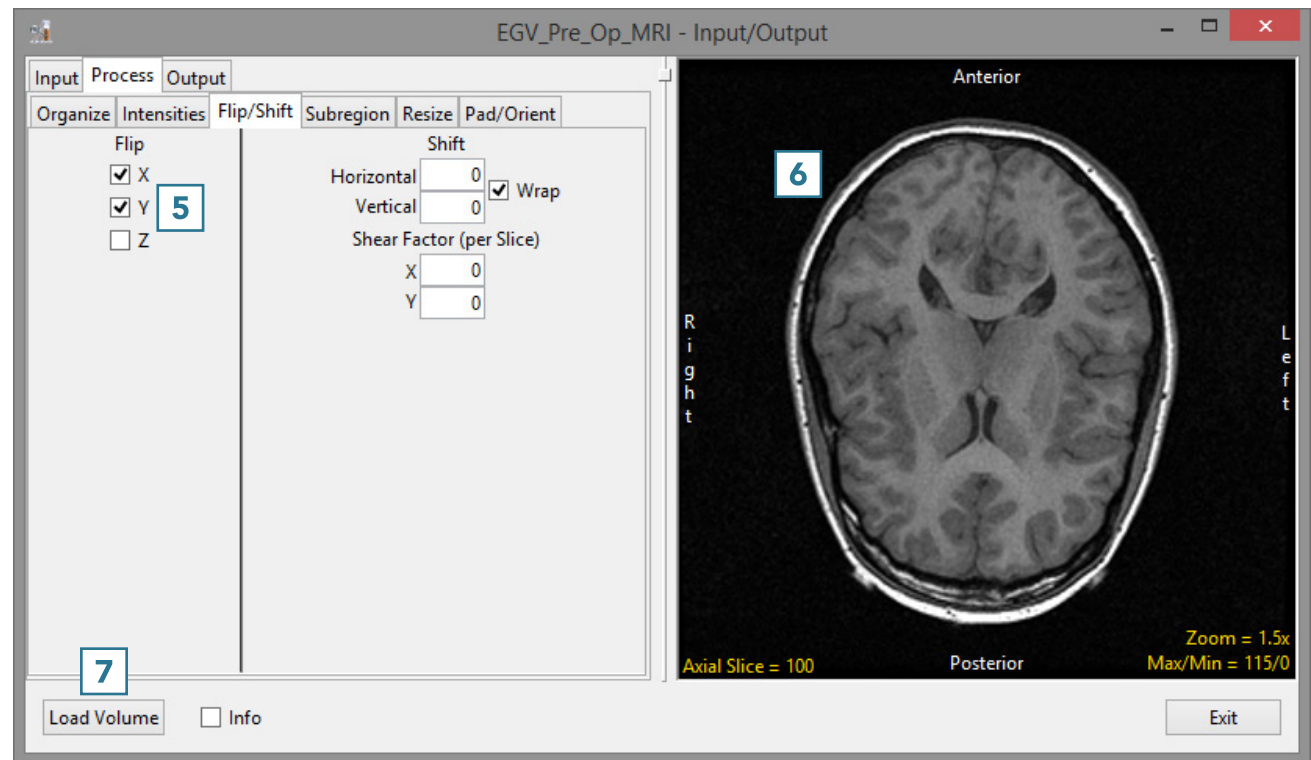
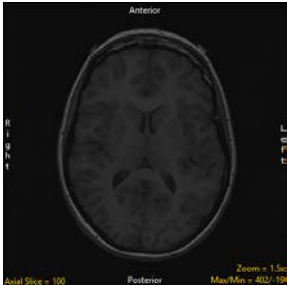
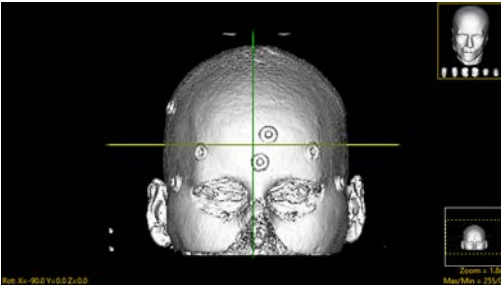
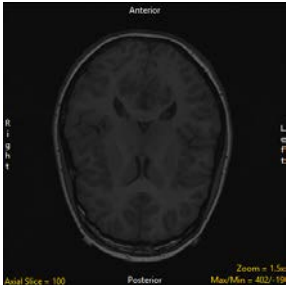
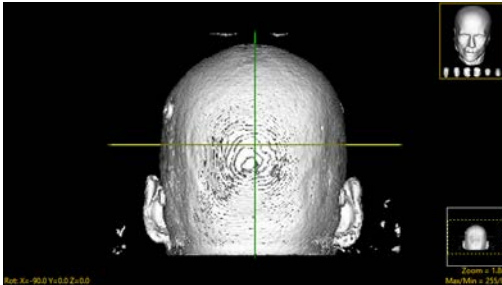
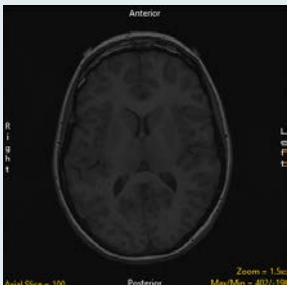
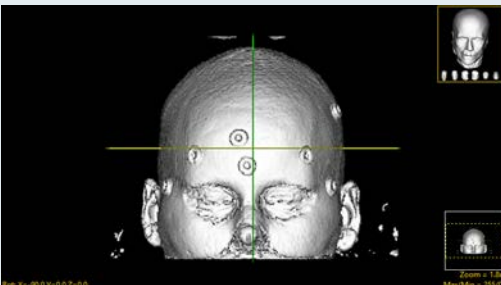

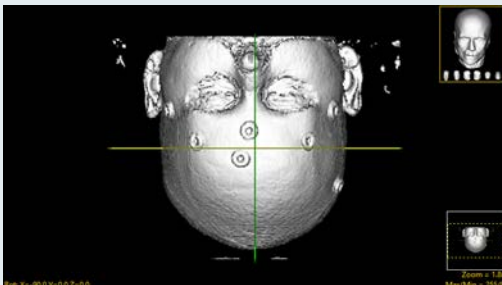
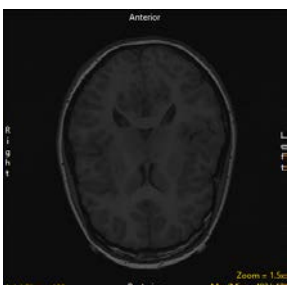
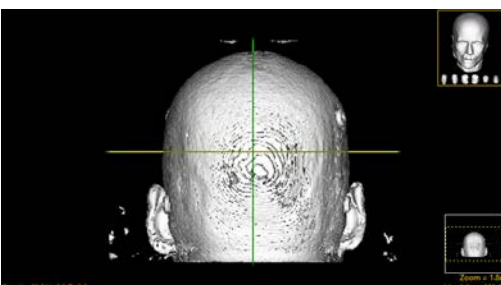
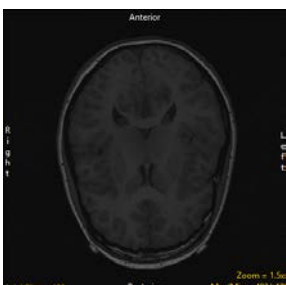
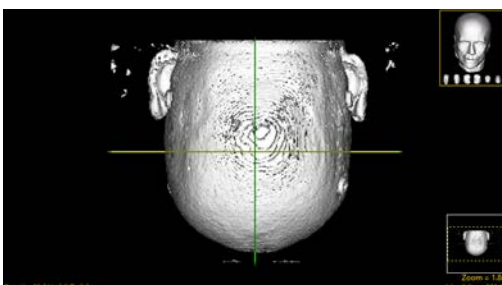
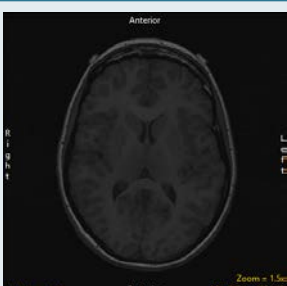
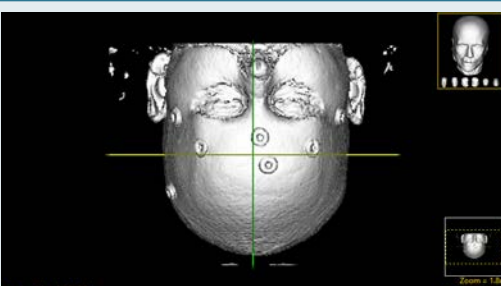
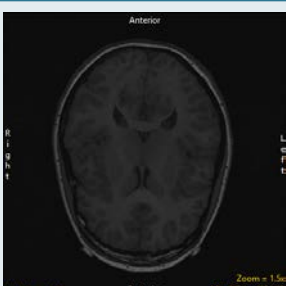
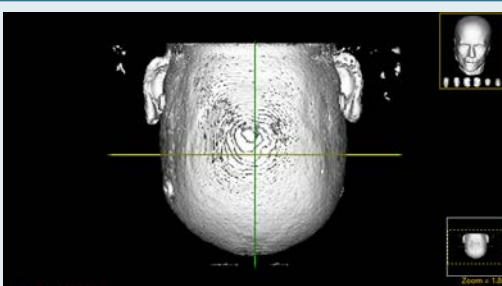




