miAnnotation: An Open Source Software Tool for Annotating Medical Images
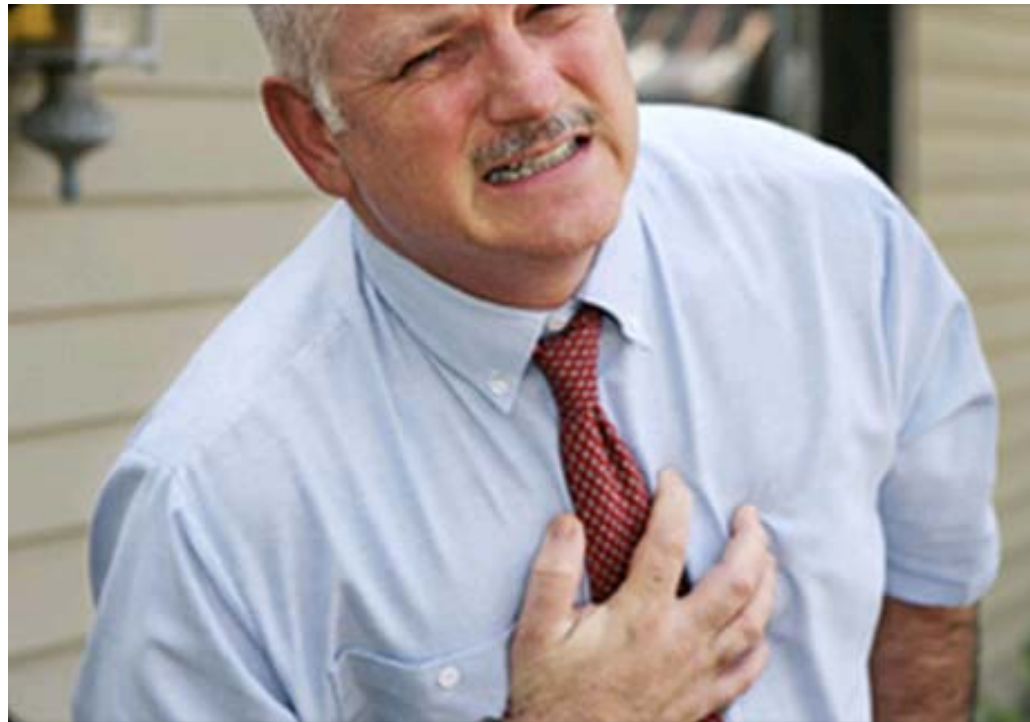
Kilian Pohl & Yong Zhang

May 2010

Symptom

70 Years Old, Chest Pain
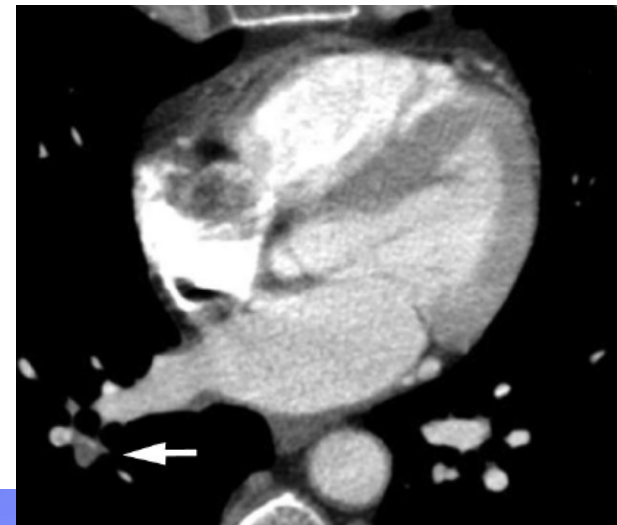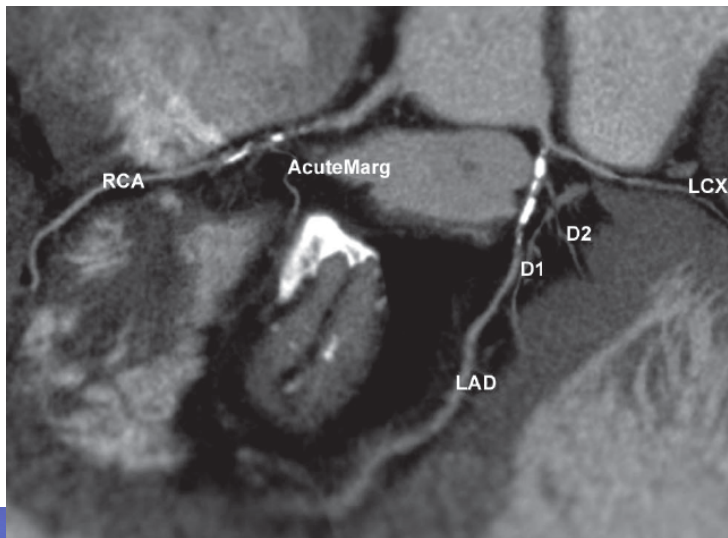
http://www.medicinenet.com/

