NA-MIC Overview

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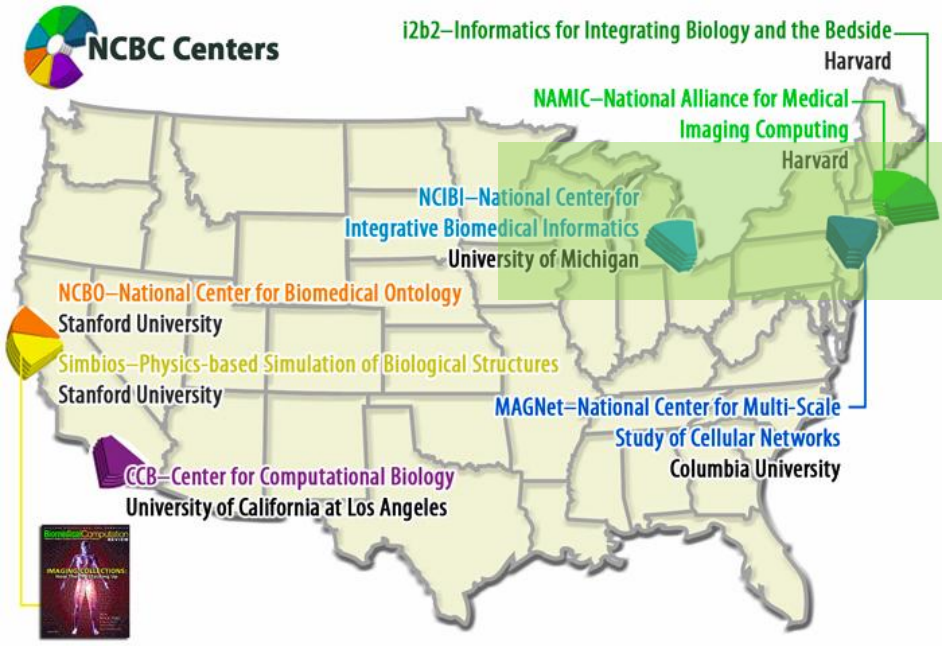
Harvard University, Boston USA

What is NA-MIC

- National Alliance for Medical Image Computing
  - www.na-mic.org
- P.I: Prof. Ron Kikinis

  Director, Surgical Planning Laboratory
- NIH Funded Center
  - National Center for Biomedical Computing (NCBC)
  - www.ncbcs.org



Slide courtesy of Ron Kikinis, MD

NA-MIC's Focus

- Medical Image Computing for personalized medicine
  - Run on your computer
  - Fast processing (clinical research)
  - Subject-specific analysis (pathology)

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Slide courtesy of Ron Kikinis, MD

Our Approach

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

Picture courtesy Gabor Fichtinger

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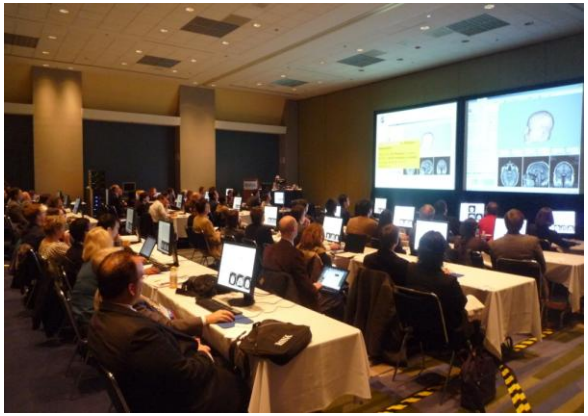
Slide courtesy of Ron Kikinis, MD

Open Community Process

- Participation from
  - Multiple institutions
  - Different disciplines



- Open to all: academia, industry, government, international
- Focused workshops (Diffusion MRI, Image-Guided Therapy)

Slide courtesy of Ron Kikinis, MD

NA-MIC Bi-Annual Project Week

Winter: Salt Lake City, Utah, USA

Summer: MIT, Cambridge MA, USA

Photo from the NA-MIC 10th Project Week – June 21-25, 2010

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The NA-MIC Software ToolKit

Free Open Source Software (FOSS)

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The 3D Slicer

- 3D Slicer is our primary platform for delivering image computing technology for personalized medicine research
- 3D Visualization and post - processing
  - Basic and clinical visualization
  - Longitudinal imaging
  - Registration
  - Segmentation

Slide courtesy of Ron Kikinis, MD

The 3D Slicer History

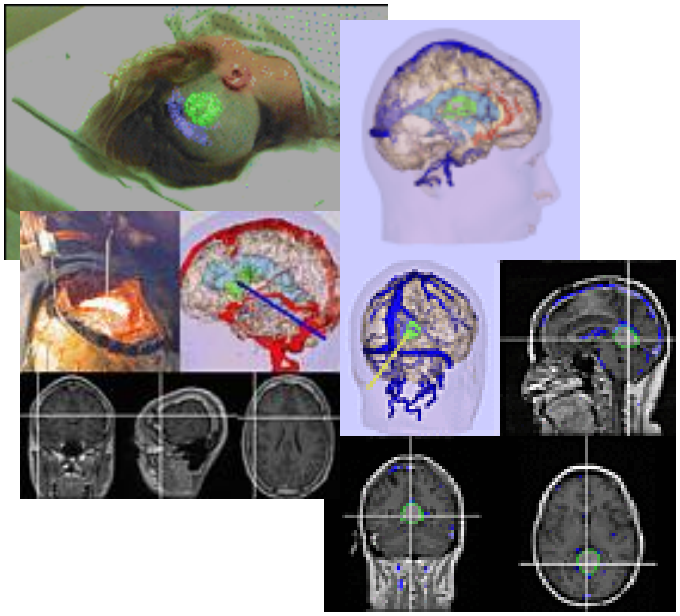

Image Courtesy of the CSAIL, MIT

- Started in 1997 between the Surgical Planning Lab (Harvard) and the CSAIL (MIT)

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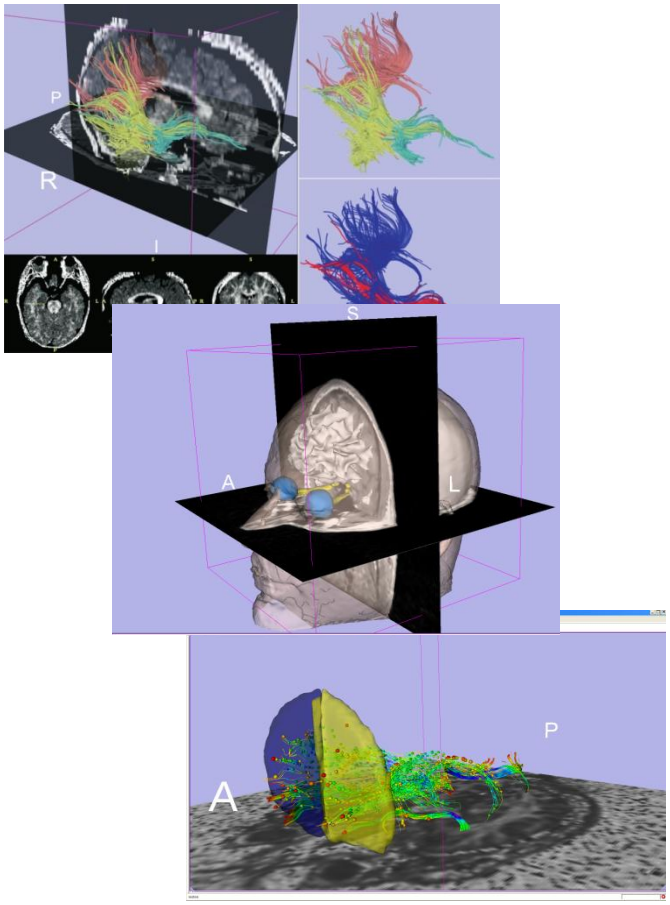
3D Slicer History



- Started in 1997 between the Surgical Planning Lab (Harvard) and the (CSAIL) MIT
- 2010: Multi-institution effort to share the latest advances in image analysis with clinicians and scientists
- 2.8 million lines of code