Table 3.2: Results of Flipping Data Along Any Combination of Axes

Flip	2D	3D	Flip	2D	3D
No flip			XY		
X			XZ		
Y			YZ		
Z			XYZ		



Shifting Data

The shift option allows data to be shifted horizontally or vertically. Data shift may be necessary to correct for slice wraparound. In this example, the front slices of a sagittally-acquired MRI data set have wrapped around to the posterior side of the data set **1** and there are slices from the inferior side of the volume that have wrapped around to the superior side of the volume. **2**



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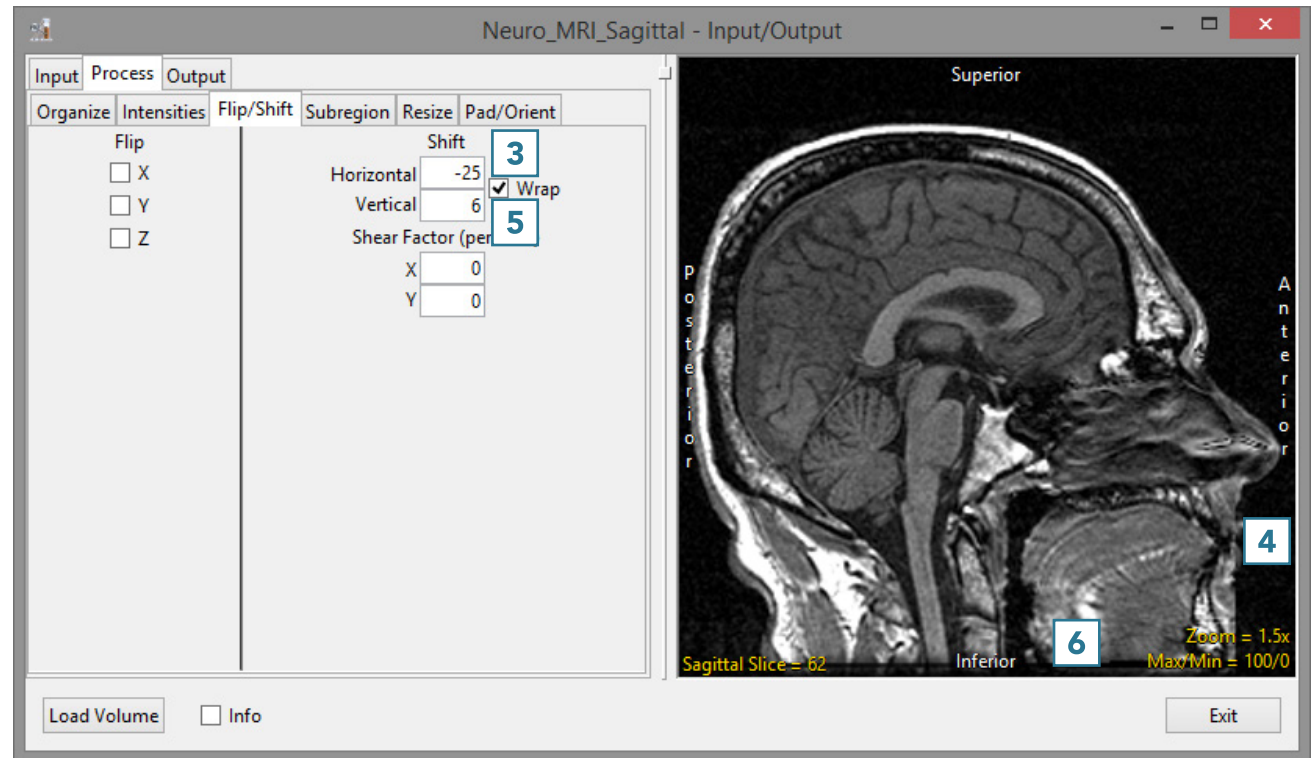


- To correct for the horizontal shift in slices, enter -25 in the Horizontal Shift field. **3**

Note that the data will be shifted back 25 slices. The last 25 slices will automatically wrap around from the posterior side of the data set to the anterior side of the data set. **4**

- To correct for the vertical shift in slices, enter 6 in the Vertical Shift field. **5**

Note that the data will be shifted up 6 slices. The top 6 superior slices will automatically wrap around to the inferior side of the data set, since the Wrap checkbox is checked. **6**