Diagnosing Patients

http://www.medicinenet.com/

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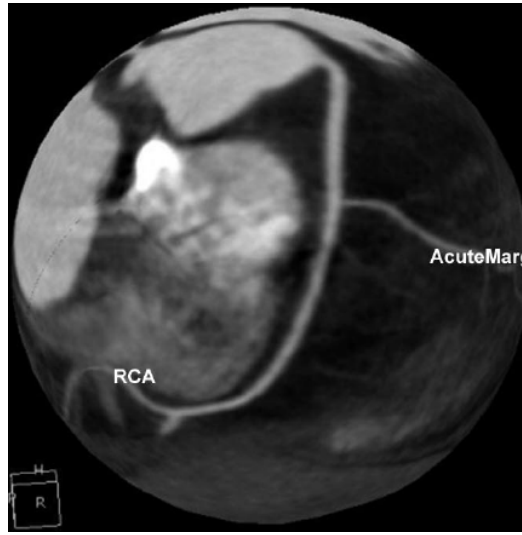
CT Angiography Images

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© 2009 IBM Corporation
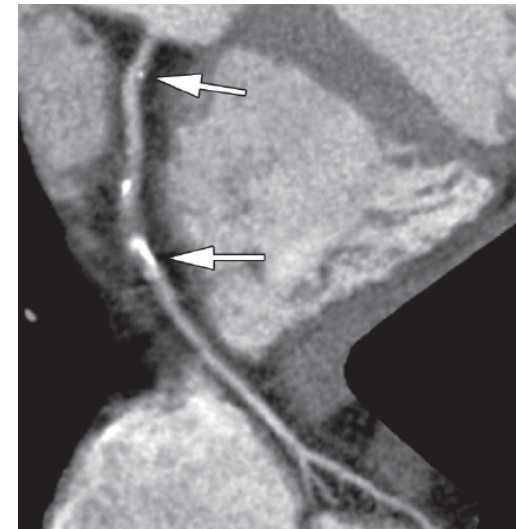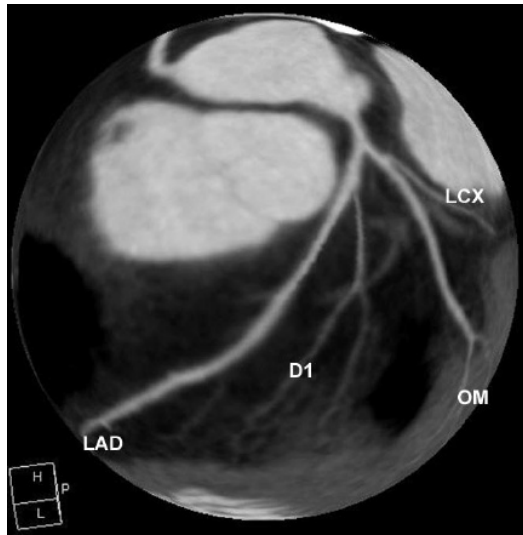
Disease Detection

