



NA-MIC

National Alliance for Medical Image Computing

<http://na-mic.org>

3D Slicer

4 February 2011

Andrey Fedorov, PhD

Steve Pieper, PhD

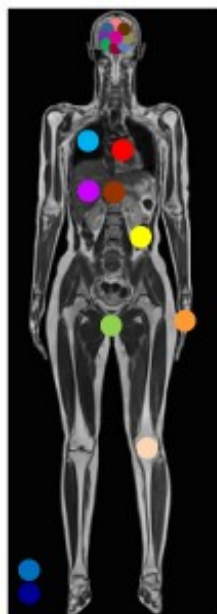
Ron Kikinis, MD

Surgical Planning Lab

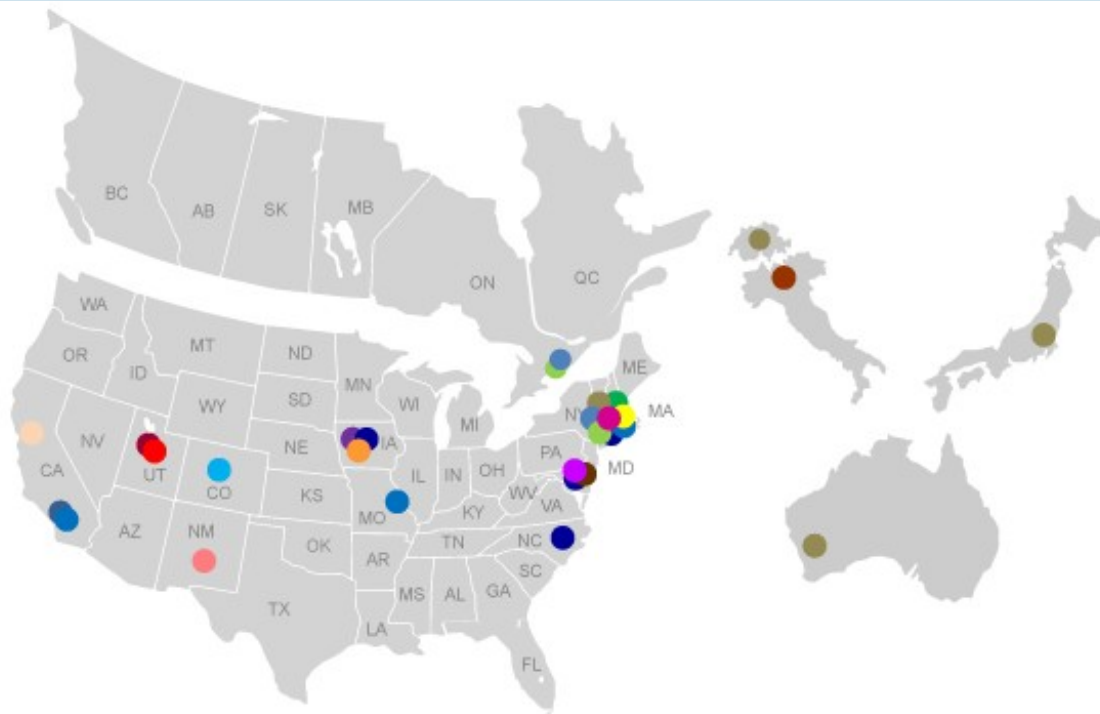
Brigham and Women's Hospital



Acknowledgments



- Autism
- Brain Cancer
- Depression
- Head and Neck Cancer
- Huntington's Disease
- Lupus
- Schizophrenia
- Traumatic Brain Injury
- VCFS
- Neuroimage Analysis
- Lung Disease
- Atrial Fibrillation
- Cardiovascular Disease
- Liver Cancer
- Colon Cancer
- Prostate Cancer
- Orthopedic Injury
- Neuromuscular Dynamics
- Image Informatics



Active

- | | | | | | | | |
|--------------------------------|--------------------|----------------------|---------------|------------------|---------------|---------------|--------------------|
| ● R01MH084795 | ● U41RR019703 | ● NSF CCF-0916526 | ● R01EB008171 | ● U01HL089897 | ● R01CA124377 | ● R01CA131718 | ● R01CA11128 |
| ● R01EB005973 | ● U54EB005149-05S2 | ● U54GM072970 | ● P41RR013218 | ● R01EB006733 | ● R01NS050568 | ● R21EB009900 | ● U54EB005149-05S3 |
| ● UL1RR025758 | ● U54LM008748 | ● U24RR025736 | ● U24RR021992 | ● U24RR021382 | ● U24RR026057 | ● AIST, Japan | ● UWA, Australia |
| ● Mario Negri Institute, Italy | | ● CO-ME, Switzerland | | ● OCAIRO, Canada | | | |

Completed

- U54EB005149-04S1

Picture courtesy Kapur, Jakab, Kikinis





The 3D Slicer

3D Slicer is a platform for delivering image computing technology for personalized medicine research

- Basic and clinical visualization
- Longitudinal imaging
- Registration
- Segmentation





Our Approach



- Open community process
- Modular and extensible architecture
- Free open source software (BSD)
- Works on your computer



Open Community Process

Community support

- mailing lists
- web-based bug reporting
- wiki for documentation
- svn for code management

