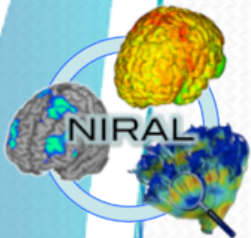




THE UNIVERSITY  
*of* NORTH CAROLINA  
*at* CHAPEL HILL

# Updates in 3D software development



**Beatriz Paniagua**

**Assistant Professor**

Departments of Computer Science and Psychiatry





# **Institutional framework**

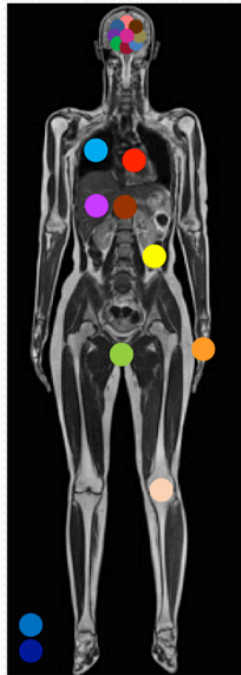


# National Centers for Biomedical Computing

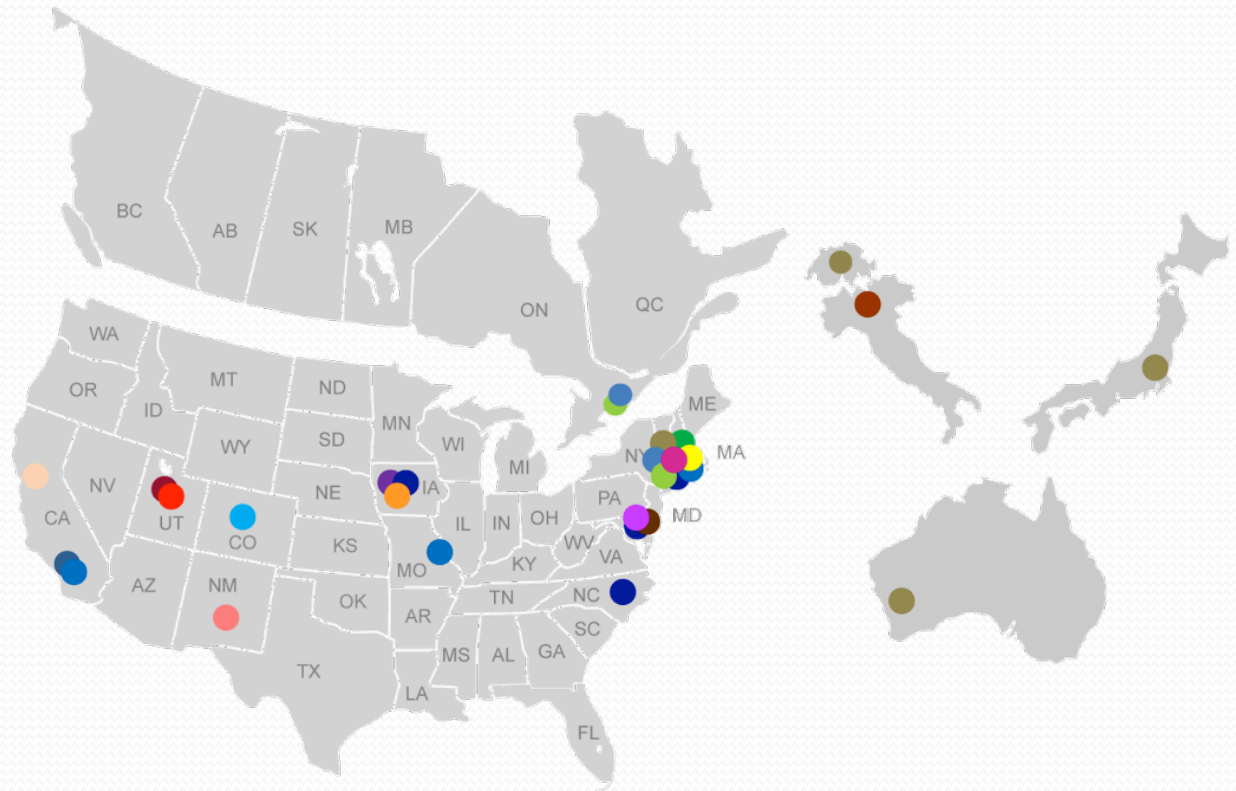




# National Alliance for Medical Image Computing



- 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

<http://www.na-mic.org>



# NA-MIC Cores



## Leadership

PI: R. Kikinis



## DBP

MIND Institute, CA  
JHU/Queens University,  
Canada  
UNC, NC  
HMS, MA



## DBP's, til 07

PNL, Brockton VA, HMS  
UCI, CA  
Dartmouth College, NH  
Indiana University,  
Indianapolis  
U of Toronto, Canada



## Algorithms

Core PI: R. Whitaker  
U of Utah  
Martinos, MGH  
MIT, MA  
UNC, NC  
Georgia Tech, GA



## Engineering

Core PI: W. Schroeder  
Kitware, Inc.  
LONI, UCLA  
BIRN CC, UCSD  
NRG, WUSTL  
GRC, GE  
Isomics, Inc.



## Service

Core PI: W. Schroeder  
Kitware, Inc.



## Training

Core PI: R. Gollub  
Martinos Center, MGH



## Dissemination

Core Co-PI: T. Kapur, S.  
Pieper  
SPL, BWH, Isomics Inc.



R. Whitaker,  
G. Gerig,  
SCI Institute, U of  
Utah



R. Whitaker,  
G. Gerig,  
SCI Institute, U of  
Utah



P. Golland,  
Eric Grimson,  
Csail, MIT



UNC



Georgia Tech  
NIRAL  
A. Tannenbaum,  
Georgia Tech





# Free Open Source Software

- Open source is a development method for software, that promises better quality, higher reliability, more flexibility, lower cost, and an end to predatory vendor lock-in.
- Research should avoid proprietary software and hardware, because
  - Locks researchers to a single vendor
  - Prevents leveraging of the work of other scientists
- The Open Source Initiative (OSI) is a non-profit corporation formed to educate about and advocate for the benefits of FOSS.