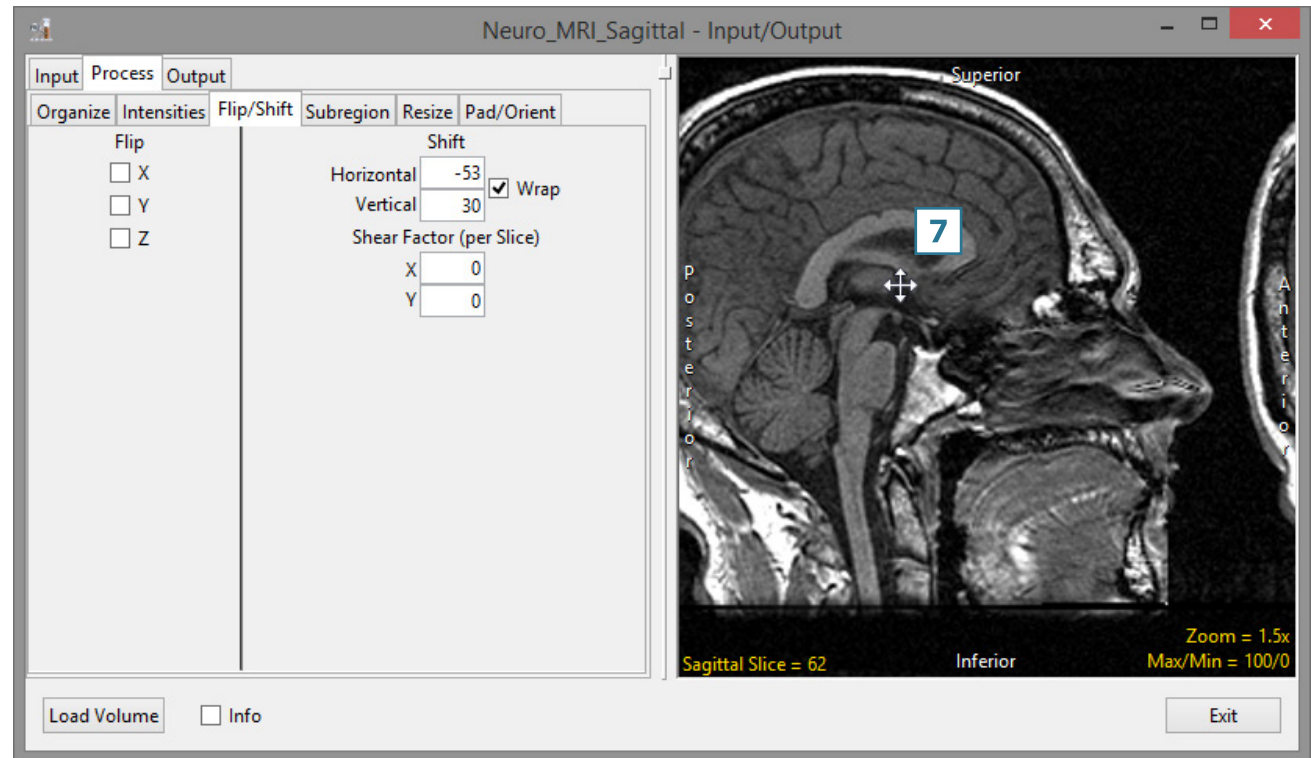


**Table 3.3: Shift Options Quick Reference**

Shift	Axial	Coronal	Sagittal
Horizontal +	To left	To left	To anterior
Horizontal -	To right	To right	To posterior
Vertical +	To anterior	To superior	To superior
Vertical -	To posterior	To inferior	To inferior

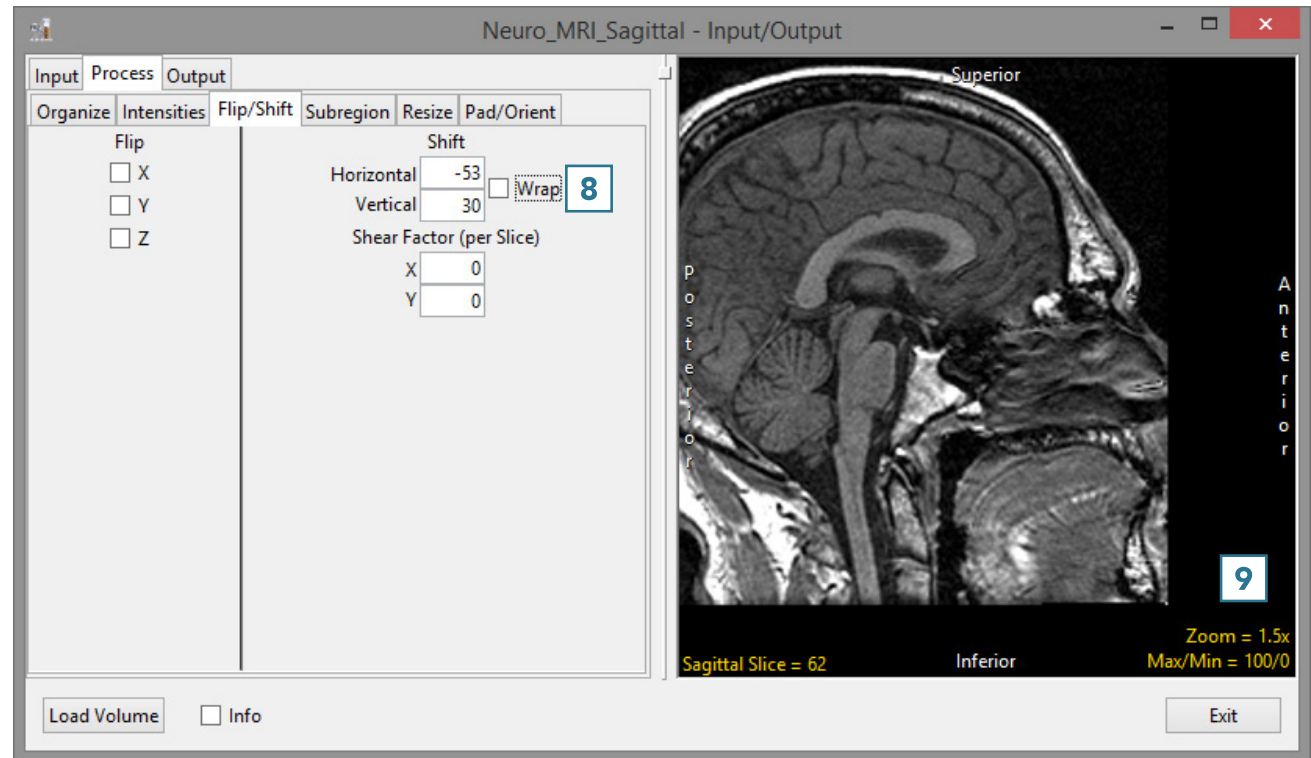


- To shift data interactively, click on the image data. Note that the cursor will update; drag the data to a new location. **7**





- Unchecking the Wrap checkbox **8** will prevent slices from being wrapped. **9**





Shear Factor Correction

Sometimes CT images are acquired with the gantry tilted obliquely (non-orthogonally) relative to the direction of the table movement. If the volume is constructed by stacking the image slices, the volume will appear sheared or skewed. AnalyzePro will automatically detect and apply the gantry tilt shear correction and the appropriate shear factor values will be populated in Shear Factor (per slice) fields. If desired, the Shear Factor (per slice) values can be manually entered.



8. Subregion

Cropping Data

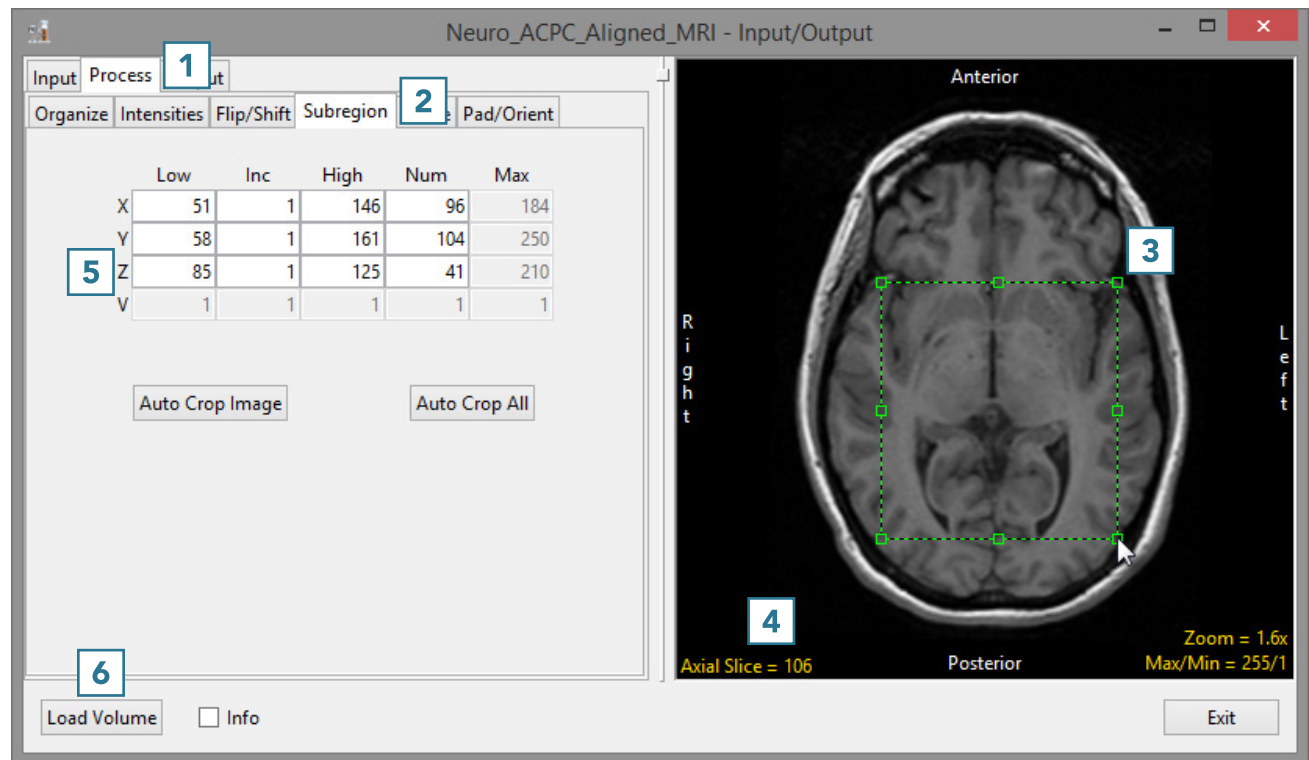
The Subregion tool in Input/Output > Process can be used to reduce the size of a data set without the need to interpolate the original voxel data. The tool can also be used to crop data to a specific region of interest, which may be beneficial for certain applications, such as [hippocampal segmentation](#).