Open to all: academia, industry, government,
international

Twice a year working weeks called *project weeks*

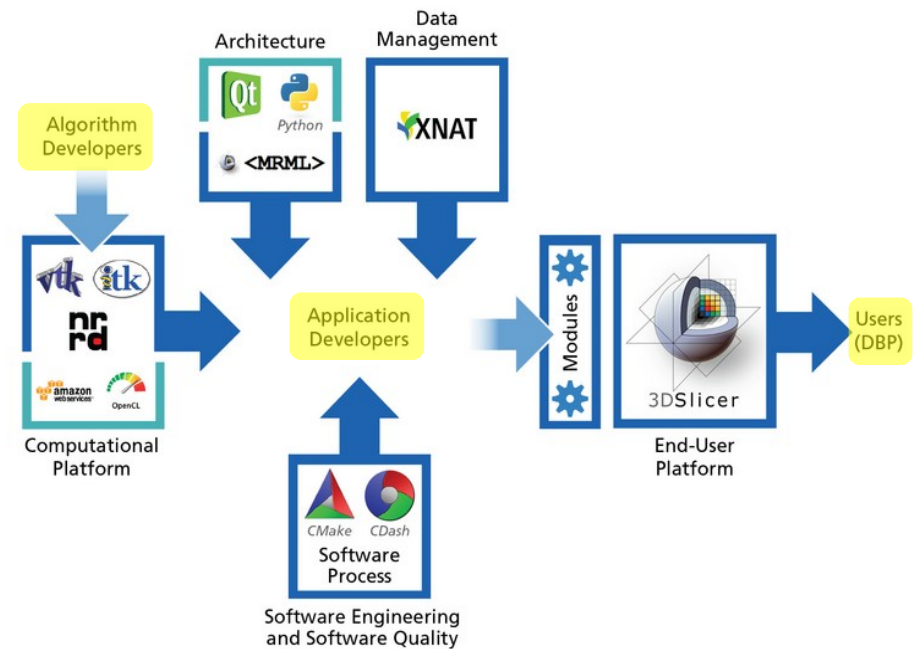
Focused workshops (DTI, IGT)





Modular Software Architecture

- NA-MIC Kit: 3D Slicer, VTK, ITK, CMake, CTest, CDash, KWWidgets, XNAT, Teem
- Other open source: Qt, Python, Tcl/Tk, SVN
- Slicer extensions





Impact

<http://www.na-mic.org/Wiki/index.php/NA-MIC-Kit>

Package	Lines of code	Person years	Price tag at 100k per person year
Slicer	1,270,816	361	\$36,122,644
KWW	207,208	54	\$ 5,406,516
VTK	1,853,529	538	\$53,808,076
ITK	848,383	237	\$23,719,173
CMake / CTest / CPack	323,454	86	\$8,590,888
CDash	78,226	19	\$1,897,060
XNat	200,985	51	\$5,149,987
Total	4,782,601	1346	\$134,694,344



Free Open Source Software

NA-MIC kit has

- BSD license
- No protected IP

No lawyers needed

Lowers barriers to collaboration

Software can move with scientists

Co-existence of proprietary and open



Fenway Park

Community Garden



Works on Your Computer

Easy download and installation

Runs natively on your computer on Windows, Mac and Linux
behind your institutional firewall

Training concept:

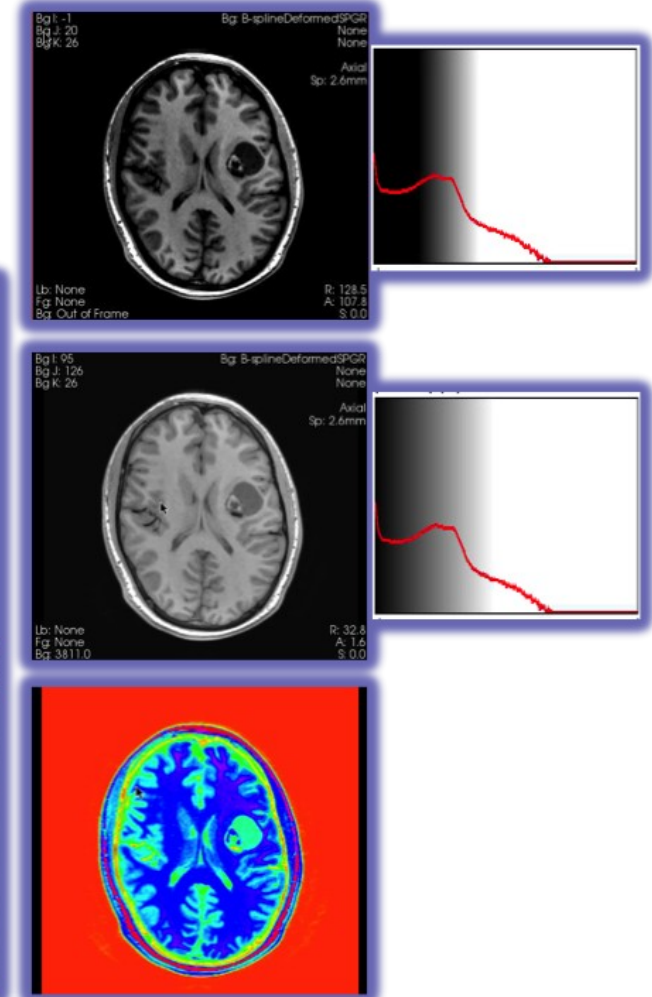
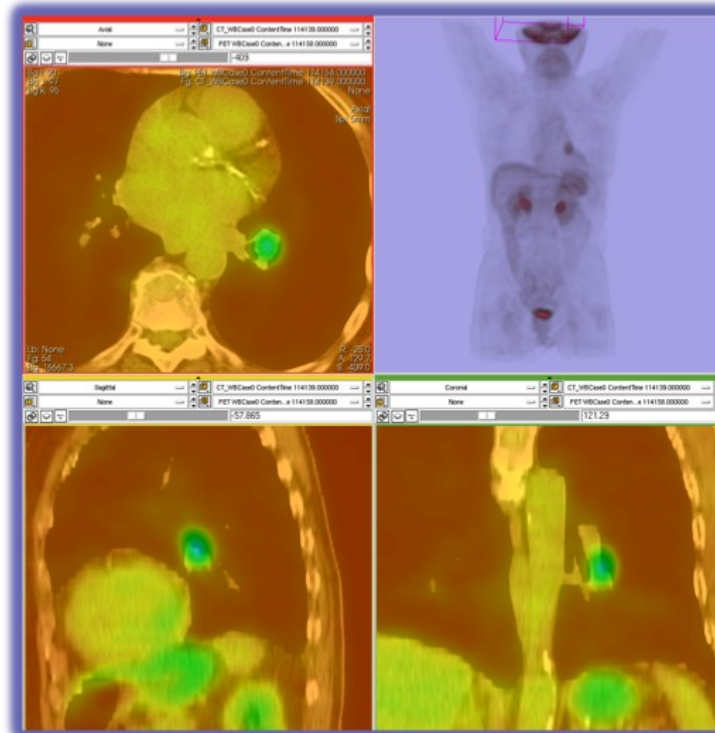
- Self guided tutorials
- Training events
- Registration and segmentation support





Basic Visualization

- Window/Level
- Corner Annotations
- Pseudocolor
- Mosaic
- Multi-modality





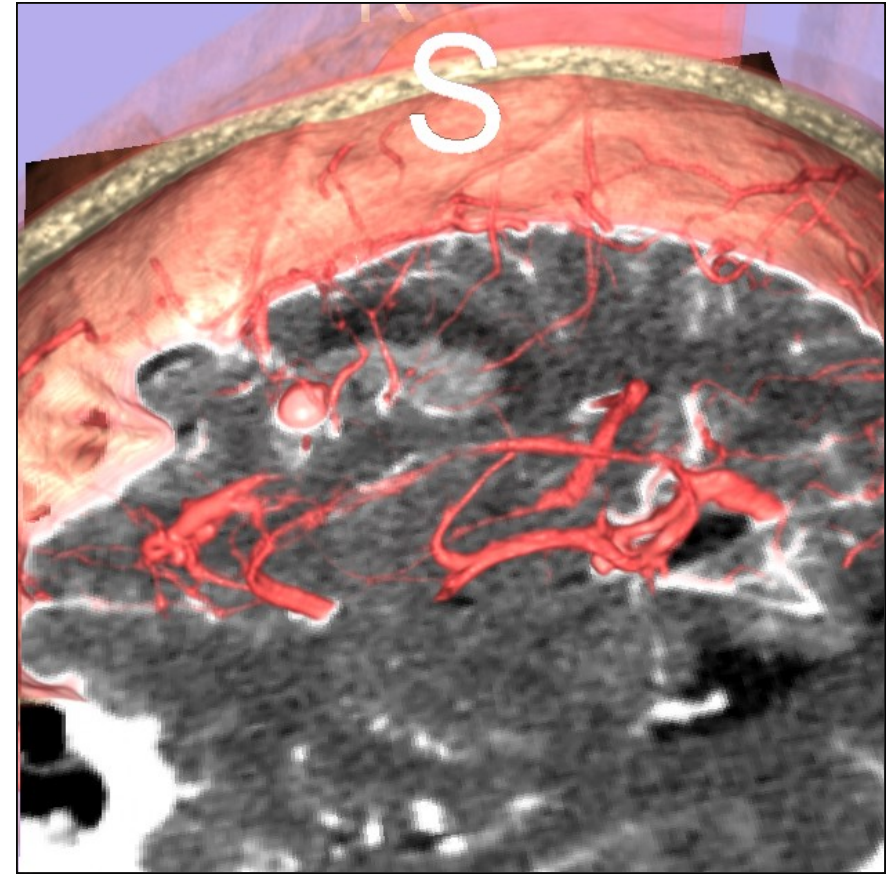
3D Visualization

Rendering techniques

- MIP (Maximum Intensity Projection)
- SSD (Shaded Surface Display)
 - Pseudocolor + Gradient Lighting
- Ray casting using transfer functions
 - Color and Opacity Transfer Functions
 - Composite display