<http://www.opensource.org/>





# Updates

- Slicer4 – released November 2011
- Methodology:
  - Shape regression
  - SPHARM-PDM mean latitude axis
- Tools:
  - Dental Tools
  - Intensity Segmenter
- Future work

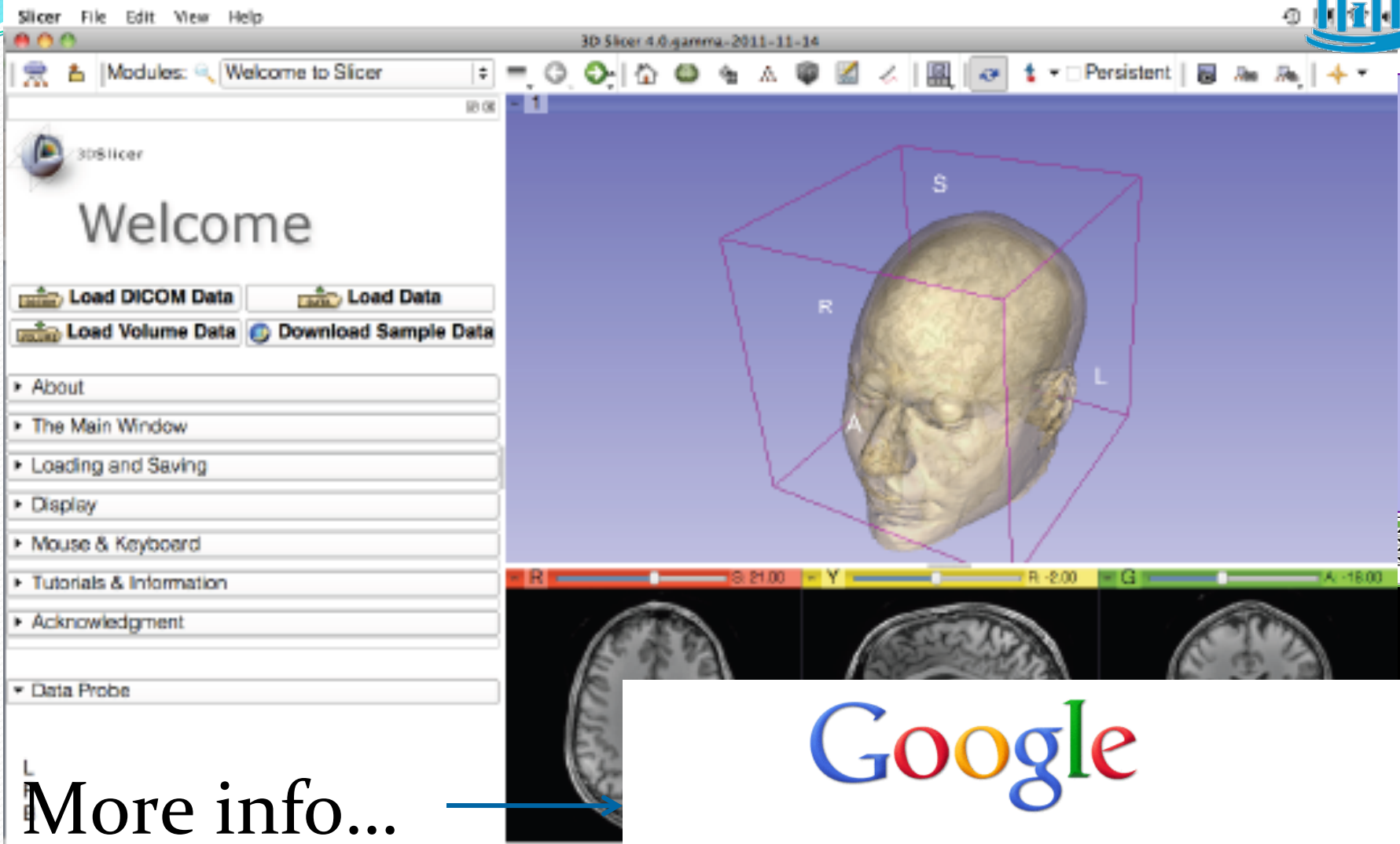


# Slicer4

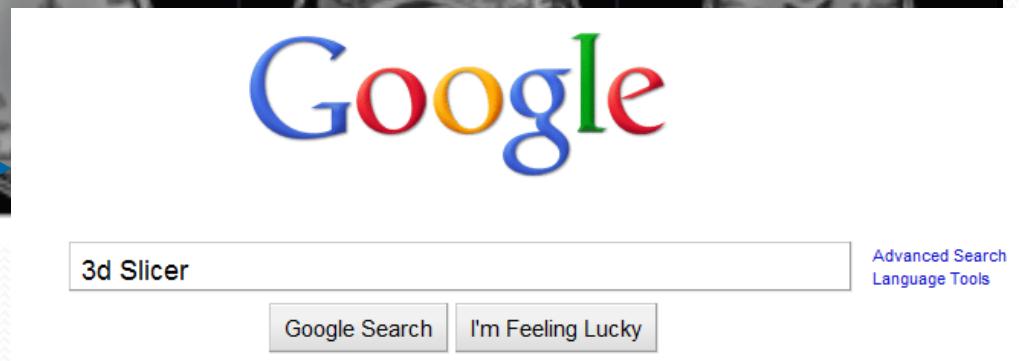




- Image analysis and data visualization
- FOSS for Windows, Linux, Solaris and Mac OS
- Updates
  - New lighter interface
  - Transition from Kwidgets to QT
  - Extension manager
  - Volume rendering
- Open Source: **No restrictions on use, no license fees**
- The source code could be used to develop a commercial package that could be sold. No need to ask for permission.
  - **You** are responsible to make sure that you comply with all regulations that apply to the way you use it. In any case, **MUST** acknowledge Slicer's contribution
- Possible to contribute. One's choice, is NA-MIC's decision, if contributions will be accepted.



More info...