more objective and effective

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The Question

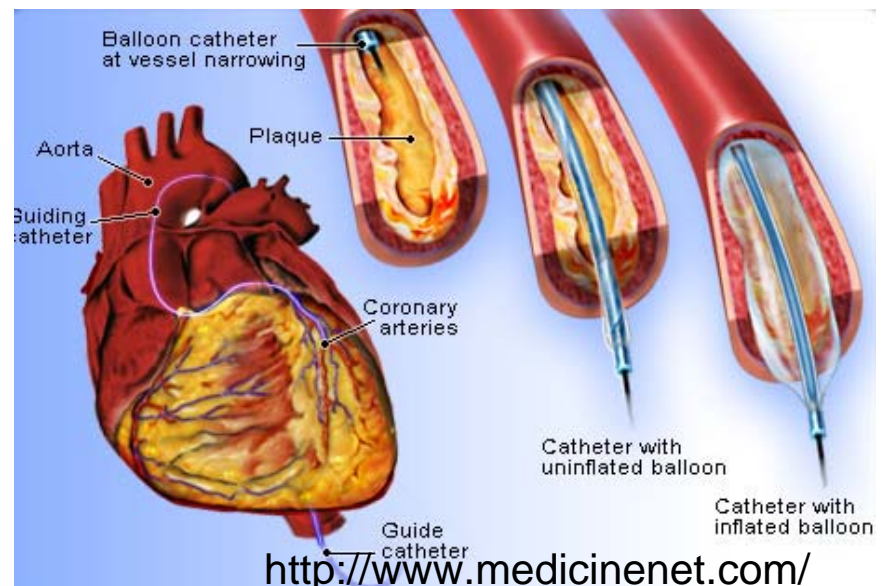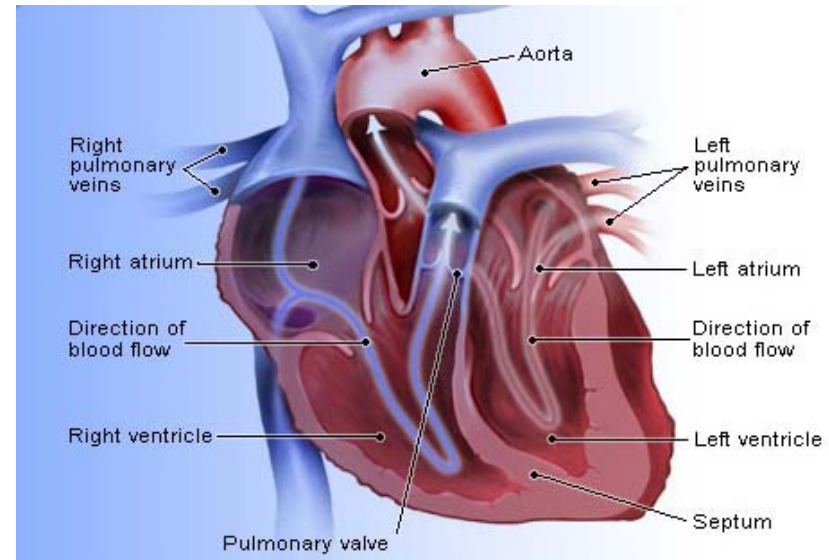Aorta, Right pulmonary veins, Left pulmonary veins, Right atrium, Left atrium, Direction of blood flow, Right ventricle, Left ventricle, Pulmonary valve, Septum

- To improve diagnosis and treatment, images need to be properly annotated and important features need to be measured.

- The questions is: *what is the best way to do that?*

Balloon catheter at vessel narrowing, Aorta, Plaque, Guiding catheter, Coronary arteries, Catheter with uninflated balloon, Guide catheter, Catheter with inflated balloon

http://www.medicinenet.com/

Goal

Received a subcontract by Harvard Medical School funded through the NIH (ARRA Suplement to P41RR013218) to develop an annotation tool for medical images that is

- Free open source

- Platform independent

- Functionality similar to commercial systems
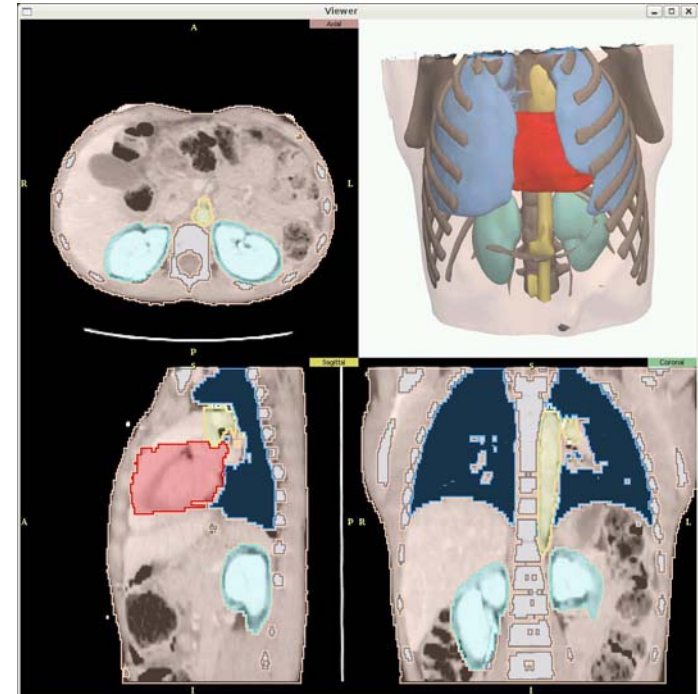
3D Slicer