Reference Labels for Standard Views

- Left/Right, Anterior/Posterior, Inferior/Superior



Volume rendered CT of a brain aneurysm with composited cross-section



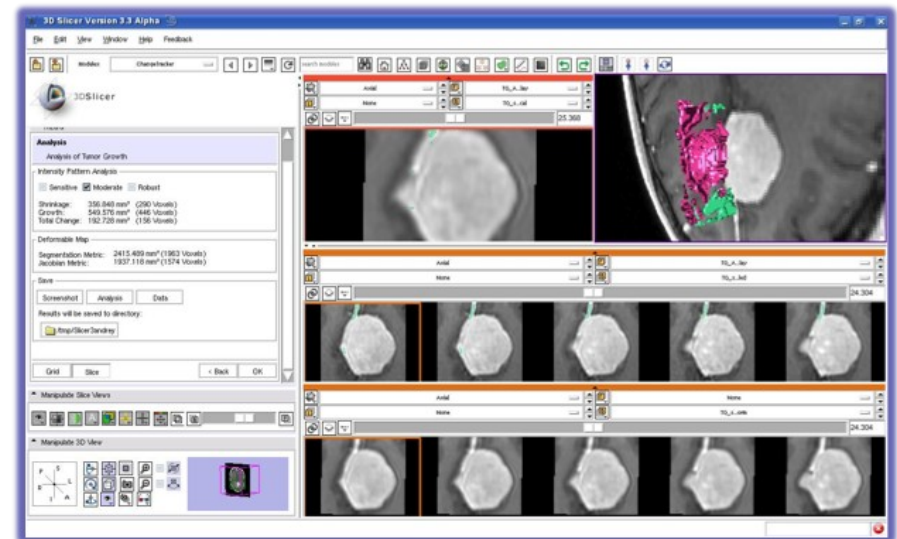
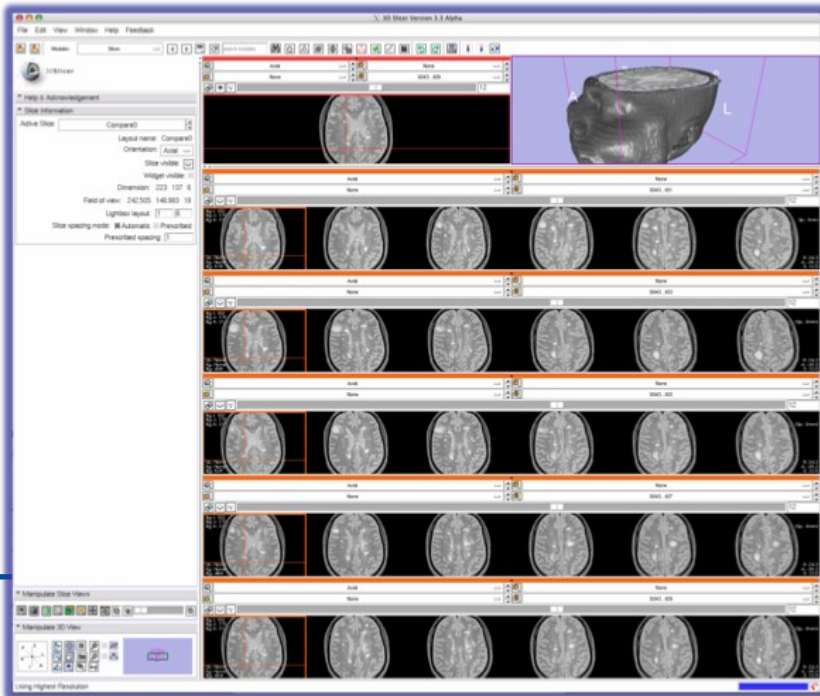
Longitudinal Imaging (4D)

Volumes Acquired Over Multiple Visits

Time-series (DCE) visualization and processing

Comparison View

- Linked Cursors
- Subtraction Imaging and Quantification



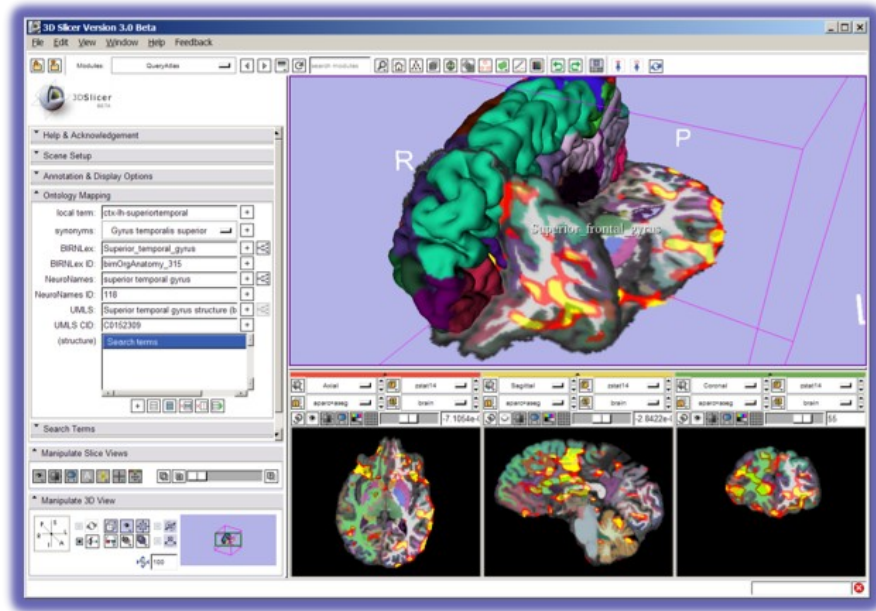
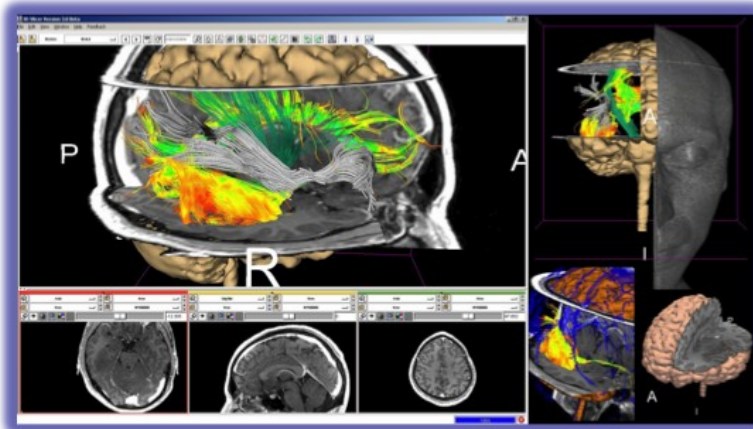