- Open Input/Output.
- Navigate to and select the data set you want to crop.
- Select Process **1** and Subregion. **2**
- To crop the data, click on the green box **3** in the display panel and adjust to the desired position.
- To define the crop in the Z range, click on the Slice option. **4**
With your left mouse button held down, move the mouse up or down to navigate through the slice data. You can also use the scroll wheel to move through the slice data. When you reach the lower limit for the crop, enter the slice number in the Z Low box. **5** Enter the upper limit slice number in the Z High box.
- Click Load Volume to load the cropped data. **6**



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<http://analyzedirect.com/data/>





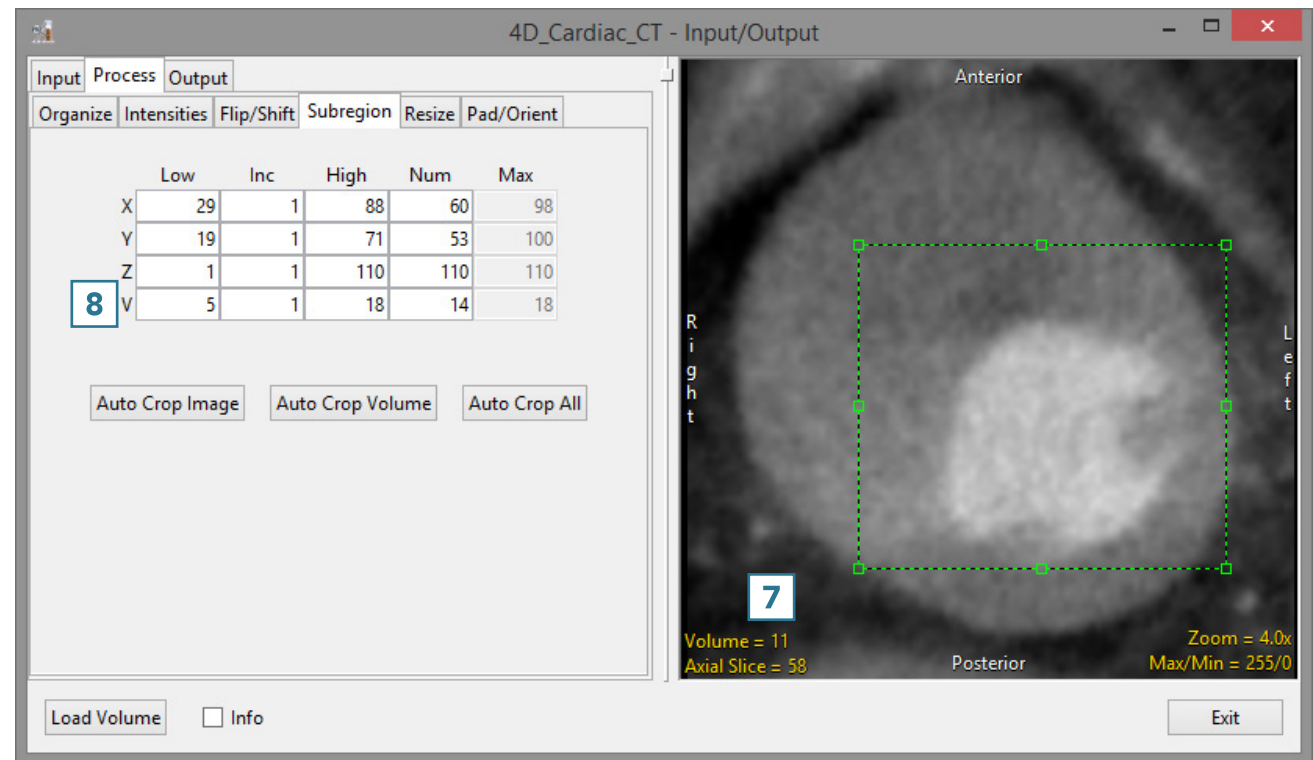
9. Cropping 4D Data

4D image data can also be cropped to remove time points from the data prior to loading. When a 4D data set is selected, a fourth dimension V (volume) will be enabled. **7** To crop a 4D data set:

- Select the Volume option **7** and use the cursor to navigate through the volumes in the data, just like you would use the Slice option to navigate through the slices in a single volume.
- Determine the volumes you want to remove from the multivolume and enter the corresponding lower and upper volume limits in the V Low and/or V High boxes. **8**