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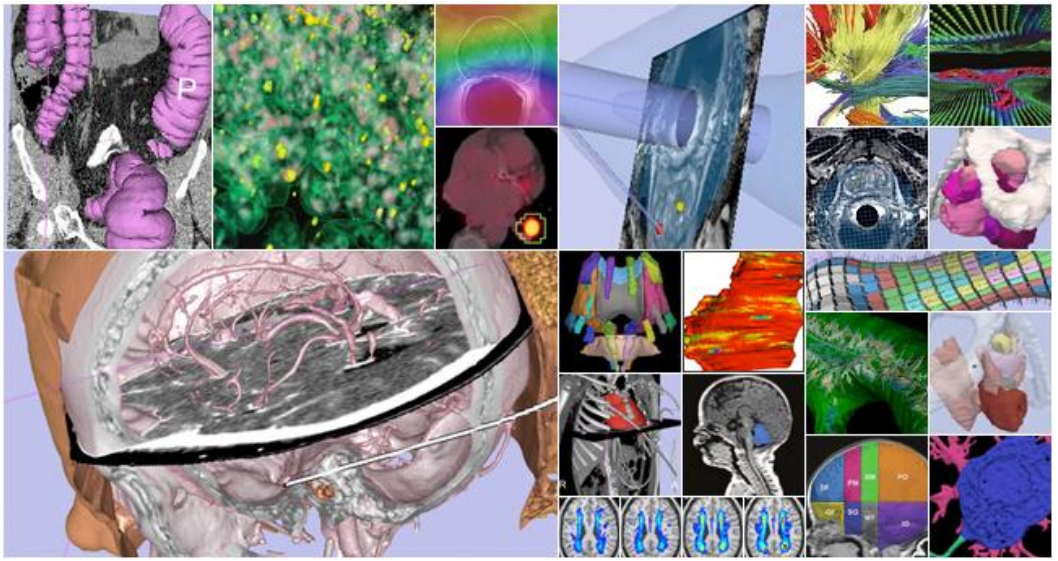
Slicer3.6 release version

- An end-user application for image analysis available on Mac, Linux and Windows



- An open-source environment for software development

- A software platform that is both easy to use for clinical researchers and easy to extend for programmers

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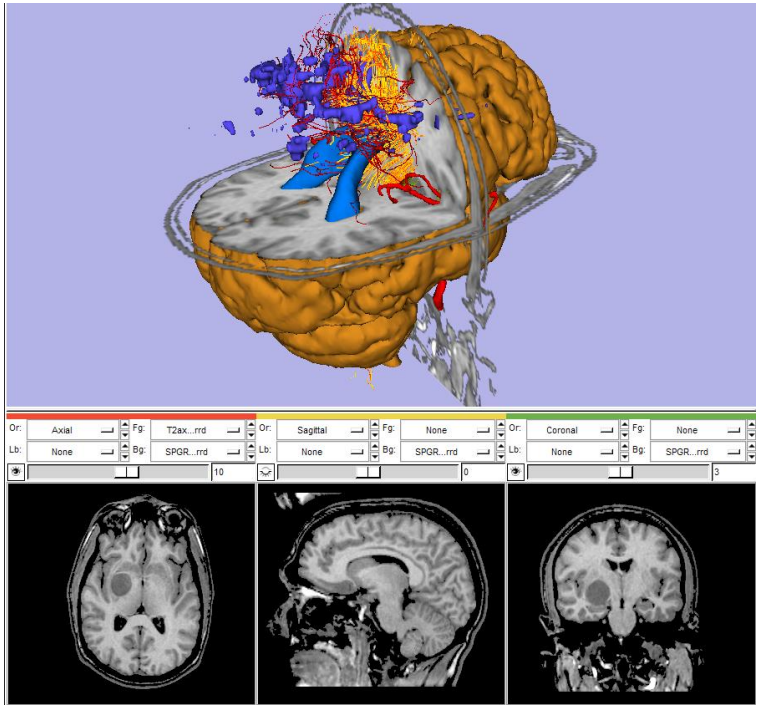
Three ways to use the NA-MIC kit

The NA-MIC kit from three user perspectives

- Clinical researchers
- Biomedical engineers
- Algorithm developers



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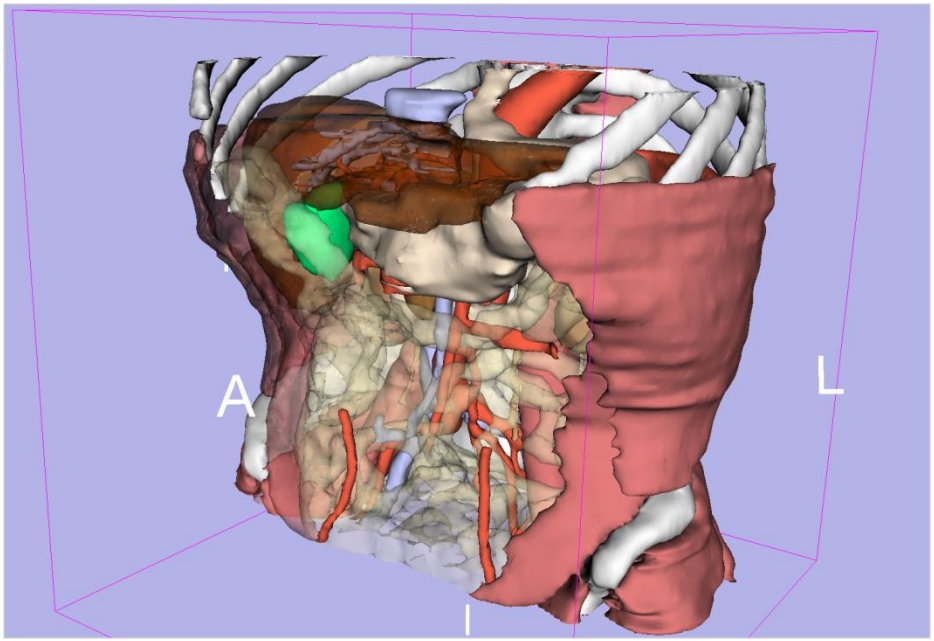
Clinical researchers



Interact in 3D to enhance data interpretation

Visualize

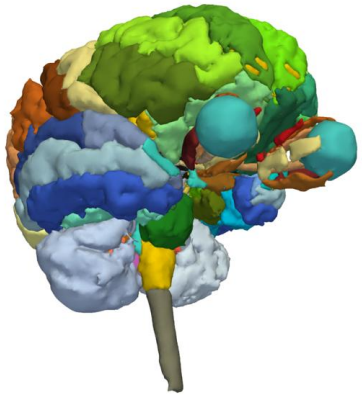
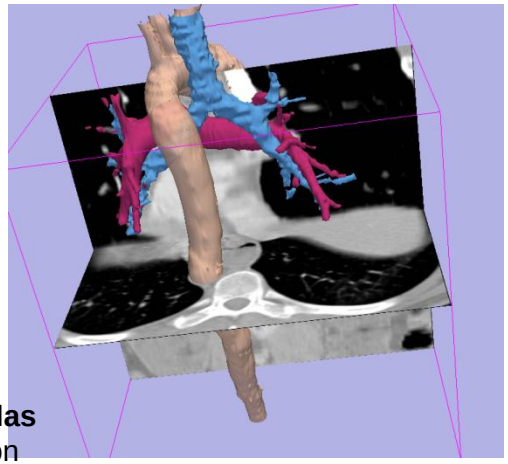
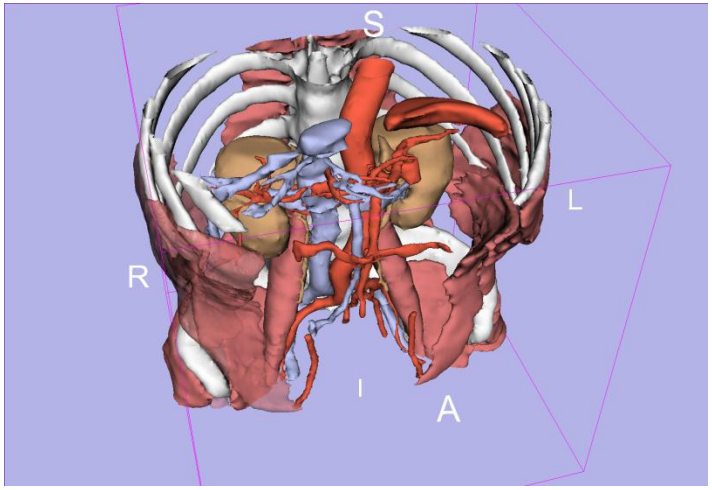