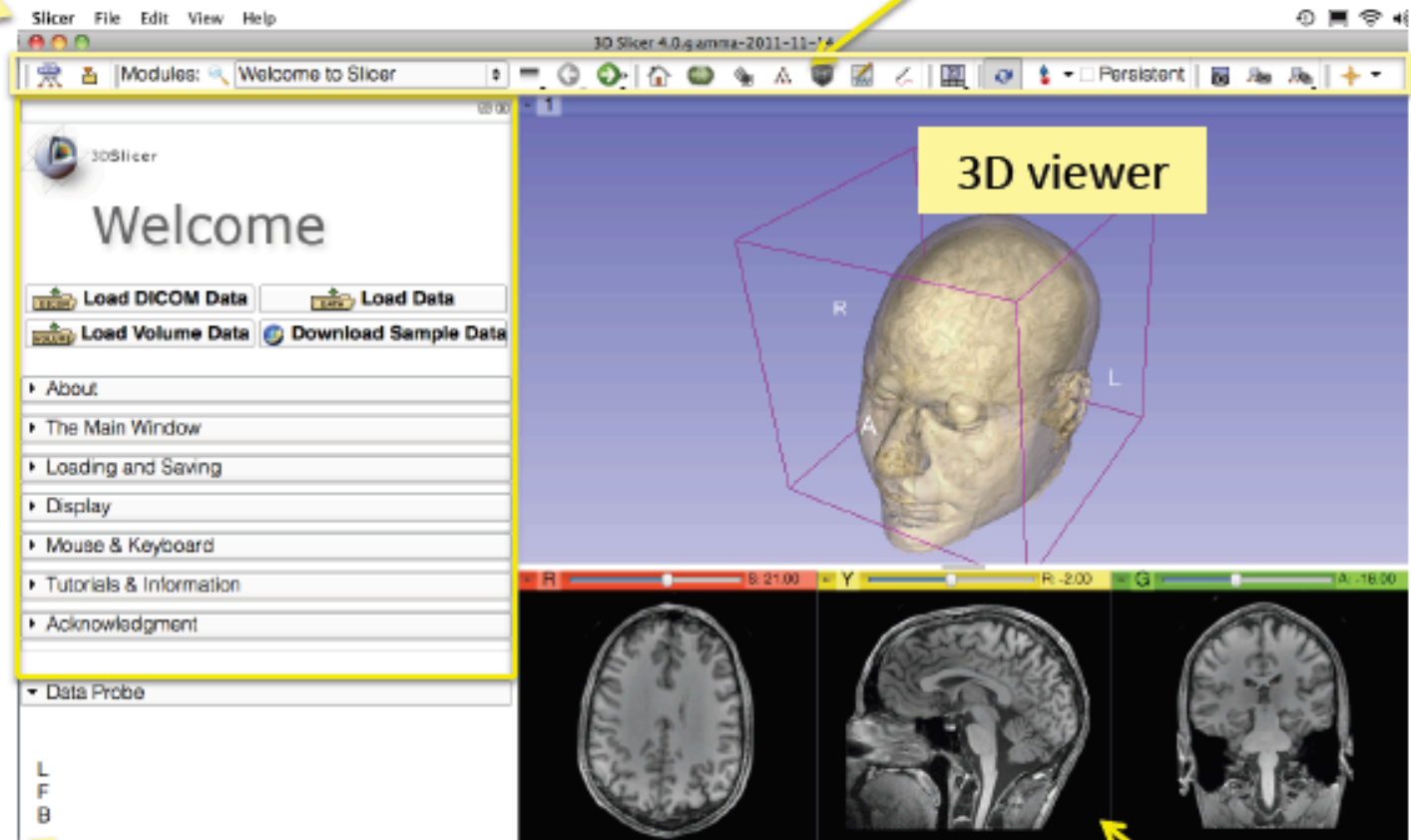
<http://www.slicer.org/>



# New interface

Main Menu

Toolbar



3D viewer

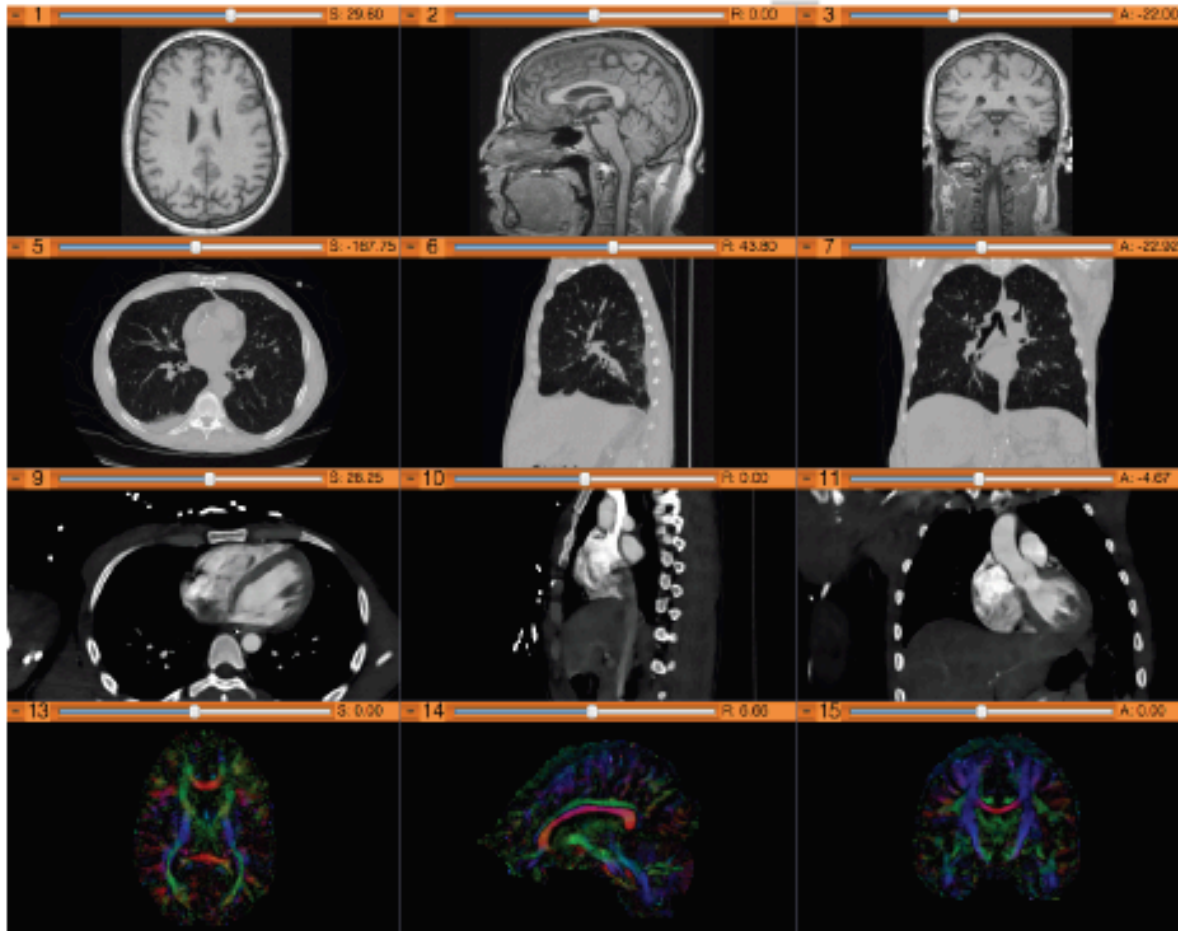
User Interface (UI) panel of the Slicer Welcome Module