Multi-Modality Imaging

Integrated Visualization of What is Known About the Subject

- Anatomical Space as Common Coordinate System
- Segmented Anatomy and Volume Rendering for Context
- Statistics Volumes
- Interactive Visualization (View, Visibility, Cropping, Slicing...)

Image Guided Therapies





Registration

Intra-subject

- Pre-Intra-Post Procedure
- Longitudinal Tracking of Disease Progression

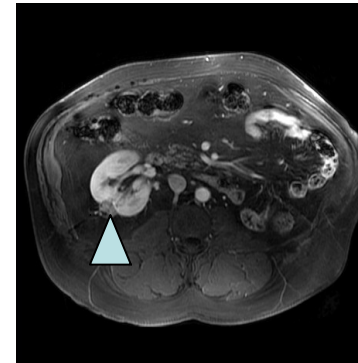
Inter-subject

- Support Group Comparison (fMRI)
- Map Anatomical Atlas to Individual

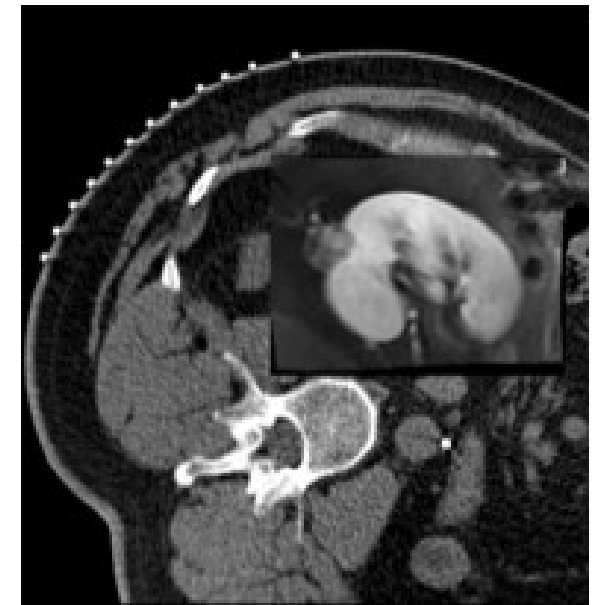
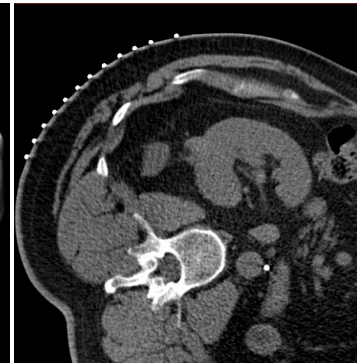
Degrees of Freedom (DOFs)

- Rigid (Rotation + Translation)
- Similarity (Rigid + Uniform Scale)
- Affine (Rigid + Nonuniform Scale and Shear)
- Polyaffine (Locally Affine Interpolation)
- B-Spline (Cubic Displacement)
- Vector Field