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10. Resize

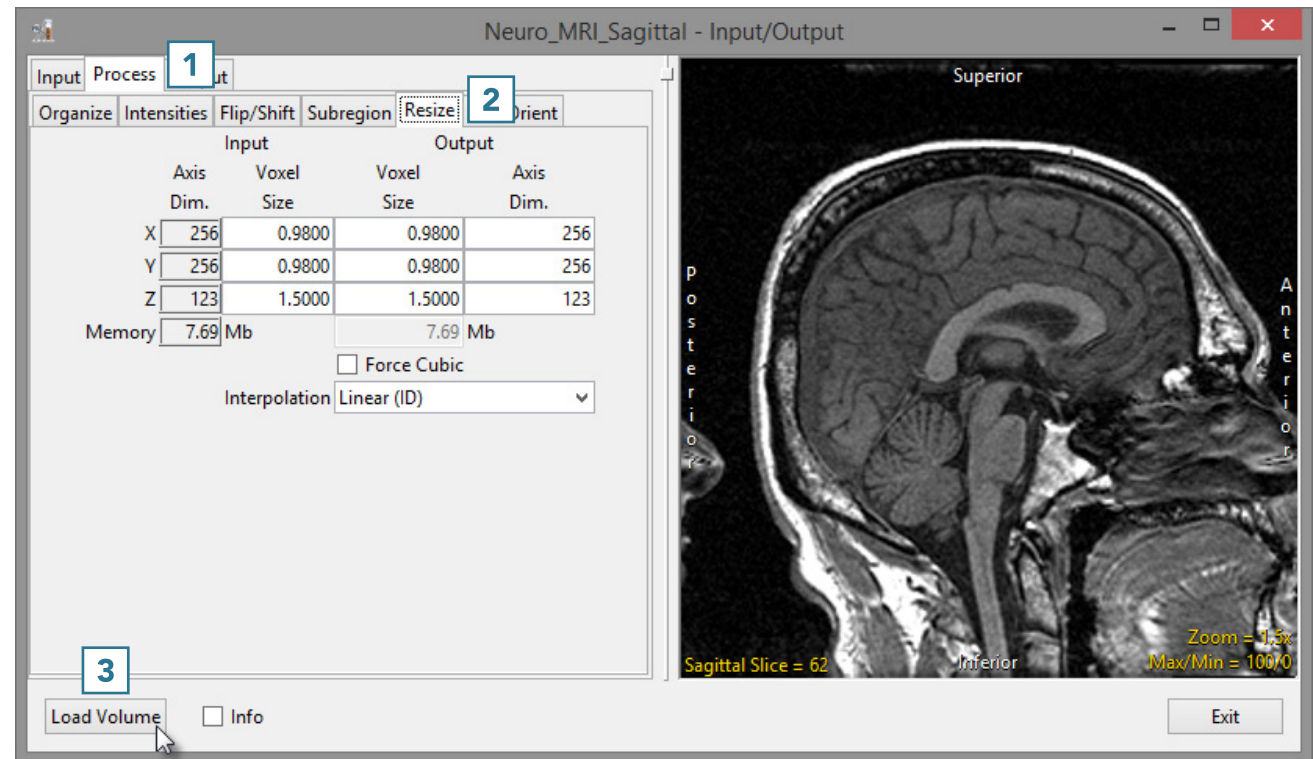
Resize can be used to resample image data. If data is acquired with anisotropic (non-cubic) voxels, resize can be used to resample the data to create an isotropic (cubic) data set.



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Resampling Anisotropic Data

- Open Input/Output.
- Navigate to and select the data set to be resampled.
- Select Process **1** and Resize. **2**
- Click Load Volume **3** to load the data set without resampling.



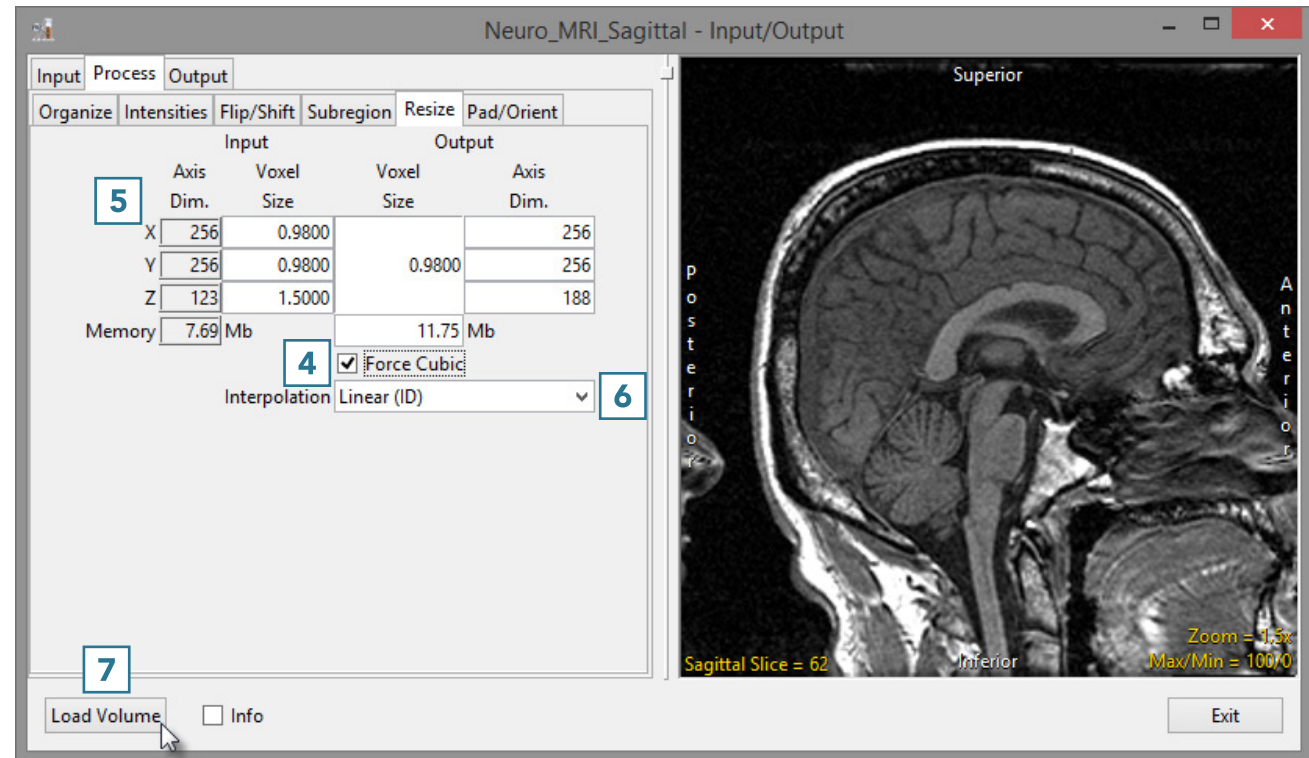


- Check the Force Cubic checkbox.

4

Note the input and output voxel size and the input and output axis dimensions. 5 The data has been resampled at the highest spatial resolution (0.98). The Z dimension which originally had a voxel size of 1.5 has now been resliced to 0.98. To accommodate this, the number of slices in the Z dimension has increased from 123 to 188 ($123 \times 1.5 / 0.98 = 188$).

- The interpolation option used to create the new slice data can be selected from the interpolation drop-down menu. 6



For information about various interpolation types, see [Table 3.4](#) or [6.1](#).

- Click Load Volume 7 and select Create New. Compare both the original and resampled data sets using Display.



Each interpolation type is either input driven (ID) or output driven (OD).

Input driven interpolation algorithms process each voxel in the input volume and map each input voxel into the output space. The actual interpolation takes place in the output space, given the projected contributions of each input voxel into that space. Input driven algorithms will always use every voxel in the input volume as part of the interpolation process.

Output driven algorithms step through each voxel in the output data set and find the corresponding set of voxels in the input data set that map into the output. The interpolation of voxels takes place in the input space, depending on the type of interpolation selected. Output driven algorithms are more common in image processing as they guarantee that every voxel in the output data set will be filled with an interpolated value.

Table 3.4: Interpolation Types

Interpolation Type	Description
Nearest Neighbor*	selects the value of the closest voxel to which the interpolation resampling maps
Linear*	applies a linear interpolation of grayscale intensity based on the distance of neighboring voxels from the interpolated voxel
Cubic Spline**	uses a cubic spline function to determine interpolated value
Windowed Sinc**	uses windowed sinc function $\sin(x)/x$ to determine interpolated value
Shape Based	only available for binary data; calculates Euclidean distance, then performs linear interpolation between distance images

*The Nearest Neighbor and Linear interpolation types can be specified as ID or OD.

**The Cubic Spline and Windowed Sinc interpolation types are both OD. Since they use higher-order functions, they account for more neighboring voxels and thus may provide a better estimate for the interpolated value. These algorithms are also more compute-intensive.