Data Probe

2D anatomical viewers



# Sample Data



Brain MRI

Chest CT

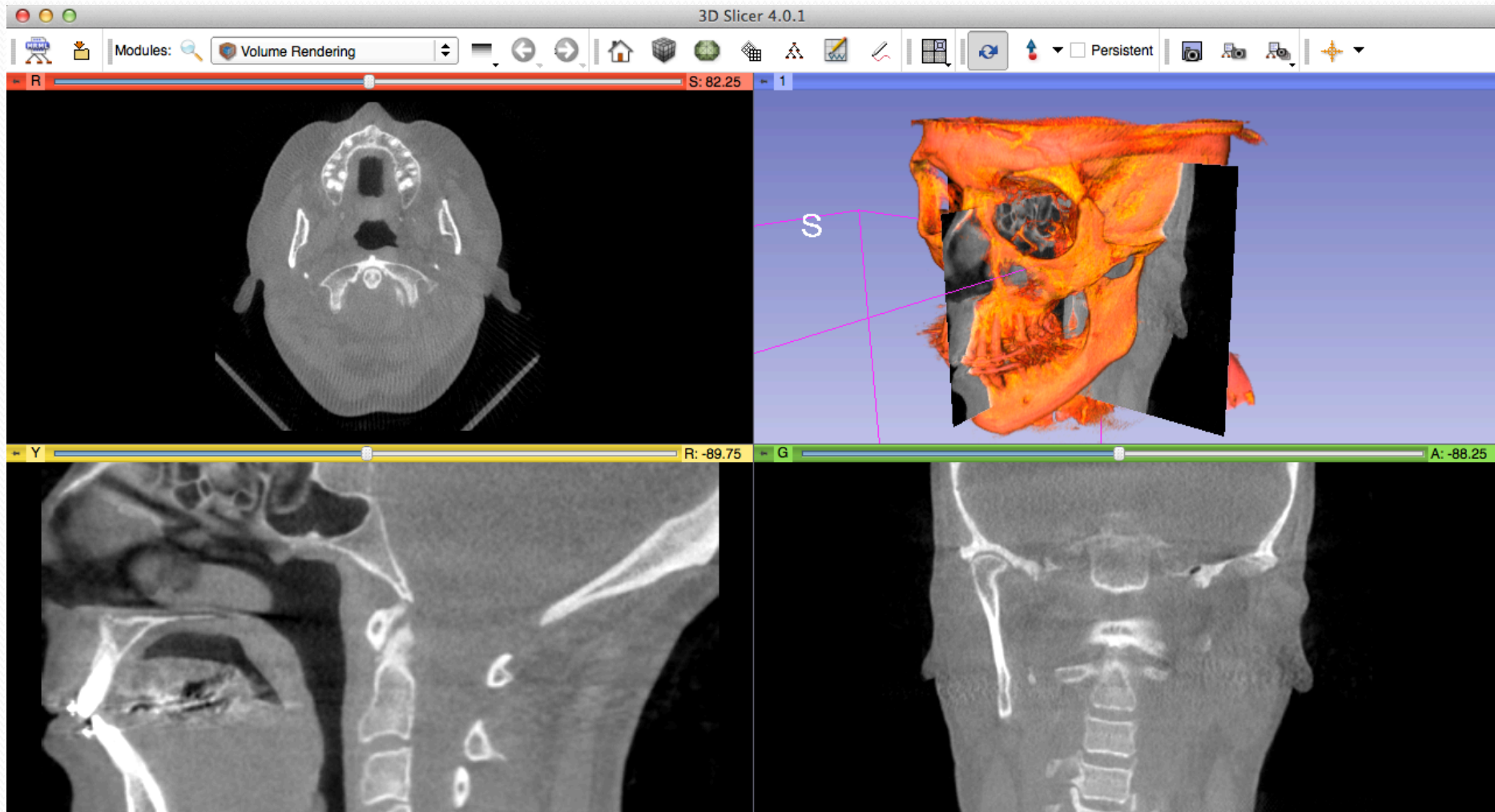
Cardiac CT

Diffusion Tensor  
Imaging (DTI) Dataset

... soon Dental CBCT



# Volume rendering





# Slicer extensions

The screenshot shows the 3D Slicer 4.1.0 interface. The main window displays a 3D view of a brain scan. Overlaid on this is the 'Extensions Manager' window, which is used to manage and install extensions. The 'Extensions Manager' window has two tabs: 'Manage Extensions (0)' and 'Install Extensions'. The 'Install Extensions' tab is active, showing a list of available extensions under the heading 'Slicer Extensions'. The list includes two extensions: 'Plastimatch' by Gregory Sharp and 'SkullStripper' by Xiaodong Tao (GE). Each extension has a star rating and an 'INSTALL' button. The 'Plastimatch' extension has a star rating of 0, and the 'SkullStripper' extension has a star rating of 1. The 'Plastimatch' extension is highlighted with a green border. The 'SkullStripper' extension is highlighted with a blue border. The 'Extensions Manager' window also has a 'Restart' button and a 'Close' button. The background interface shows the 'Modules' menu with 'Data' selected, and the 'Nodes' panel with 'Scene' expanded. The 'Scene Model' is set to 'Transform', and the 'Filter' is empty. The 'Data Probe' panel is visible at the bottom left.

3D Slicer 4.1.0

Modules: Data

3DSlicer

Help & Acknowledgement

Display & Modify Scene

Nodes

- Scene
  - View
  - Default Scene Camera

Scene Model: Transform

- Display MRML ID's
- Show Hidden nodes

Filter:

Load & Add Scenes Or Individual Datas

Data Probe

L  
F  
B

Extensions Manager

Manage Extensions (0) Install Extensions

### Slicer Extensions

Categories

- All
- CARMA
- Examples
- Registration
- Segmentation

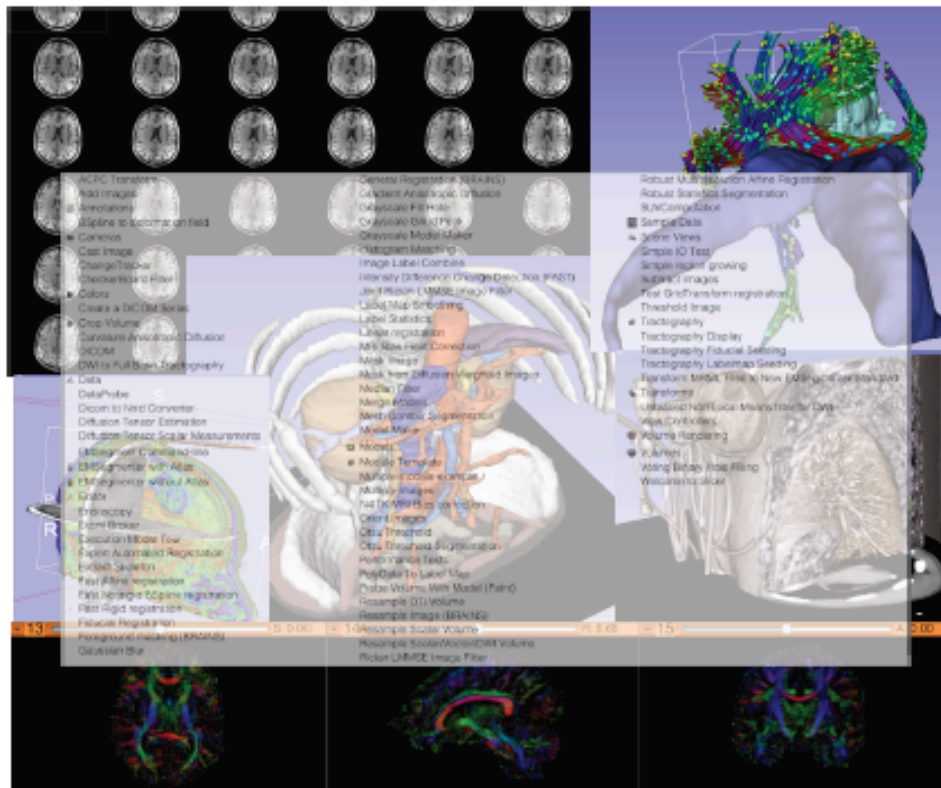
showing results 1-2 of 2

Extension Name	Author	Star Rating	Star Count	Action
Plastimatch	Gregory Sharp	★☆☆☆☆	(0)	INSTALL
SkullStripper	Xiaodong Tao (GE)	★★★★★	(1)	INSTALL

Restart Close



# More...



To learn more about Slicer and its different functionalities, please visit the Slicer4.0 compendium

<http://www.slicer.org/slicerWiki/index.php/Documentation/4.0/Training>



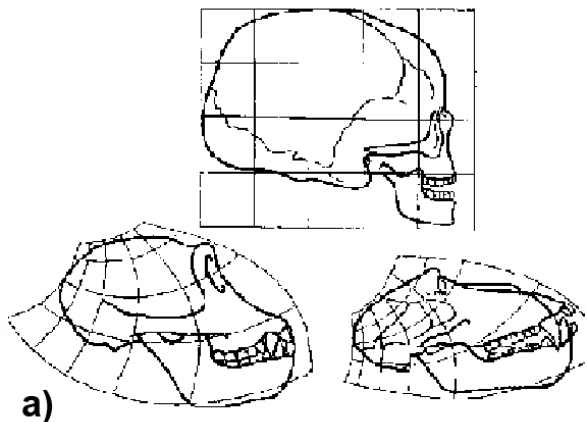
# Methodology development



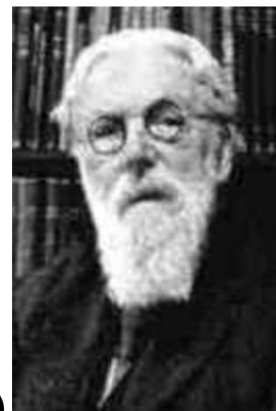


# Shape Analysis

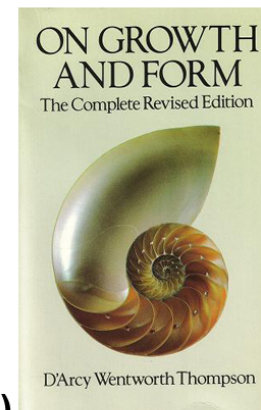
- Algorithms development, 3D structural shape analysis
  - Correspondence, SPHARM-PDM & particle based entropy systems
  - Statistical Analysis, MANCOVA.
- Experienced clinicians are able to evaluate and diagnose 3D anatomical structures by looking at 2D classical imaging techniques → **difficult to quantify**



a)



b)

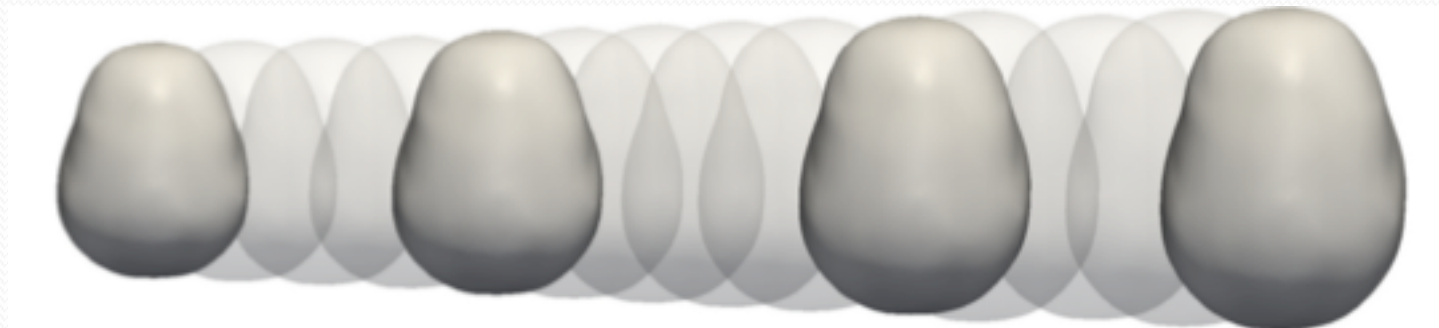


c)



# Shape regression

- Longitudinal Computational Anatomy, computer models of anatomical evolution
- Estimating growth trajectories for 4D atlas construction
- 4D growth models provide a tool to generate shapes at any instant in time (within the interval defined by the data), offering us the opportunity to continuously measure shape properties