Preprocedure MR



Intraprocedure CT





Segmentation

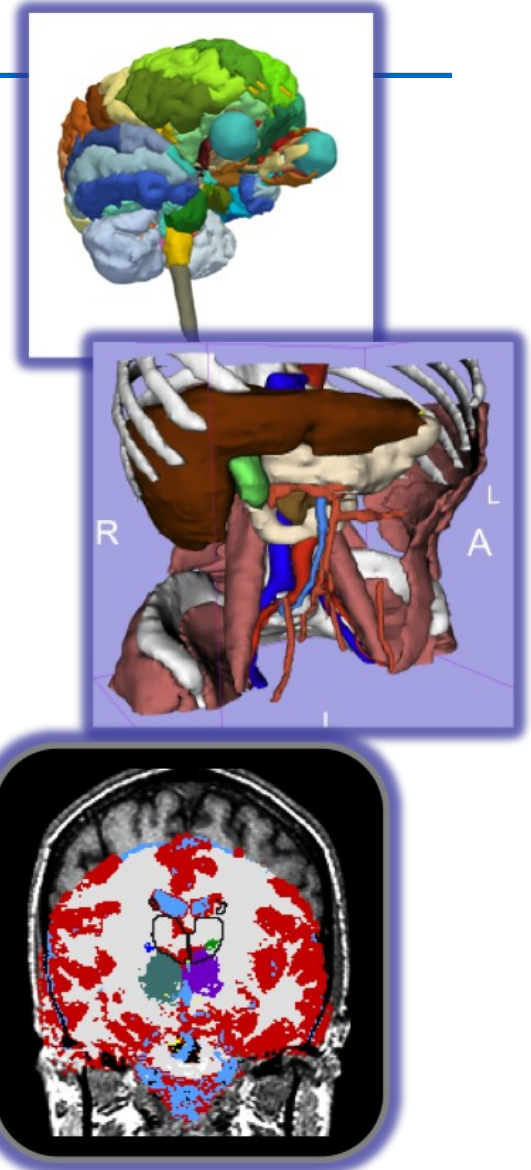
Definition: Assignment of Anatomical Labels to Image Regions

- Not an Exact Science
 - Anatomists Disagree
 - Definition Depends on Scale and Modality

Manual editing capabilities

Automated techniques

- Intensity Driven: Function of Image Measurements
 - Thresholding is Most Common (Typically Bad for MRI)
 - Level sets, “Grow Cut”
- Atlas Driven: Registration of Manually Labeled Data
 - Also difficult for clinical scans
- Hybrid Approaches Typically Required
 - E.g. Expectation Maximization (EM)





www.slicer.org



3DSlicer
Version 3.6

A multi-platform, **free and open source** software package for
visualization and **medical image computing**

[Download](#)[Tutorials](#)[Reference](#)[Feedback](#)

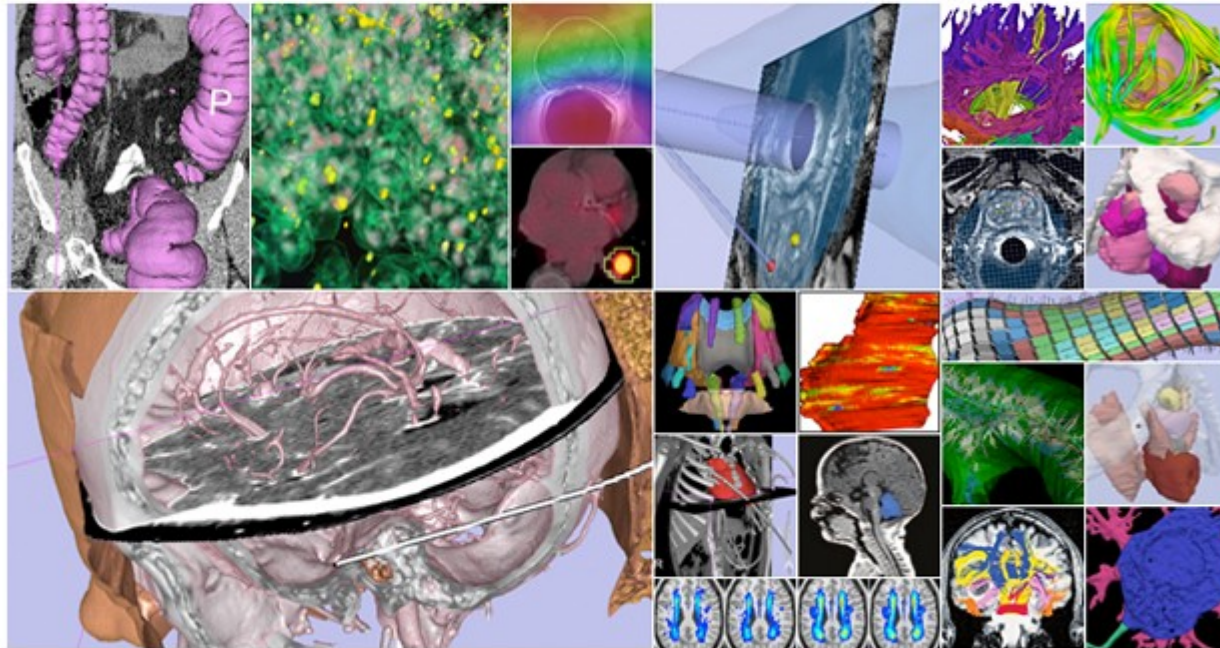
Slicer Wiki

About Slicer

- ▶ Introduction
- ▶ Acknowledgments
- ▶ Contact Us

Resources

- ▶ [Download](#)
- ▶ For Users
- ▶ For Developers
- ▶ Commercial Use
- ▶ NCIA
- ▶ Publication DB
- ▶ Image Gallery
- ▶ Slicer Community
- ▶ Source Code
- ▶ Licensing
- ▶ Mailing Lists
- ▶ Web Archive



Slicer version 3.6 has been released. Find out more...