11. Pad/Orient

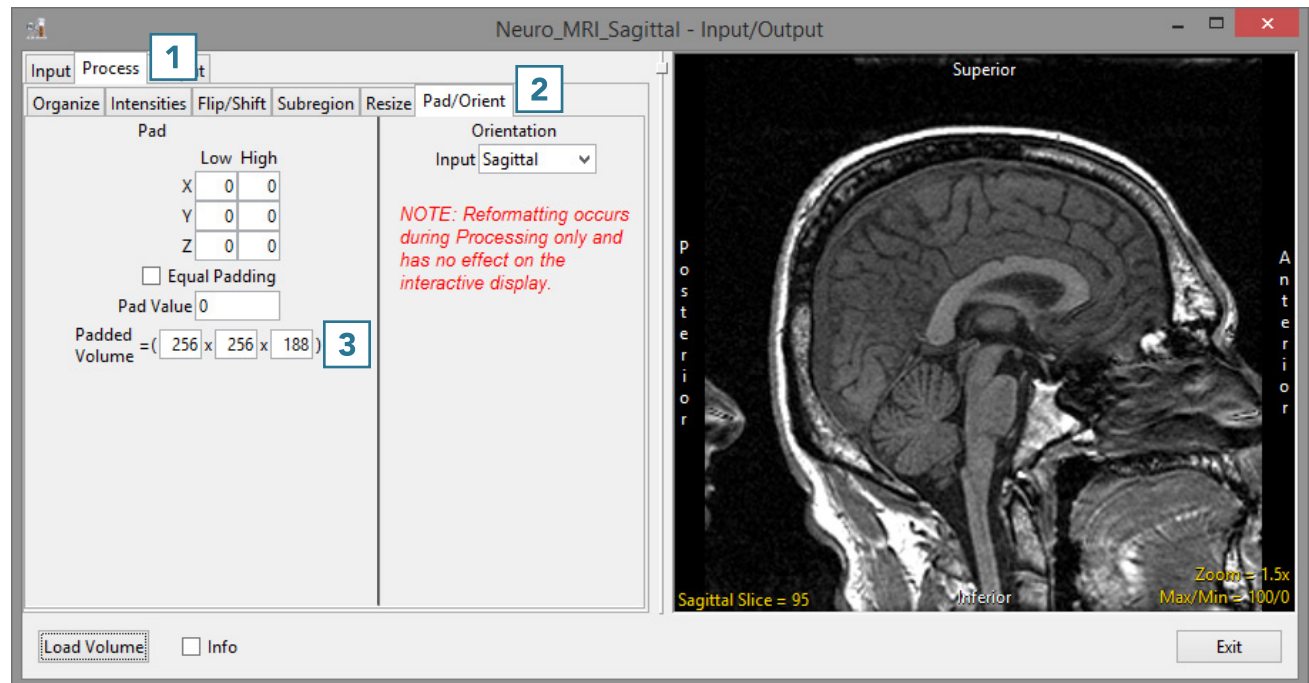
Padding Data

The Pad/Orient option can be used to pad image data. This may be necessary to create a data set with certain dimensions or to make a data set isovolumetric (equal number of slices in each orientation).

- Open Input/Output.
- Navigate to and select the data set to be padded.
- Select Process **1** and Pad/Orient. **2**
- Note the slice dimensions for the data are reported in the Padded Volume fields. **3**

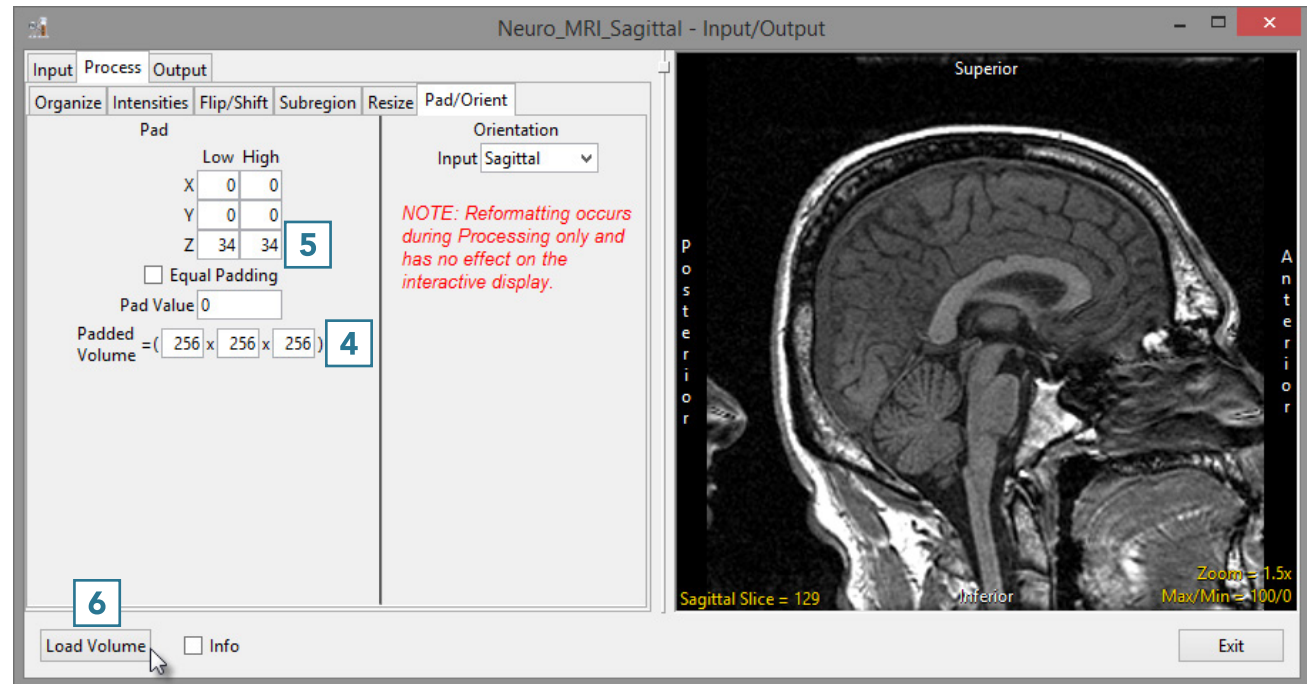


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- To make the data set isovolumetric, update the appropriate Padded Volume field.
4 The Pad tool will try to apply an equal number of slices to pad the data in the pad axis. 5
- Users can also choose to pad all slices to either the Low or High field for the appropriate axis.
- Click Load Volume 6 to load the data.