Image from the SPL-PNL Brain Atlas
Talos IF, Jakab M, Kikinis R, Shenton ME





- User-driven views of anatomical structures
- Overlay between 2D grey-levels images and 3D anatomical structures
- Intuitive interaction with the 3D models

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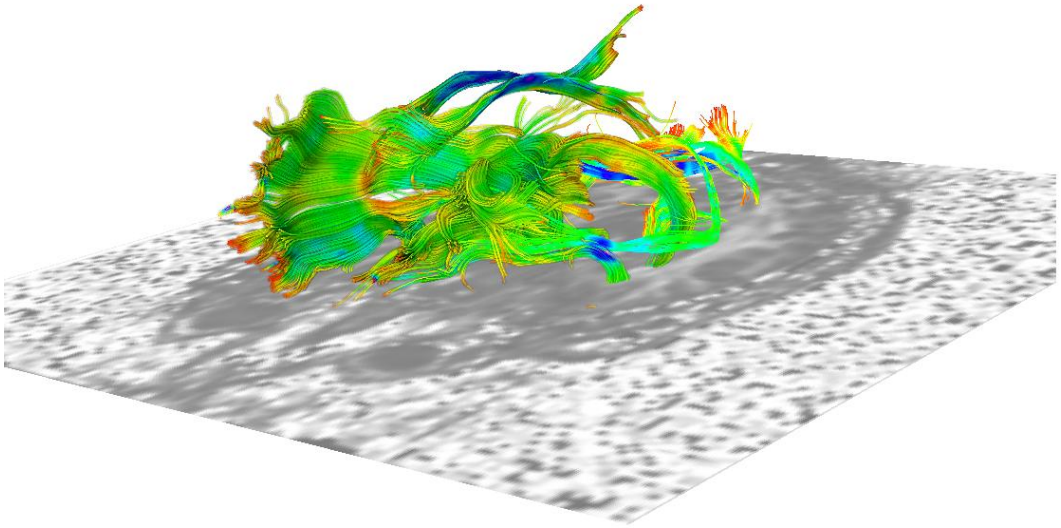
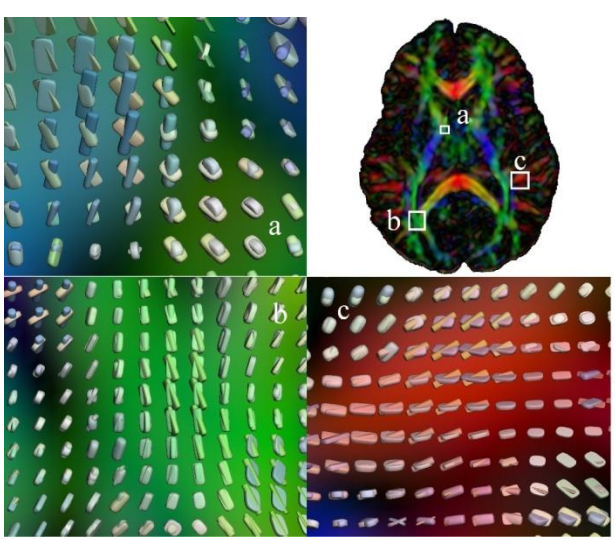
Biomedical Engineers



Extract relevant information from complex data

Analyze



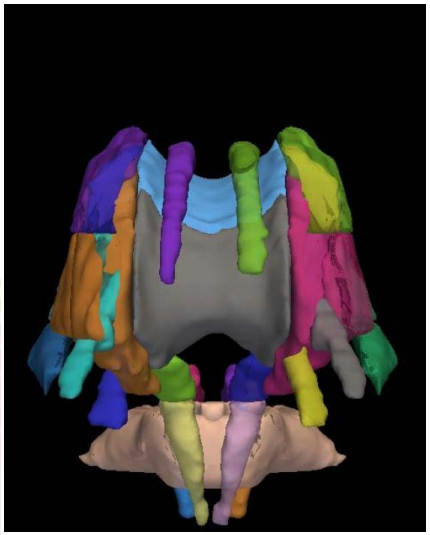
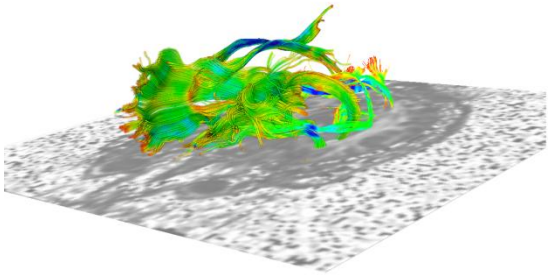
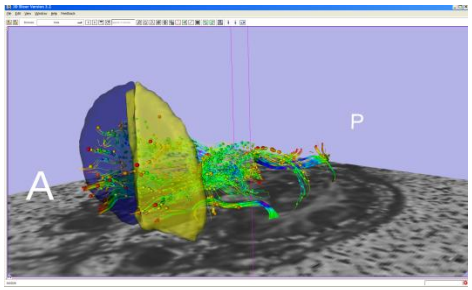


Image courtesy of Mahnaz Maddah, MIT

- Advanced analysis of complex data
- Multimodal data fusion





- Clinical parameters extraction

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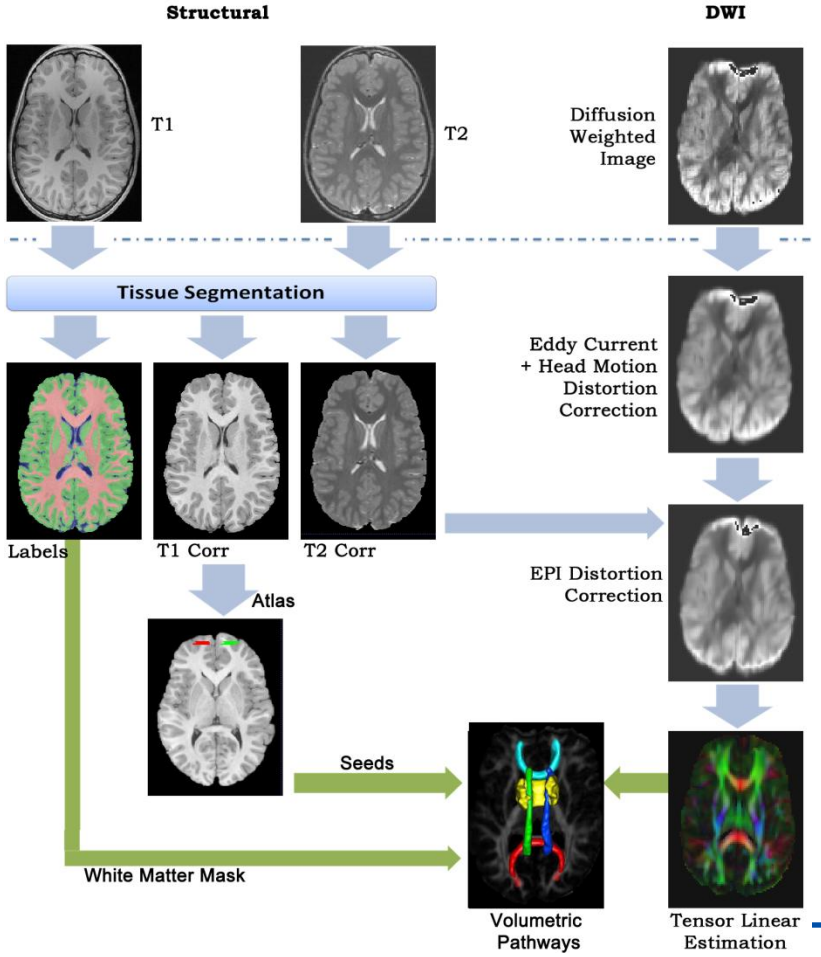
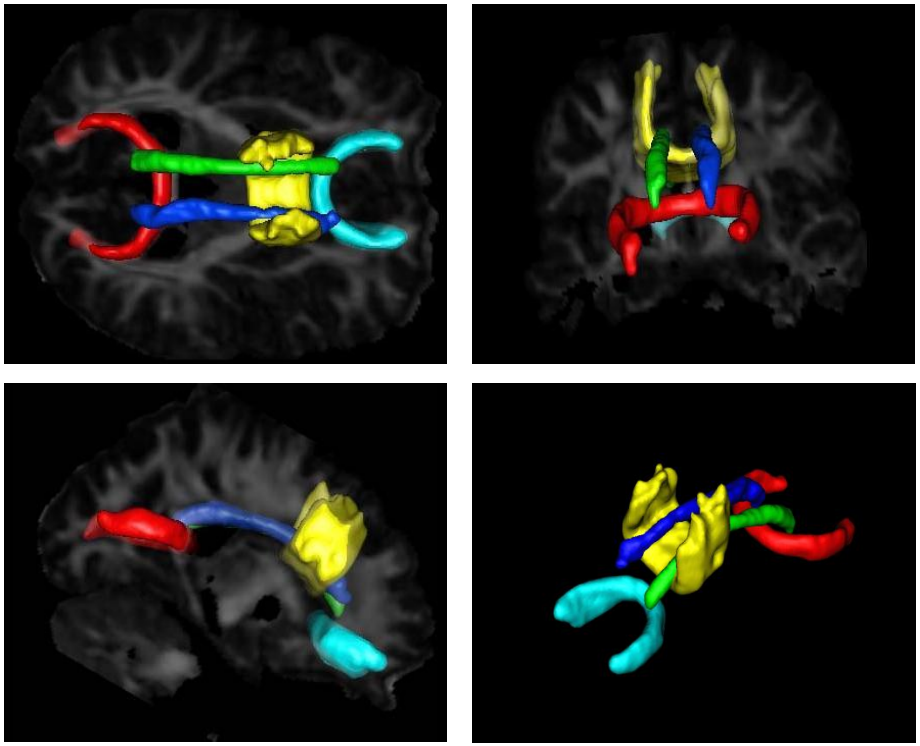
Analyze