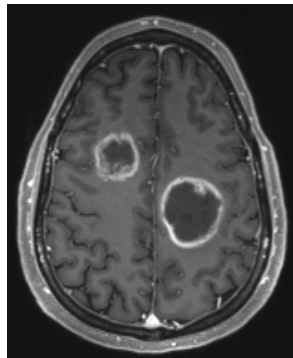
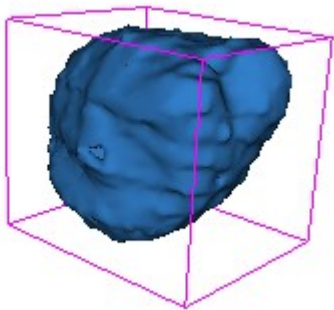
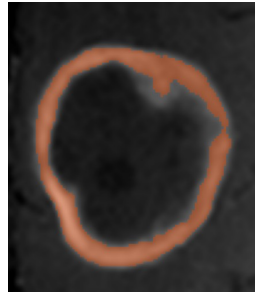
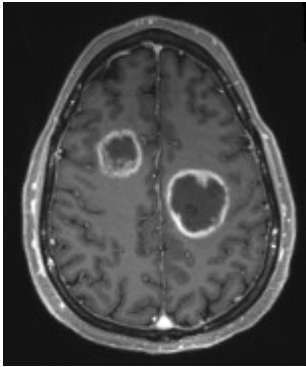
Slicer building blocks

- **Data**
 - What can I load/create in Slicer?
- **Presentation**
 - How can I explore my data?
- **Analysis**
 - How can I process my data?





Data



- Volumes
- Labels
- Transforms
- Models
-



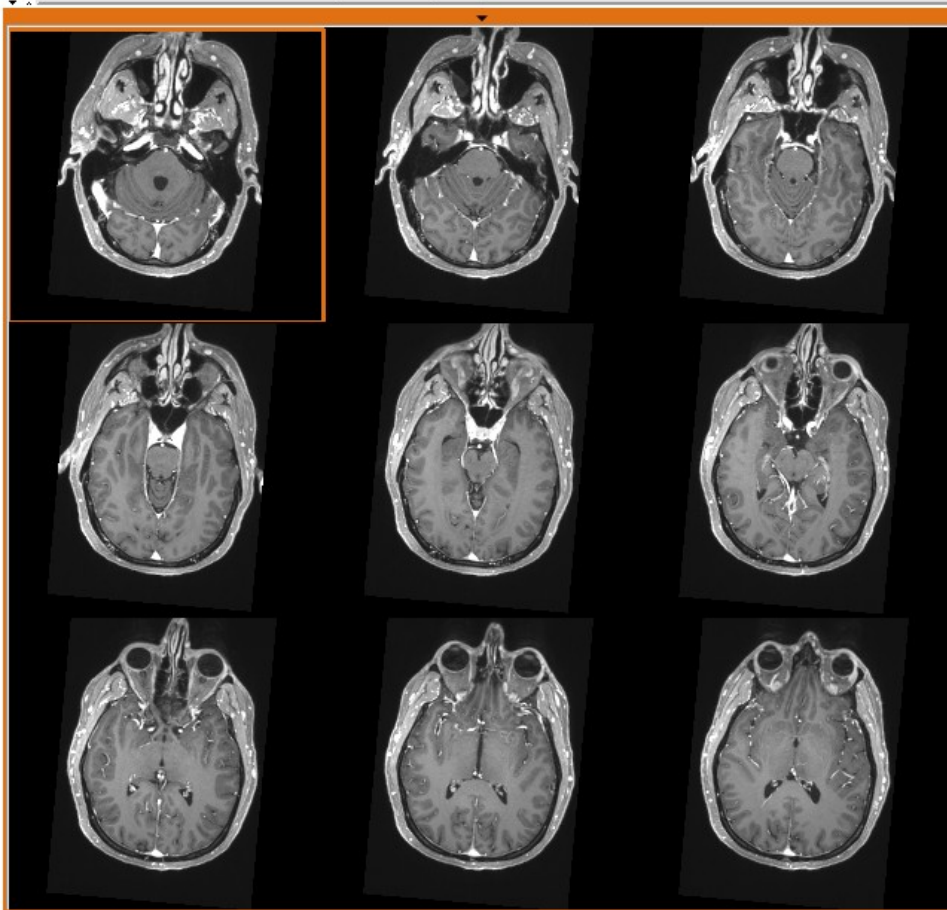
Presentation



- **Slice viewers**
 - Overlays
 - Color maps
 - Window/level
 - Annotations
 - Reformat
- Lightbox
- 3D viewer
- Layouts