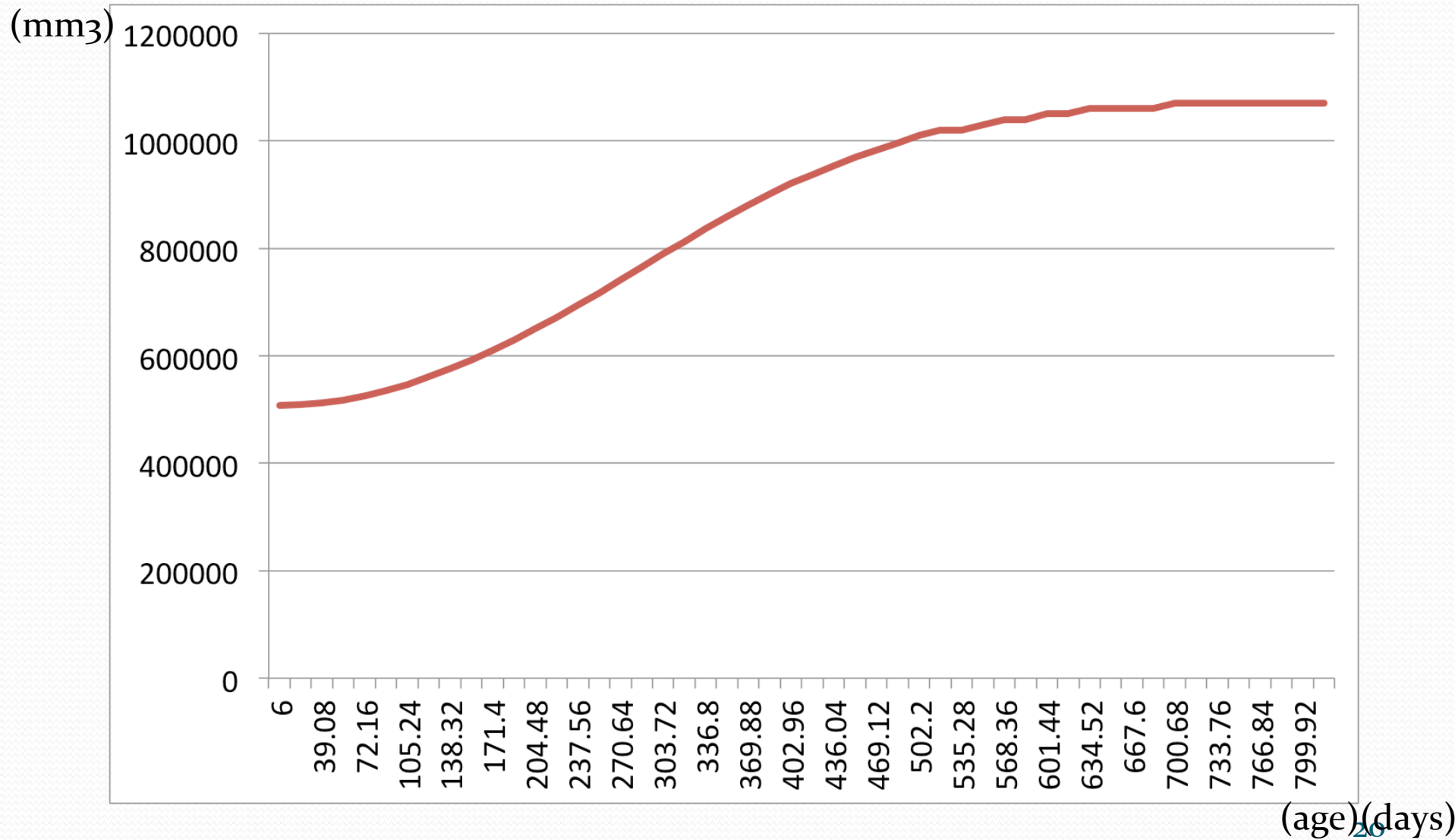


# Brain atlas superior view



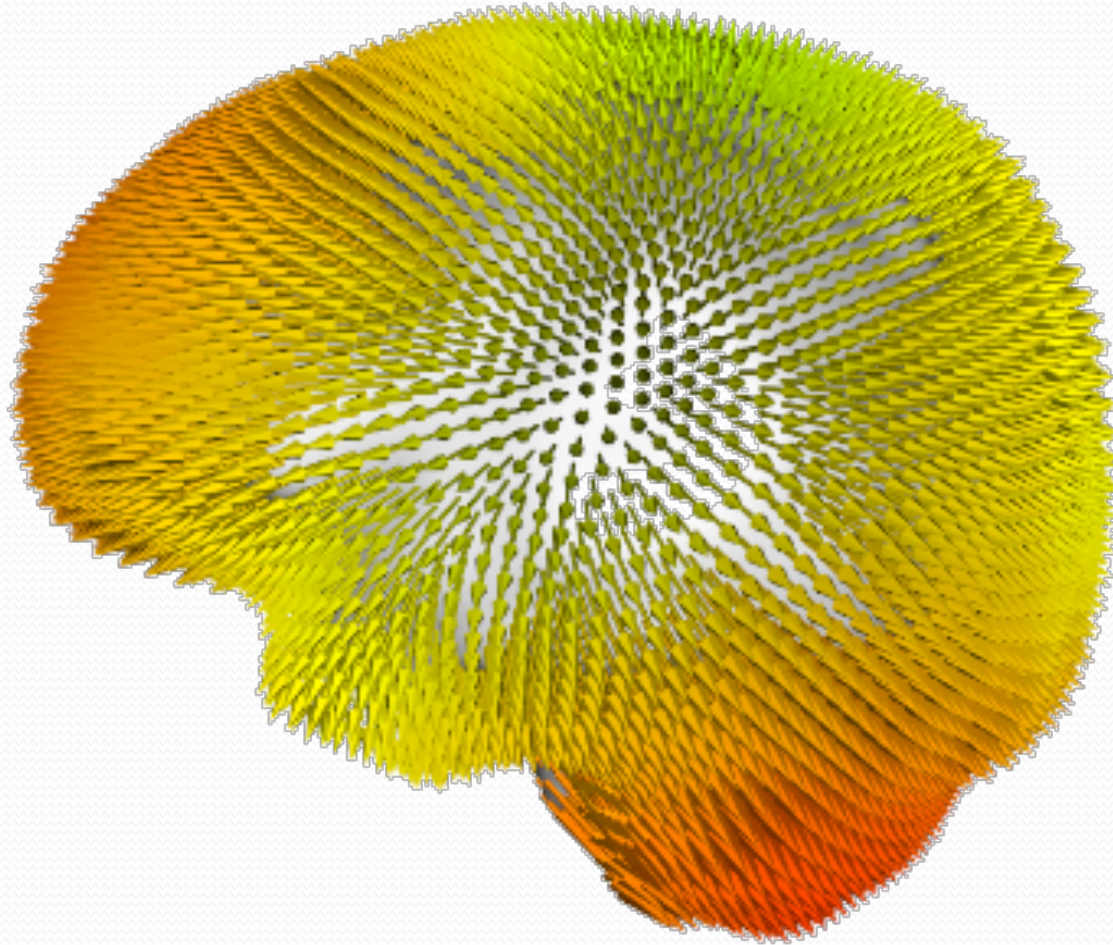


# Atlas regressed volume





# Atlas correspondence



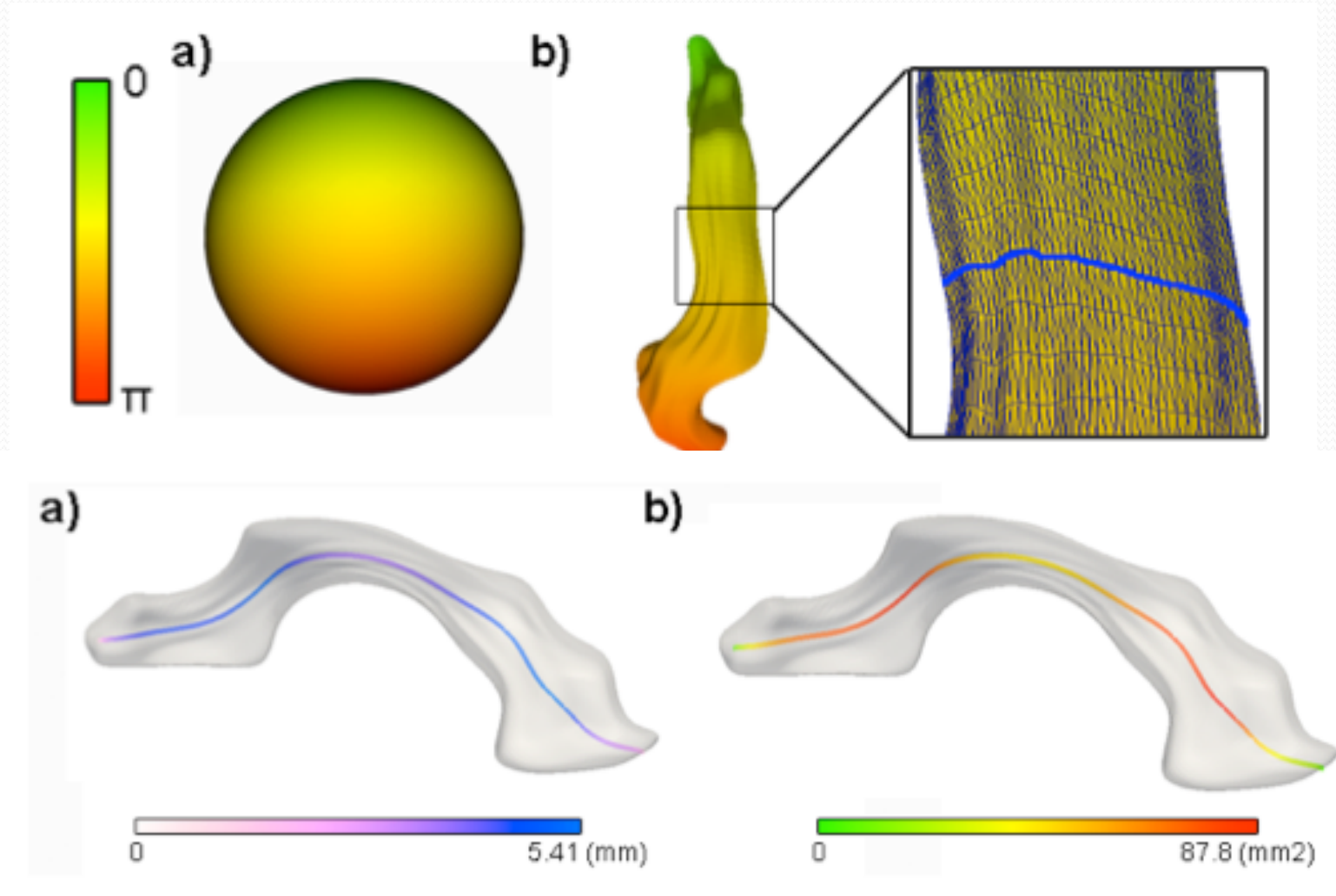
0 mm

29 mm





# Mean latitude axis





# Software development



# Dental Tools

- Tools and utilities for bone, teeth, skin, airway morphological assessment
  - Scan Converter
  - Relax Polygons
  - Surface utilities: VTK2Meta, Meta2IV, ...
  - Intensity Segmenter
- Only few direct download binaries, mostly code
- Multi-institutional development effort