Statistical Analysis of Anatomy from Medical Images





Courtesy of Tom Fletcher, University of Utah.

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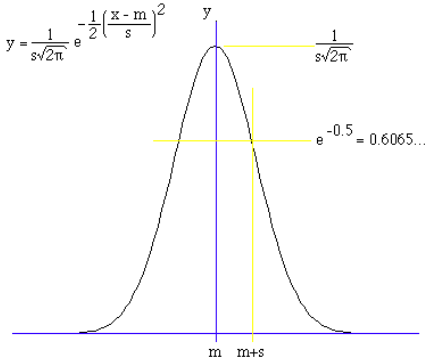
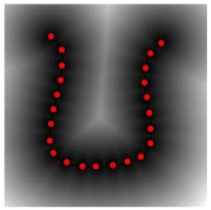
Algorithm Developers

$$\ln p(X \mid \pi, \mu, \Sigma) = \sum_{n=1}^{N} In \{ \sum_{k=1}^{K} \pi_k N(x_n \mid \mu_k, \Sigma_k) \}$$

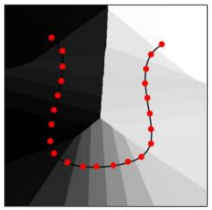


$$p_j^{(k)} = \frac{\sum_{i:D_{ij}=1} W_i^{(k-1)}}{\sum_i W_i^{(k-1)}}$$

$$q_j^{(k)} = \frac{\sum_{i:D_{ij}=0} \left(1 - W_i^{(k-1)}\right)}{\sum_i \left(1 - W_i^{(k-1)}\right)}.$$



(a)

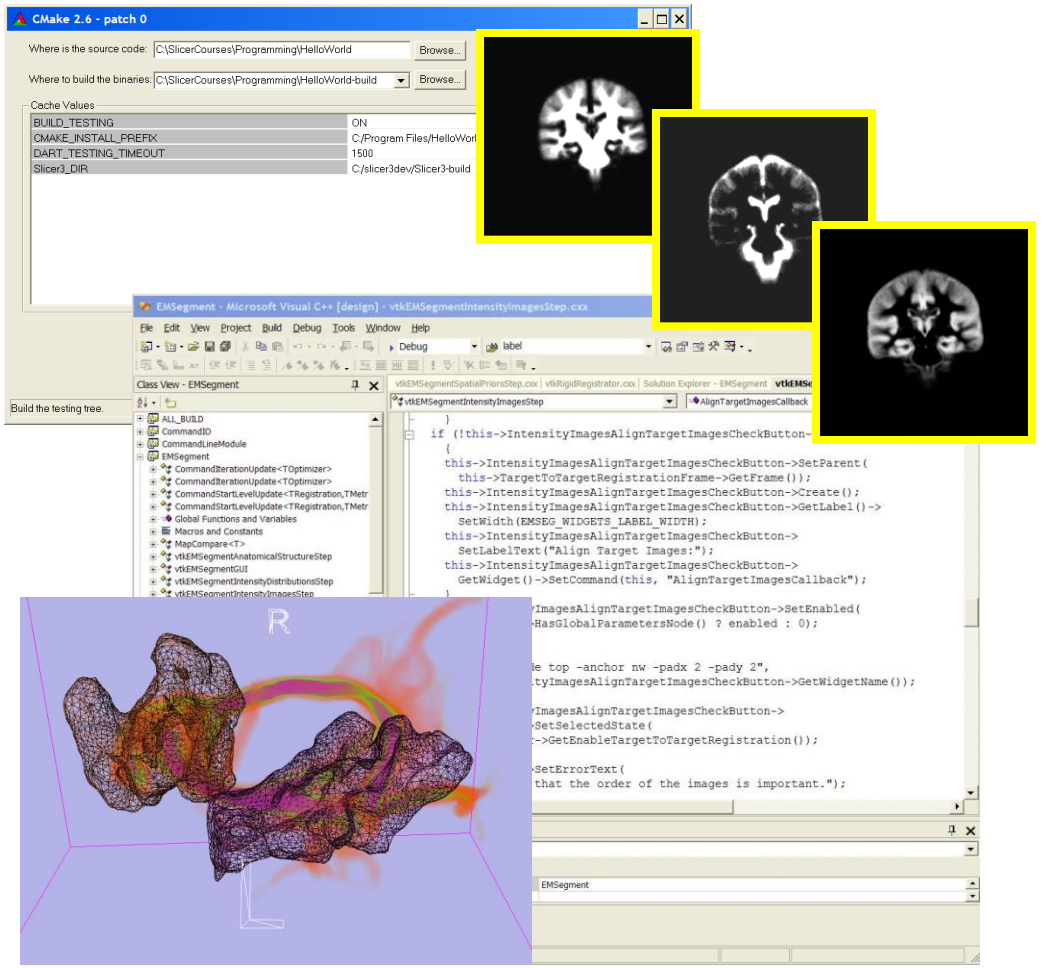


(b)

```
#include "itkDiscreteGaussianImageFilter.h"
int main ( int argc, char * argv[])
{
      PARSE_ARGS;
       typedef itk::Image< short,  3 >   ImageType;
       typedef itk::ImageFileReader< ImageType  >  ReaderType
       typedef itk::ImageFileWriter< ImageType >  WriterType;
       ReaderType::Pointer reader = ReaderType::New();
       WriterType::Pointer writer = WriterType::New();
       reader->SetFileName( FilterInputVolume.c_str() );
       writer->SetFileName(FilterOutputVolume.c_str());
       typedef itk::DiscreteGaussianImageFilter <ImageType,  ImageType> FilterType;
       FilterType::Pointer filter = FilterType::New();
```

Develop plug-ins to extend image analysis capabilities

Create



- Integrate external executables with the Slicer3 platform
- Develop plug-ins in C++, Tcl or Python
- Build upon the NA-MIC kit to meet your scientific goals