Presentation

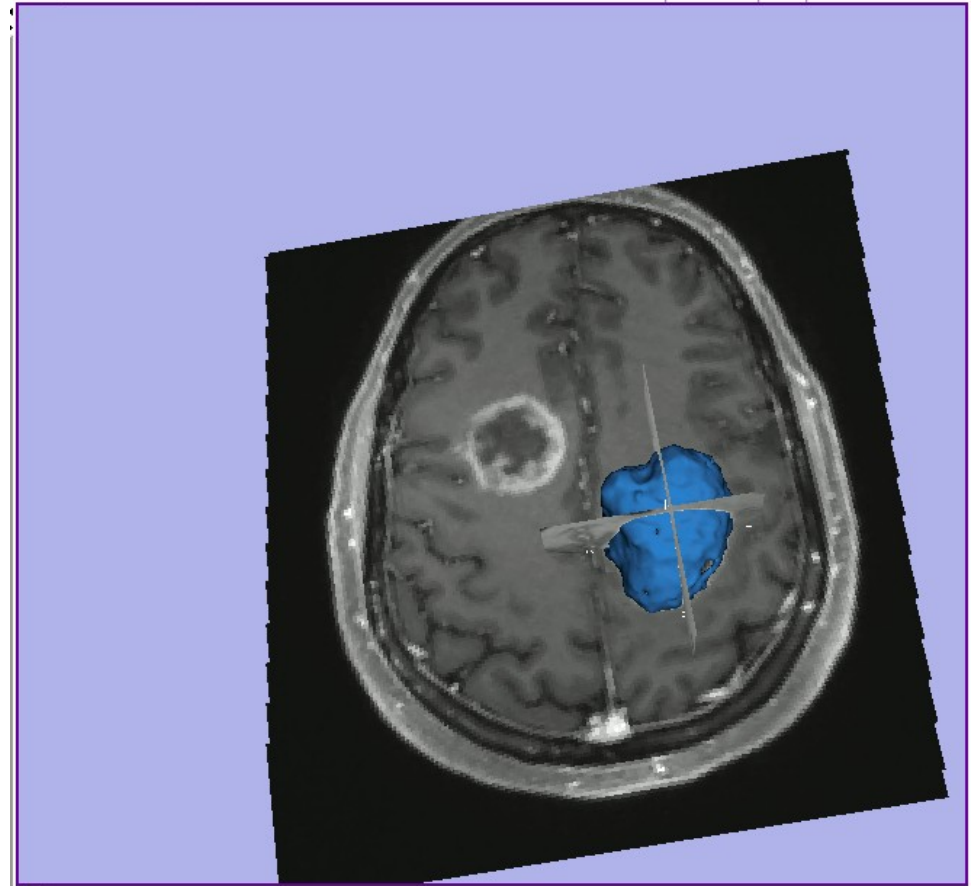


- Slice viewers
- **Lightbox**
- 3D viewer
- Layouts



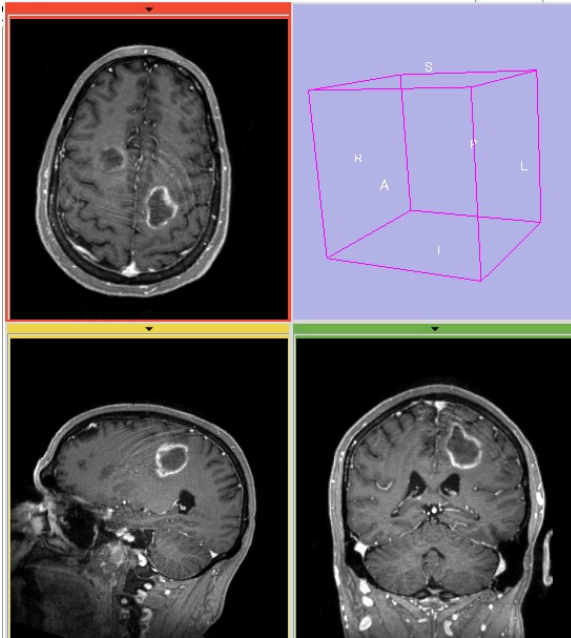
Presentation

- Slice viewers
- Lightbox
- **3D viewer**
- Layouts

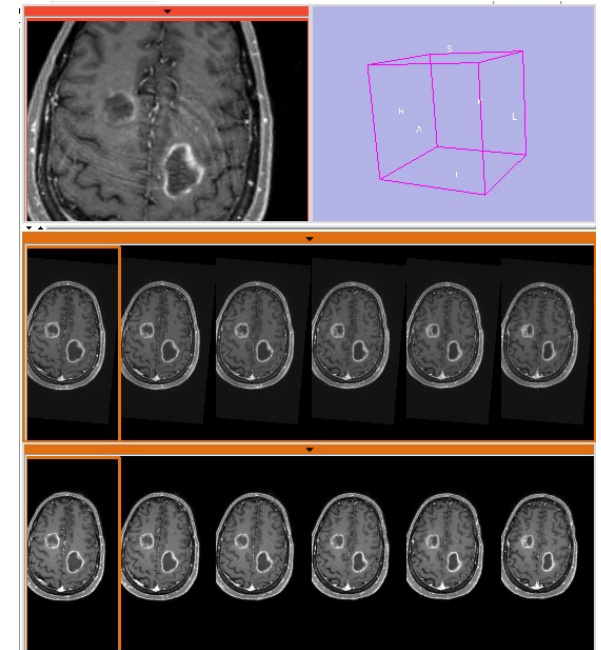




Presentation



- Slice viewers
- Lightbox
- 3D viewer
- **Layouts**





Putting it all together



<http://www.brickartist.com/>



Slicer Scene = data + presentation

Slicer Scene is saved as a .mrml file
MRML = Medical Reality Markup Language



Scene snapshots

- Recorded scene configurations customized for a specific task