Correcting an Orientation Flag

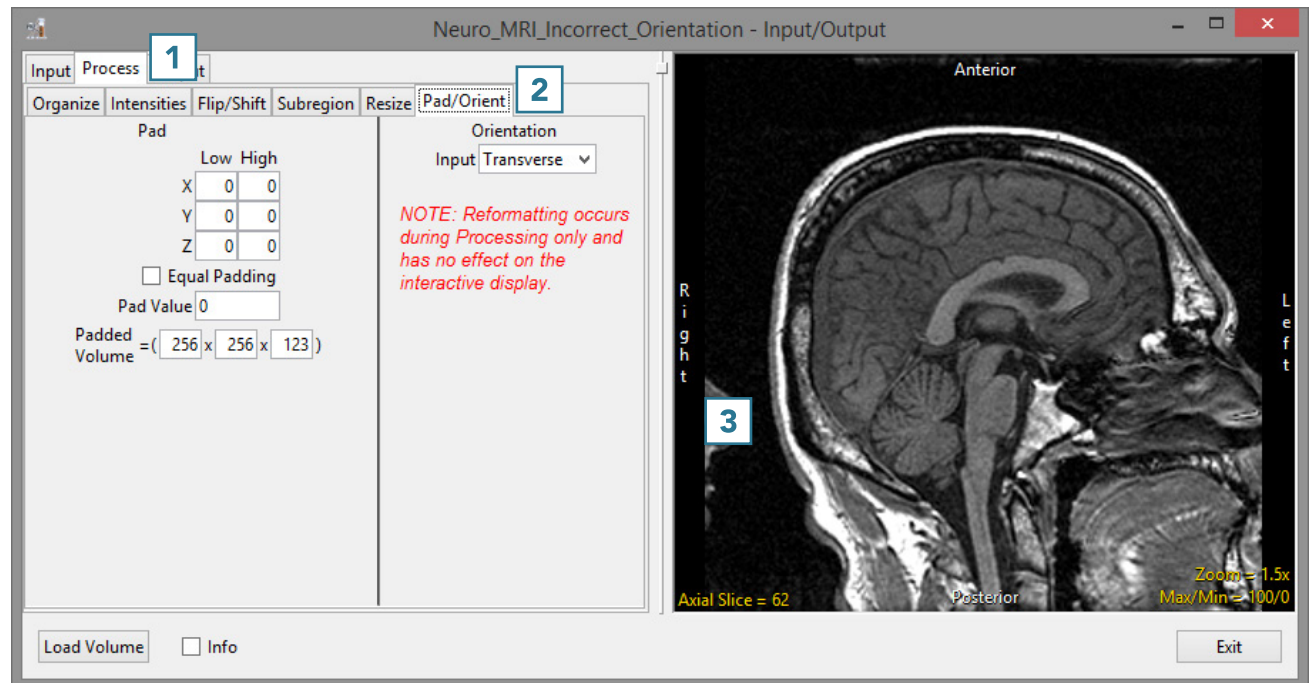
If a data set is loaded with an incorrect orientation flag, it will not orient correctly in other AnalyzePro modules. The Orientation option can be used to correct this.

- Open Input/Output.
- Navigate to and select the data set to be padded.
- Select Process **1** and Pad/Orient. **2**

Note that the orientation of this sagittally-acquired data set is marked as axial. **3**

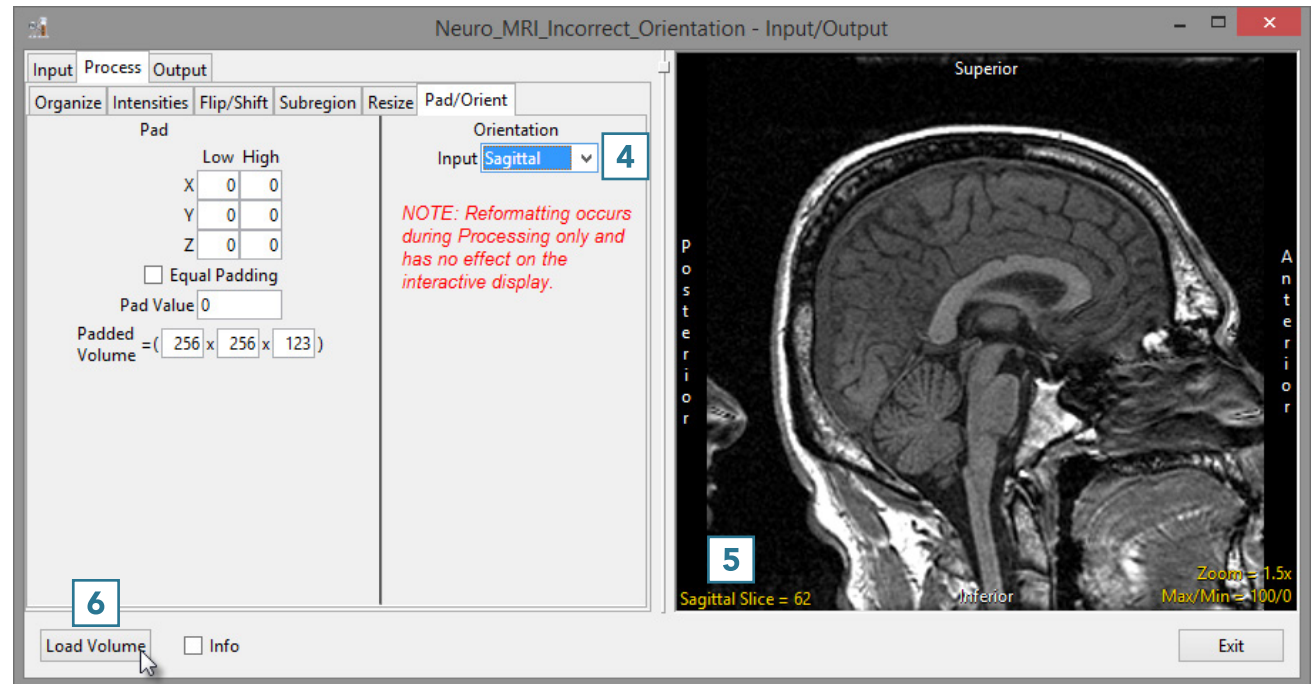


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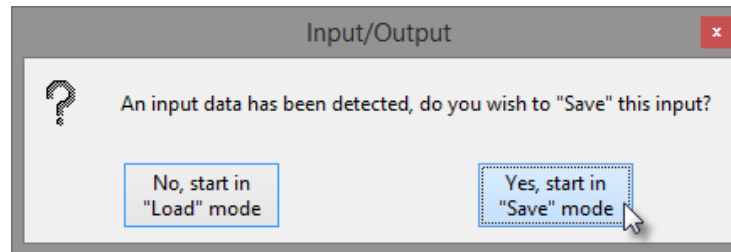
- To correct this, set the Orientation Input option to Sagittal. **4**
- Note that the axis labels in the preview are corrected. **5**
- Click Load Volume **6** to load the data.





Output: Saving Data

Data can be exported from AnalyzePro as easily as it can be loaded into the program. Input/Output will open in Save mode when a data set is selected.