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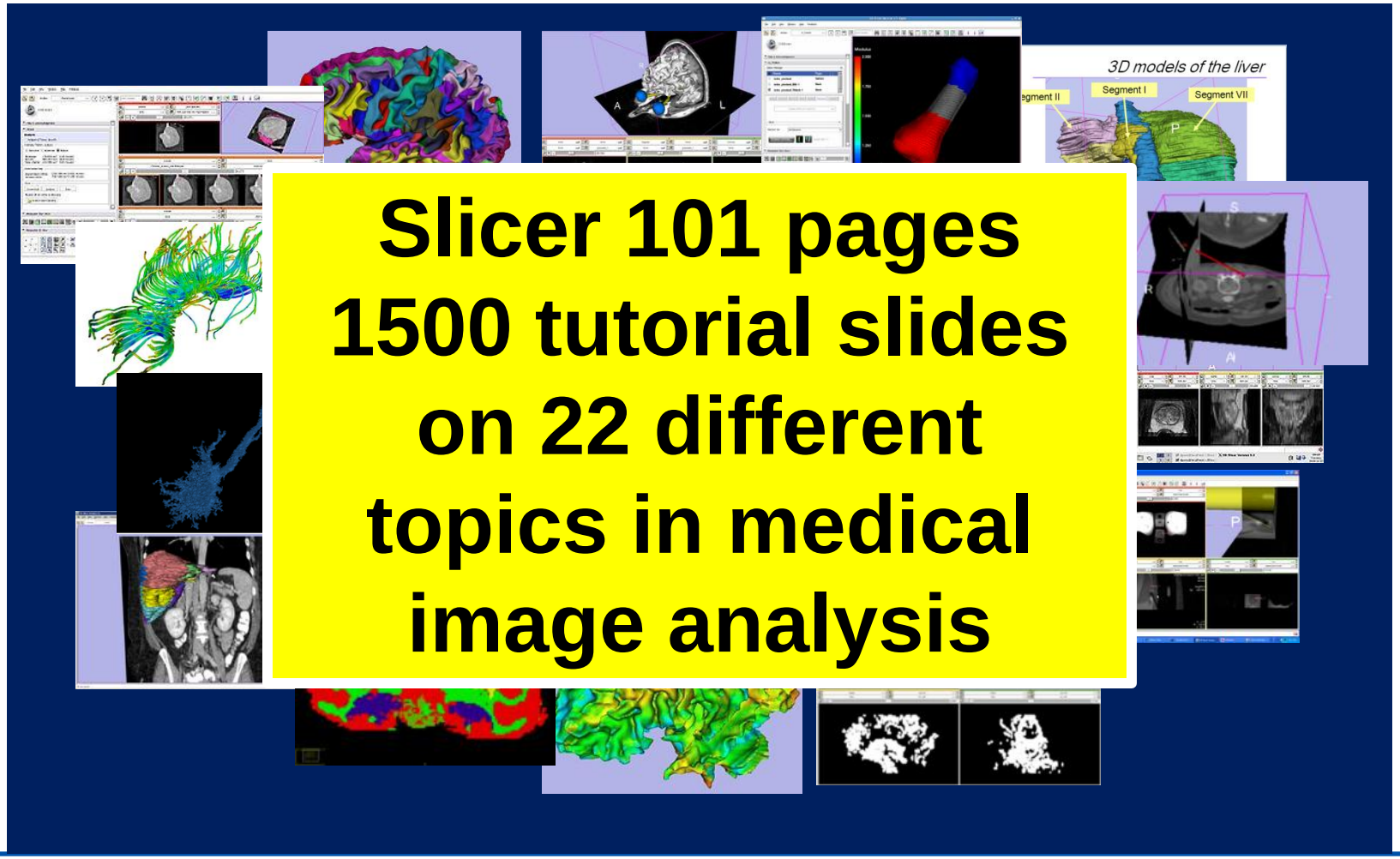
Clinical researchers
Biomedical engineers
Algorithm developers

Translate techniques into skills

NA-MIC Compendium



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NA-MIC Workshops

2005-2010: More than 1,000 scientists and clinical researchers trained by NA-MIC

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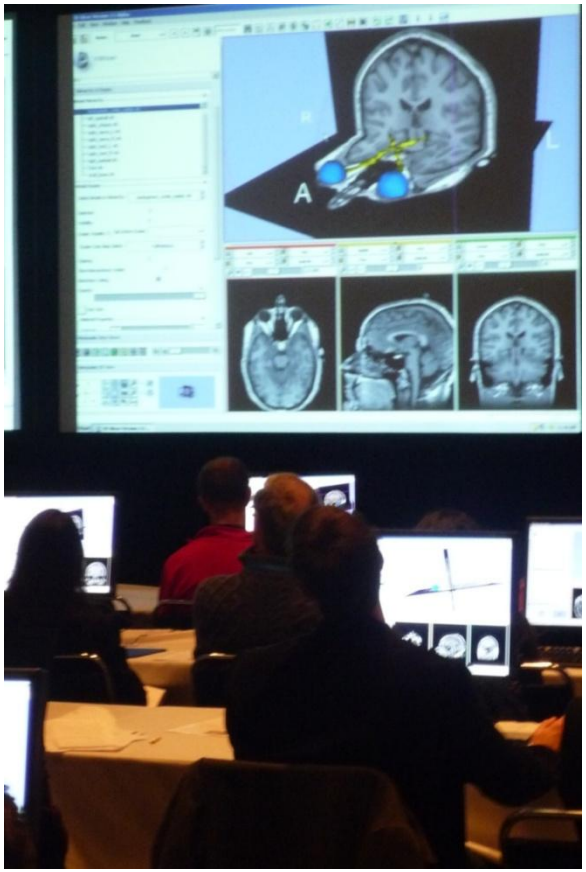
Slicer: A Technology Delivery Platform



- Integrated solution for delivering technological breakthroughs to the clinical research community
- Practical aspects: Open-source and available on all major computer platforms

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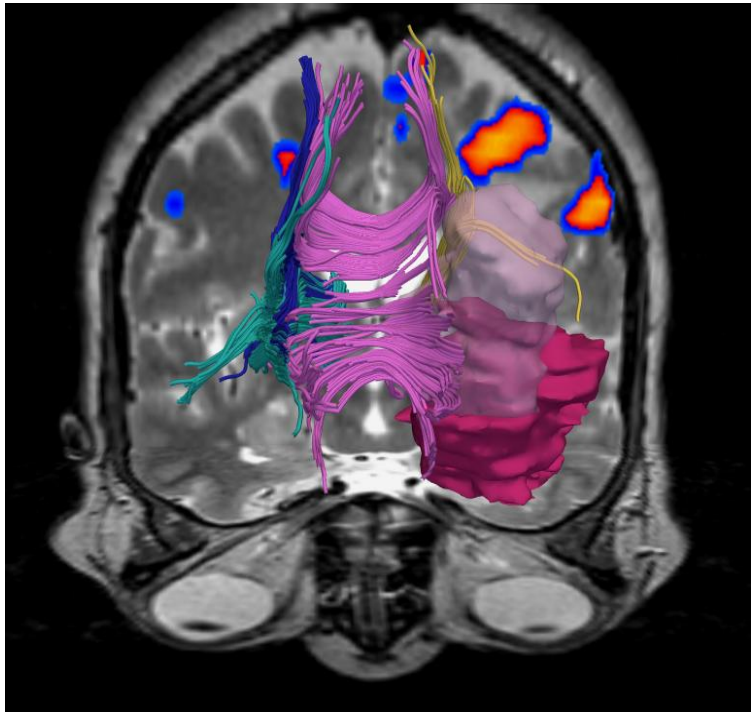
Slicer in Image Guided Therapy

- To facilitate application of state-of-art medical image processing in IGT
- Extension of open source concepts to IGT, including hardware