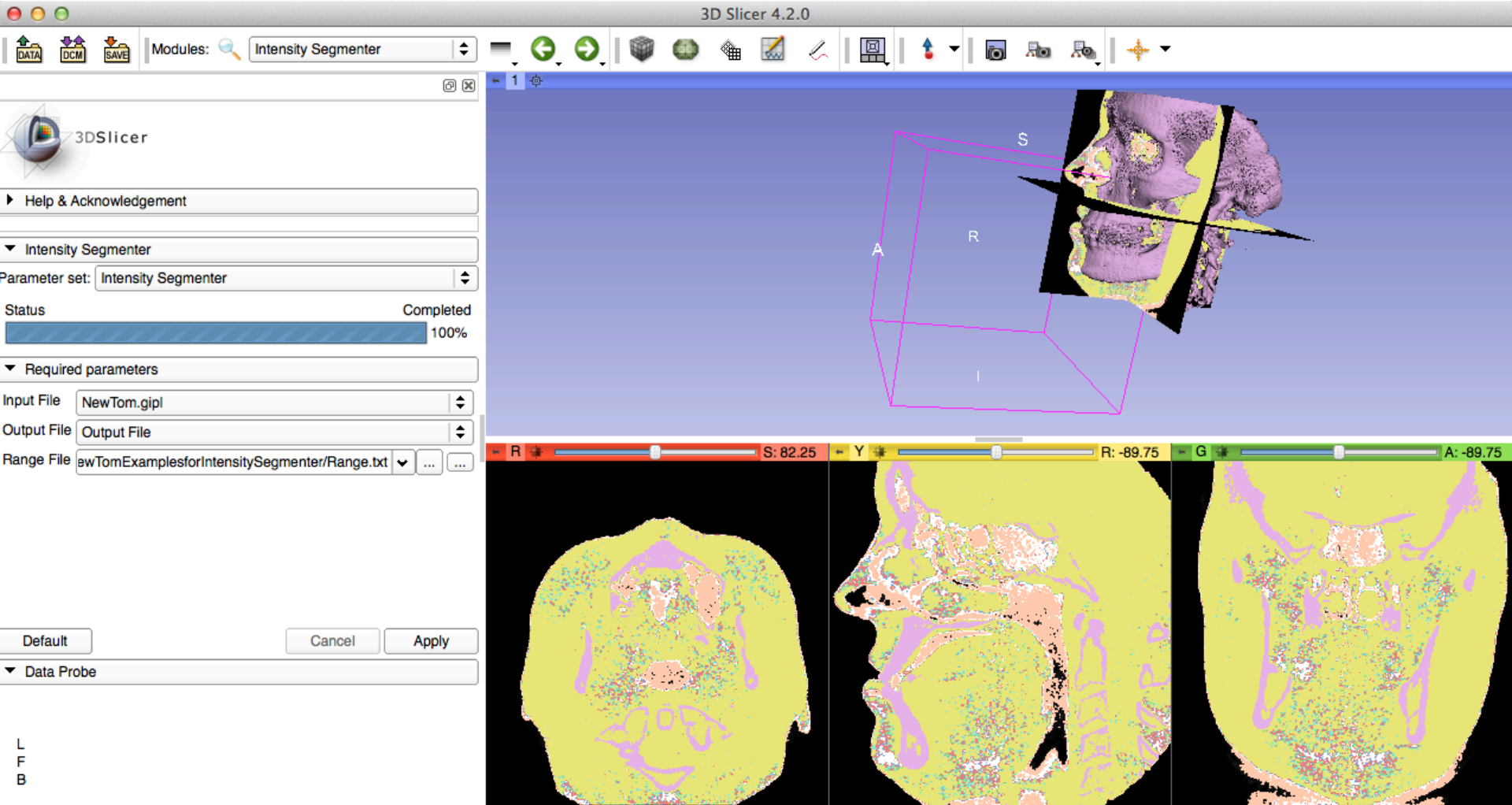


# Dental research

- Neuro-Imaging Research and Analysis Lab (UNC):
  - PI, Martin Styner
  - Research on diverse brain morphometry studies.
  - Emphasis on **shape analysis** and structural research for neurodevelopmental diseases.
- Orthodontics Research Lab (UofM):
  - PI, Lucia Cevidanes.
  - Diverse 3D imaging studies related with dentistry applications, asymmetry, TMJ OA, orthognatic surgery.

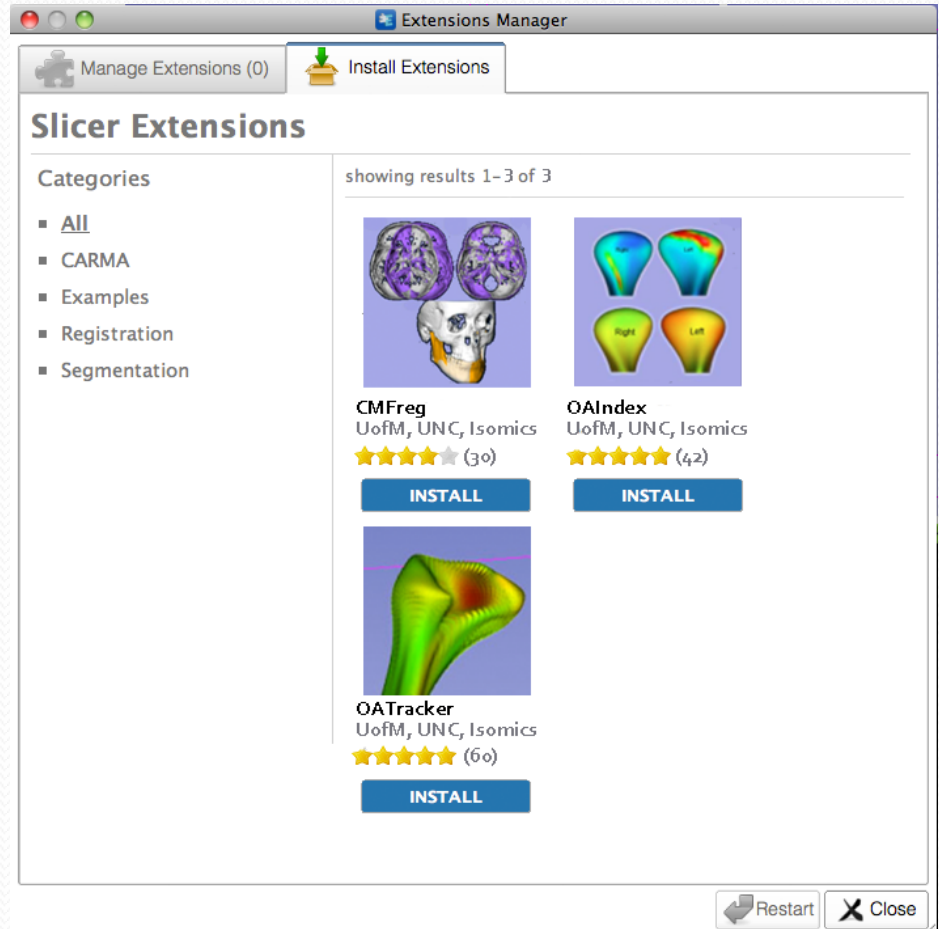


# Intensity Segmenter



# Future work

- Slicer4 extensions
  - SPHARM-PDM
  - Dental Tools
  - TMJ tools
- Application of new methodology to Dental Projects
- Training events





# Conclusions

- Interdisciplinary, multi-institutional software development benefits medical imaging research.
- FOSS = Free Open Source Software
  - **3DSlicer version4**
  - Advanced morphology analysis **methods**
  - Working on easily-interfaced **tools** in Slicer4



# Acknowledgements

- NAMIC: Sonia Pujol, Ron Kikinis, Steve Piper
- NIRAL lab: Martin Styner, Ipek Oguz, Francois Budin...
- SCI Utah Univ: Clement Vachet, Guido Gerig, James Fishbaugh
- UNC Dentistry: Abeer Alhadidi, David Walker, David Baranowski...
- UofM lab: Dion Taylor, Joao R. Goncalves , Cauby Chaves Jr
- CWRU: Mark Hans, Martin Palomo