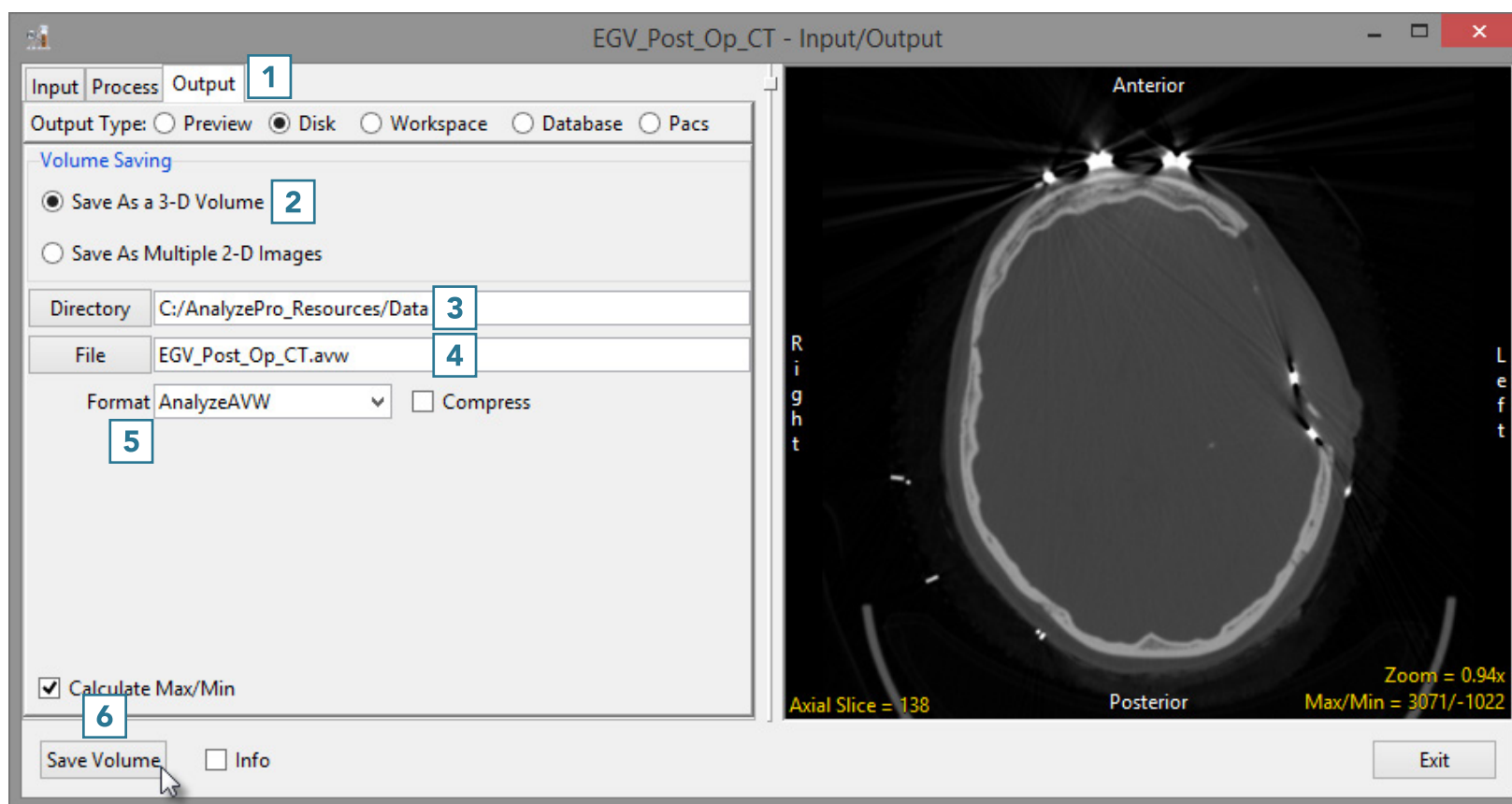


12. Opening Input/Output in Save Mode

- Select a data set and open Input/Output.
- A window will open, prompting you to open in Load or Save mode. Select Save mode.

13. Saving a Data Set

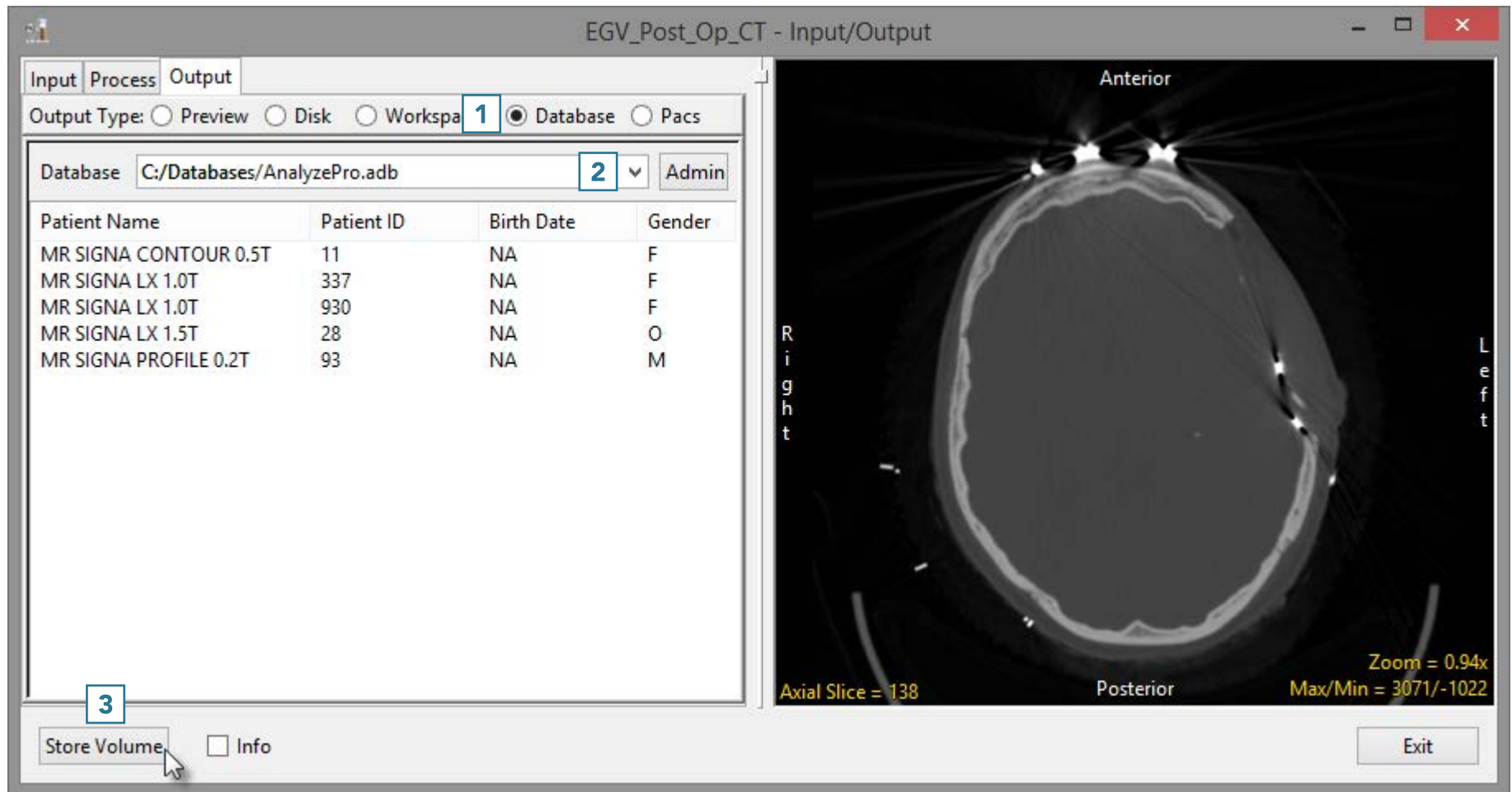
- Input/Output will open with Output selected and the Output Type set to Disk. **1**
- Choose to save the data as a 3D Volume **2** (default) or as multiple 2D images. The selection will determine the formats you can select for saving the data (see [Table 3.1](#)).
- Use Directory **3** to select the location where you will be saving the data.
- Use File **4** to rename the data.
- Use Format **5** to specify the file format for the saved data.
- Select Save Volume to save the data.





14. Storing Data in a Database

- Select the Database option. **1**
- If required, select a database from the drop-down. **2**
- Click Store Volume. **3**



- The Edit/Add DICOM tags window will open. Use this tool to add or edit any DICOM tag information.
- Click Apply Tags and Continue. **4**
- The data will be exported to and merged into the database.

Edit/Add Dicom tags

Edit DICOM tags

Patient

ID (0010,0020) 500

Name (0010,0010) Joe Bloggs

DOB (0010,0030)

Gender (0010,0040) M

Study

ID (0020,0010)

Description (0008,1030)

Date (0008,0020)

Accession (0008,0050)

Modality (0008,0060)

Portion (0008,0015)

☒ (0020,000d) Make New Study Instance UID

Series

ID (0020,0011)

Orientation ☒ Axial ☐ Coronal ☐ Sagittal

Description (0008,103e)

Procname (0008,1030)

☒ (0020,000e) Make New Series Instance UID

Other Tags

(gggg,eeee)

Apply Tags and Continue

Clear

Add Tag

Cancel



15. Sending Data to PACS

- Right-click on the data to send to PACS. **5**
- Select Send Patient **6** and choose the PACS AET where you want to send the data. **7**
- To configure PACS, see [Configuring PACS Communications](#).