National Center for Image-Guided Therapy, www.ncigt.org

Surgical Navigation and Robotics Laboratory

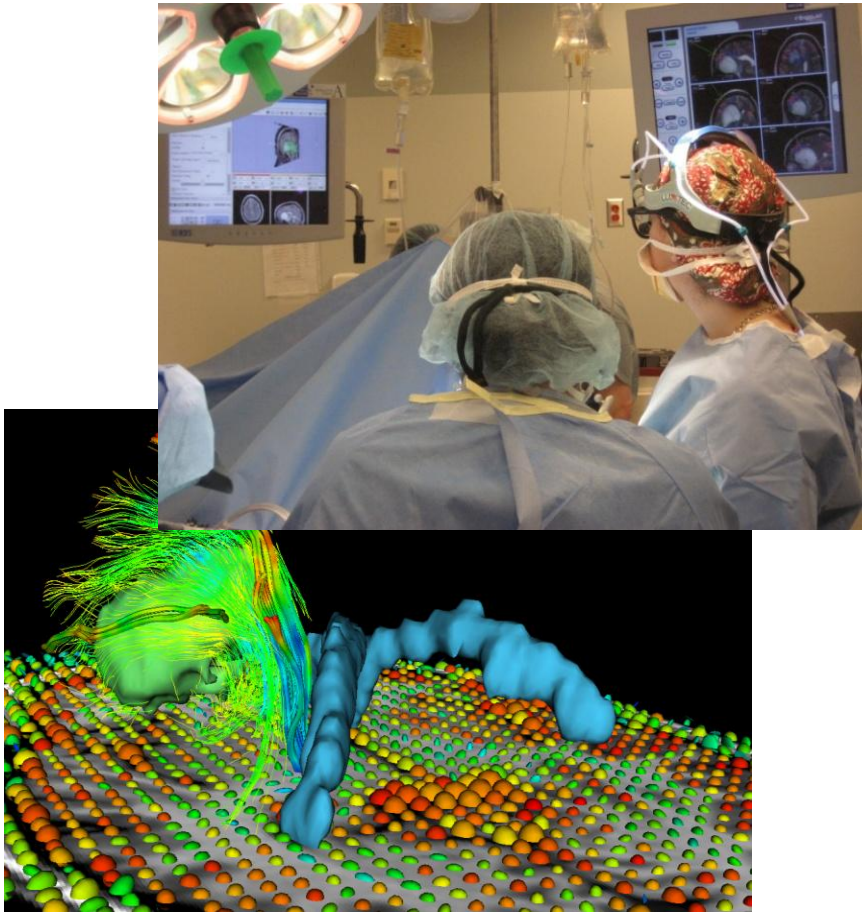
Intelligent Surgical Instrument Project, Japan

 © 2010, ARR

Slicer courtesy of Noby Hata

Example: Clinical Case Image Guided Neurosurgery

- **Patient specific analysis**
  - Where are important structures in the vicinity of the tumor?
  - Grey matter function, white matter tracts
  - Research in a clinical setting



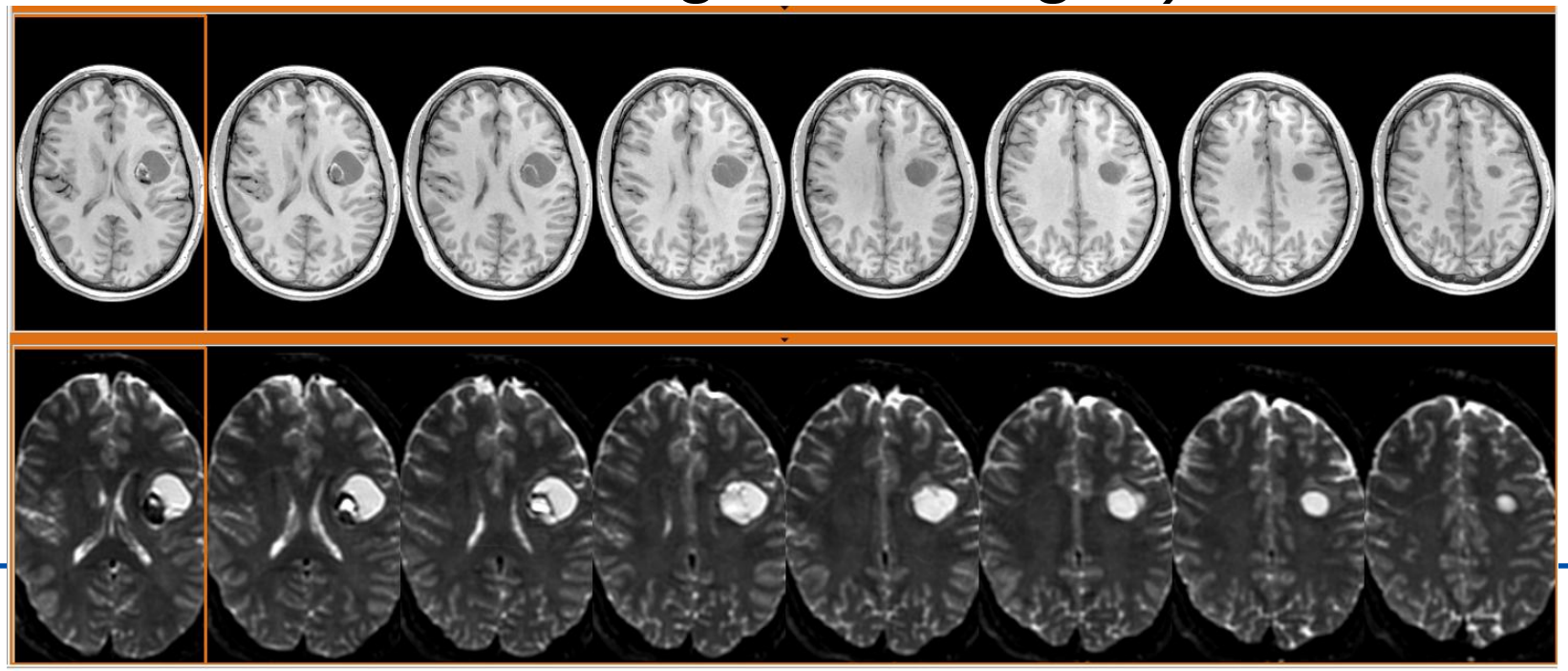
Golby, Pieper, Lemaire, BWH Neurosurgery

Slide courtesy of Ron Kikinis, MD

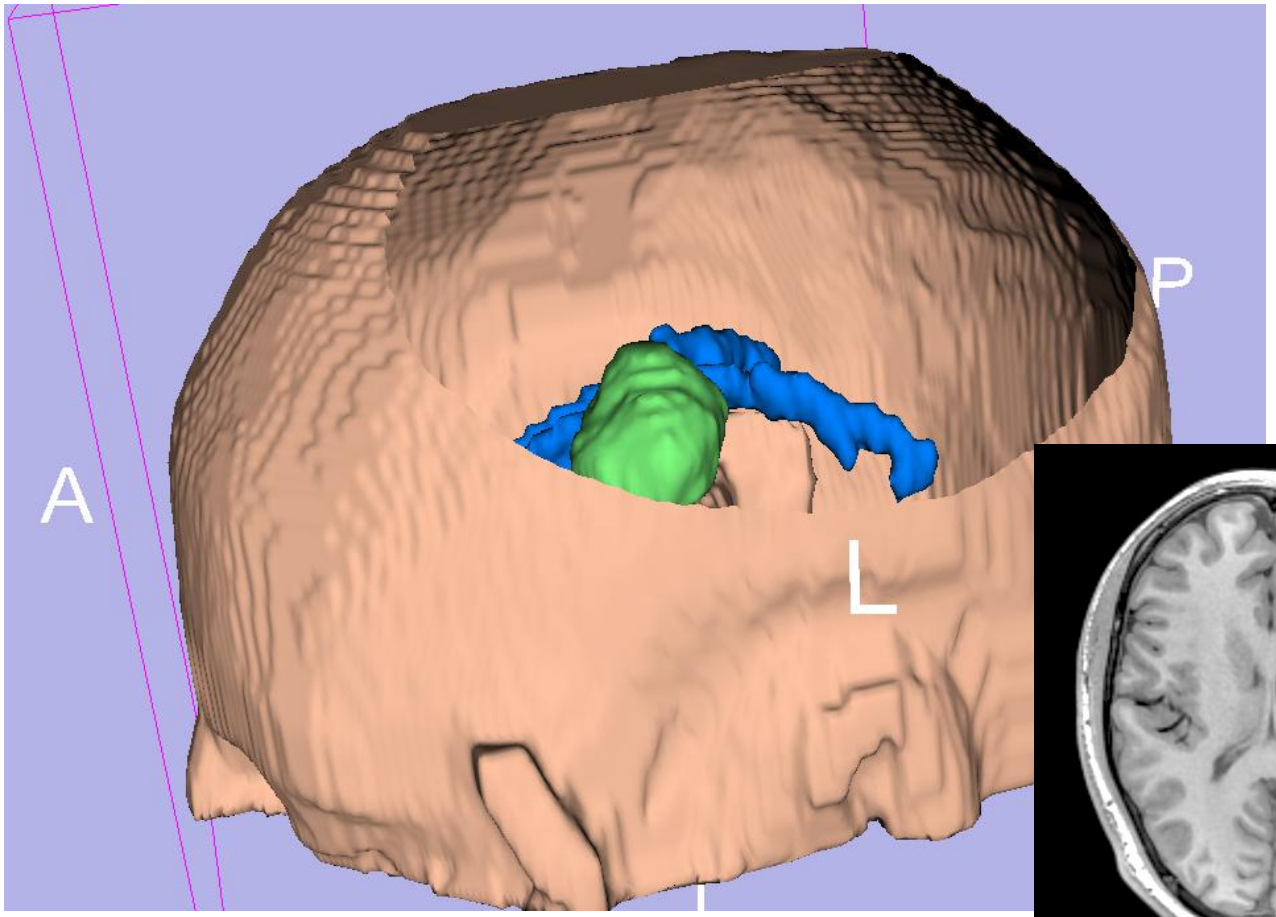
Example: A Clinical Case

- Right handed male patient, 20 years old
- Scan of the head after sport trauma (