3DSlicer

- a multi-platform, free open source software for exploring novel *image analysis* and *visualization* techniques.
- consists of more than over a million lines of code, mostly *C++*, 250 active developer, 5K downloads in 2009.
- has extensive *algorithmic* and visualization functionality.
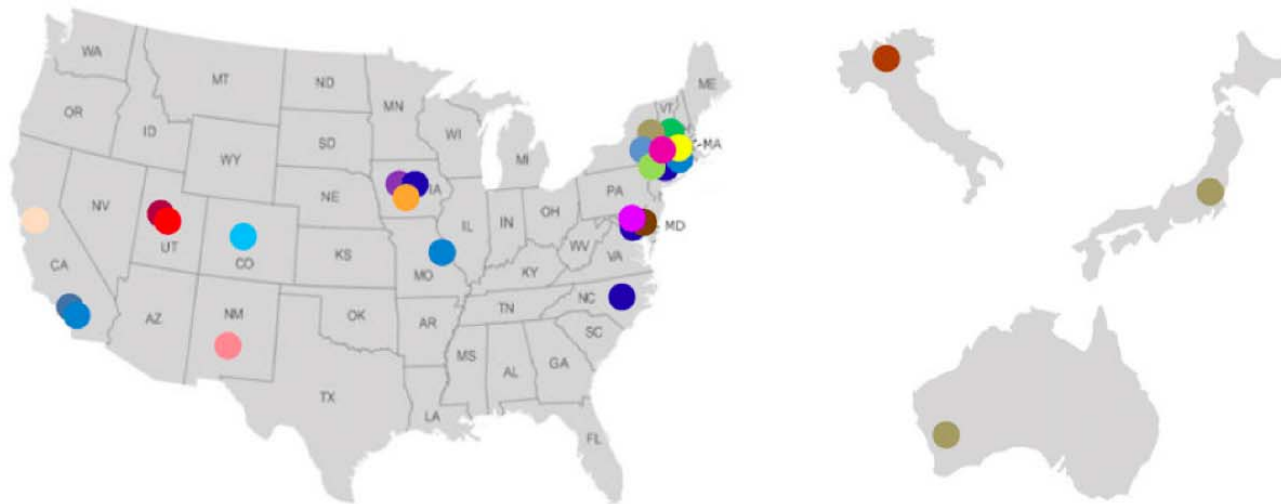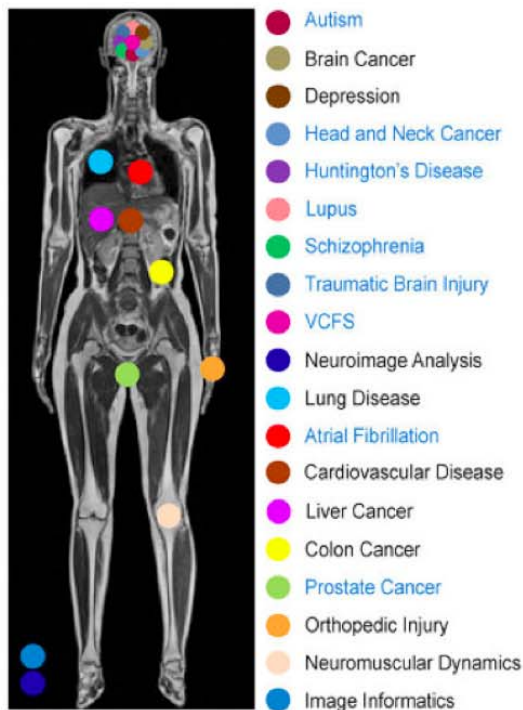- a research platform and NOT FDA approved.