MR T1 and T2 Weighted images)

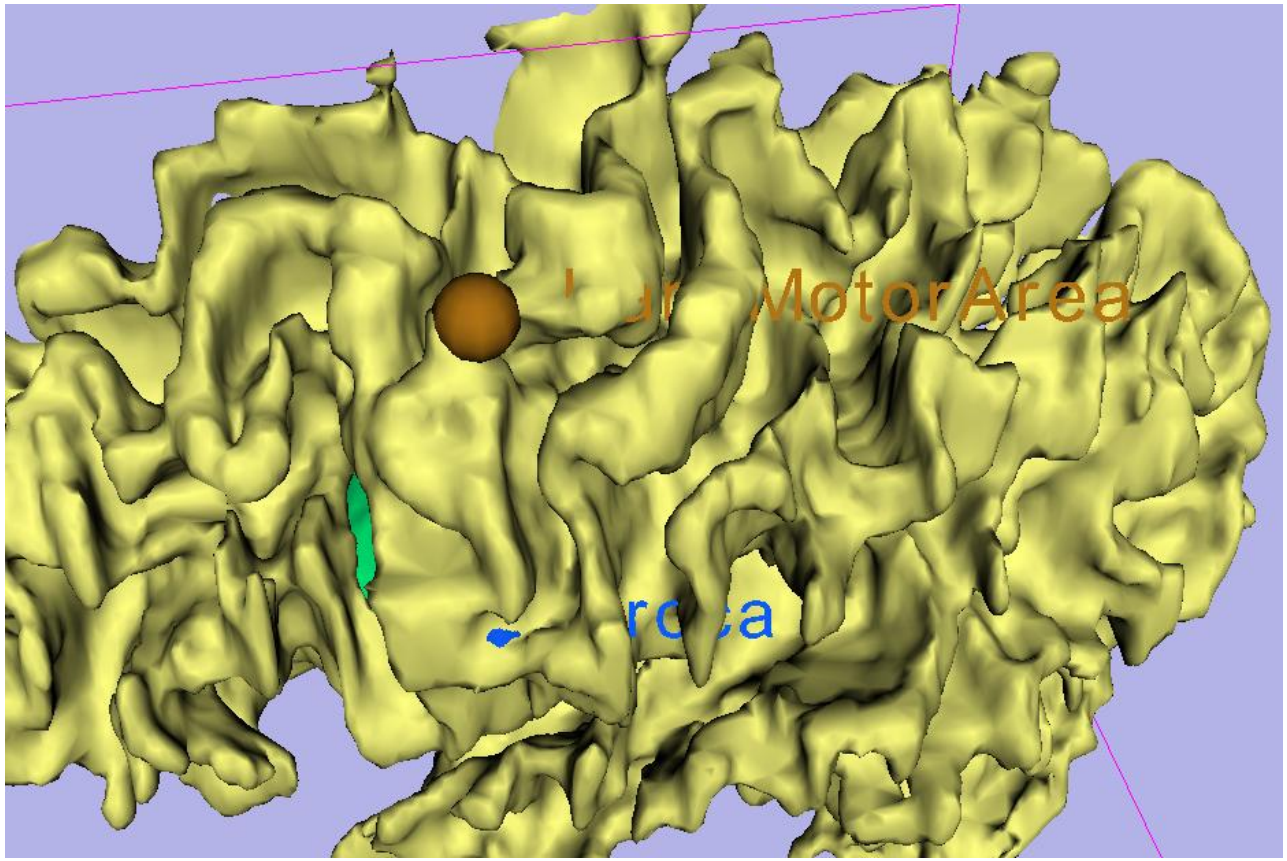


A Clinical Case: Overview



Slide courtesy of Ron Kikinis, MD

A Clinical Case: White Matter



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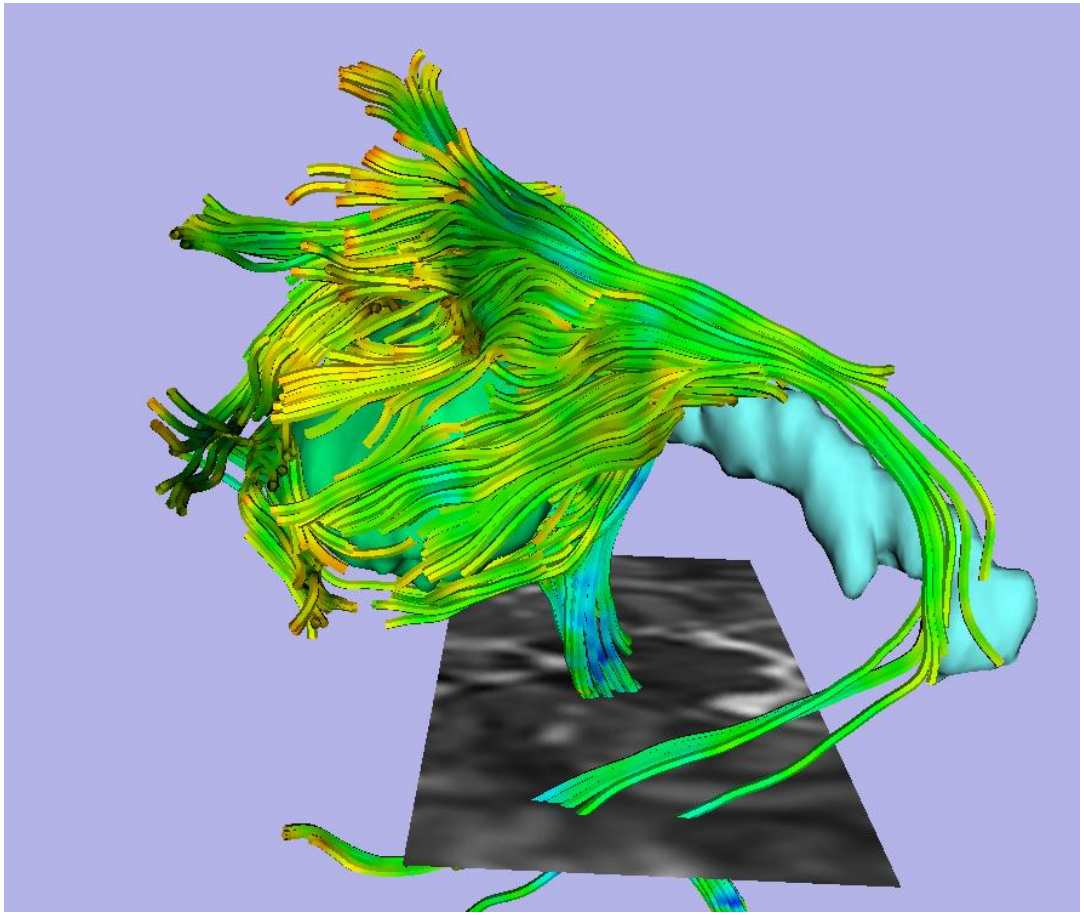
A Clinical Case: Peritumoral Tracts



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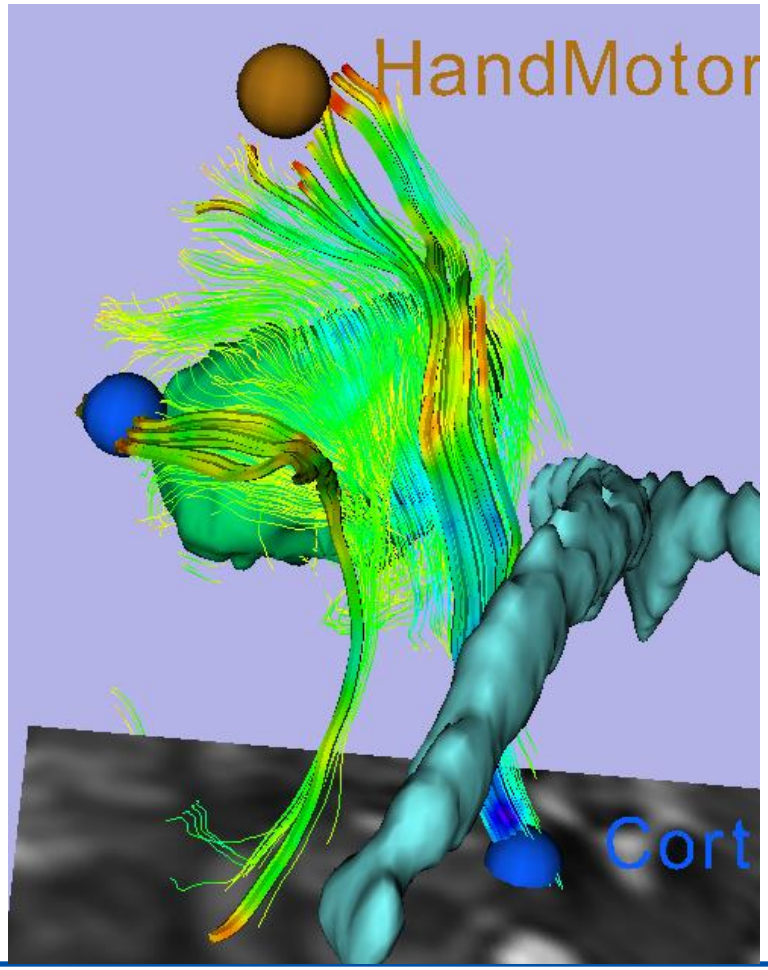
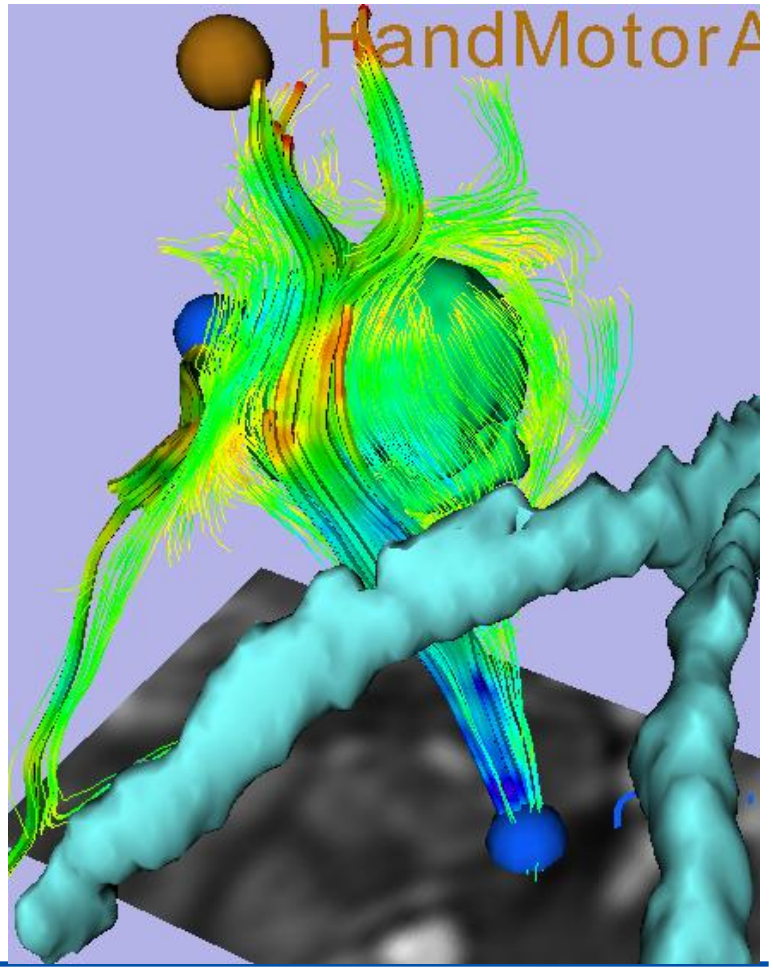
A Clinical Case: Virtual Probing





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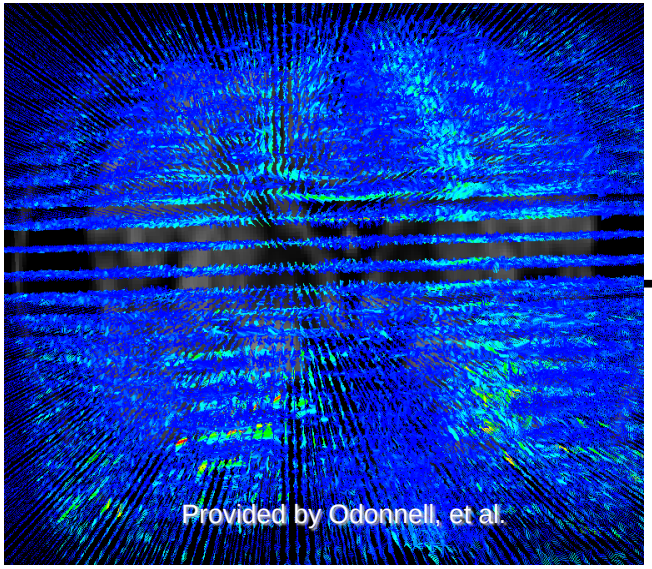
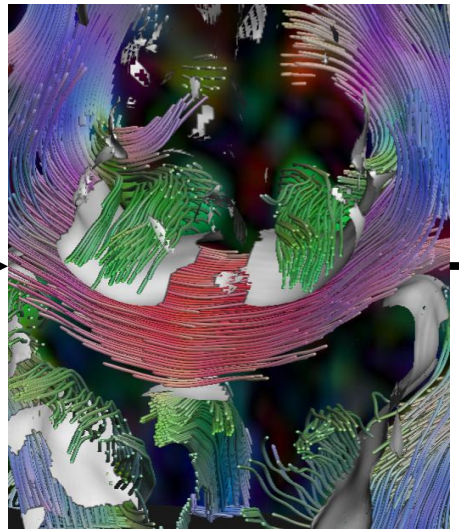
A. Golby, N. Hata, H. Liu

NA-MIC's Science

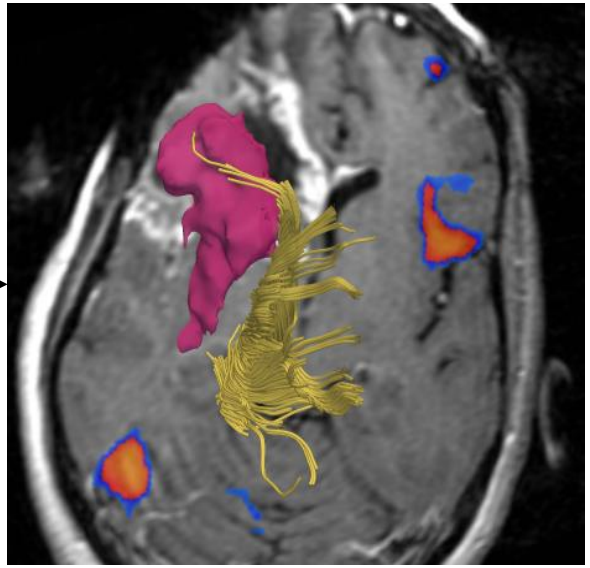
- Algorithm research
- Tool development
- Biomedical Research

Golby, Archip et al.





Provided by Kindlmann, et al.



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Acknowledgments

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NIH U54EB005149

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NIH P41RR013218

Surgical Planning Laboratory,
Brigham and Women's Hospital

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