Parameters for a virtual fixture

Virtual fixture

Tooltip of virtual slave robot
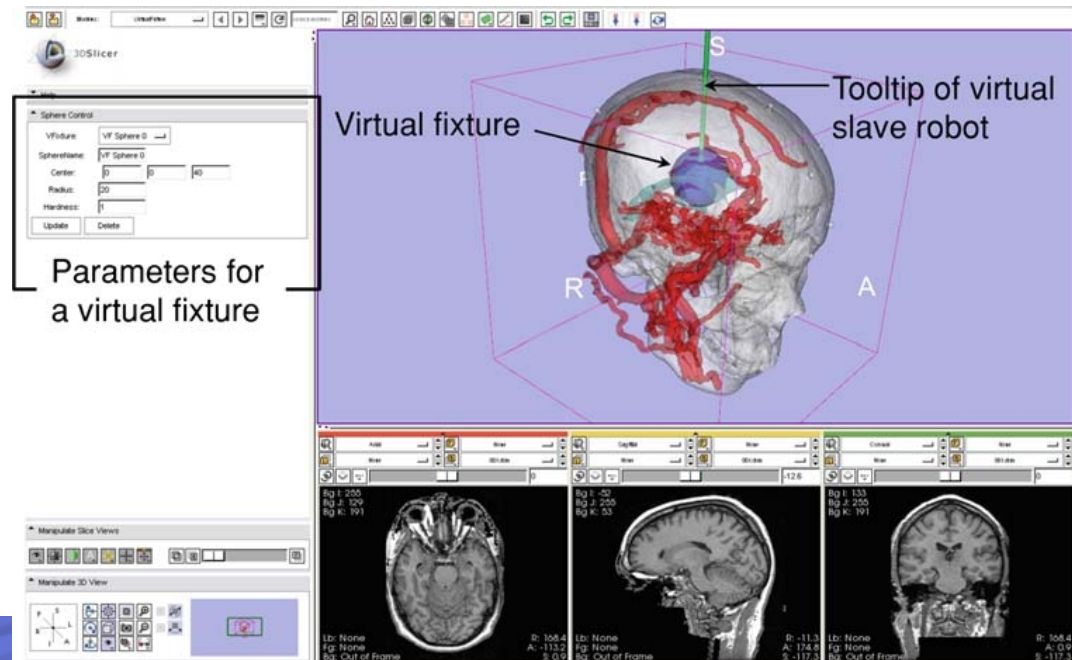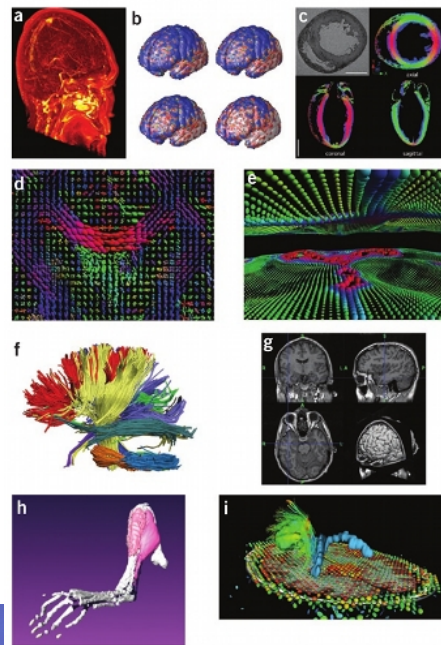
Slicer Features

Visualization
Filtering
Registration
Segmentation
DTI
Quantification
Real-time Integration

Core Slicer Contributors

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	R01CA111288	R01EB005973
U54EB005149-05S2	U54GM072970	P41RR013218	R01EB006733	R01NS050568	R01EB009900	U54EB005149-05S3	UL1RR025758	U54LM008748
U24RR025736	U24RR021992	U24RR021382	U24RR026057	Mario Negri Institute, Italy	AIST, Japan	UWA, Australia		

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Development Environment
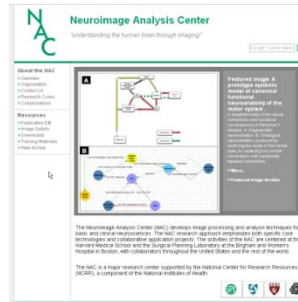
Web Page, Wiki
& Mailing Lists

Training, Workshops
& Tutorials
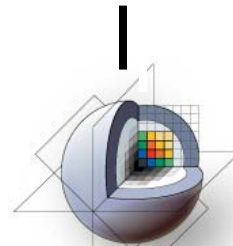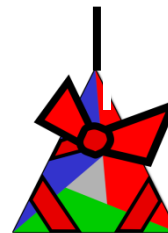
Dashboard, Testing,
& Nightly Builds
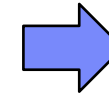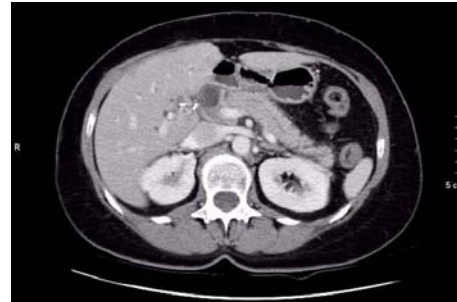
SVN, Cross Platform
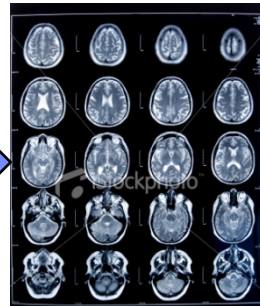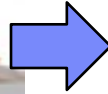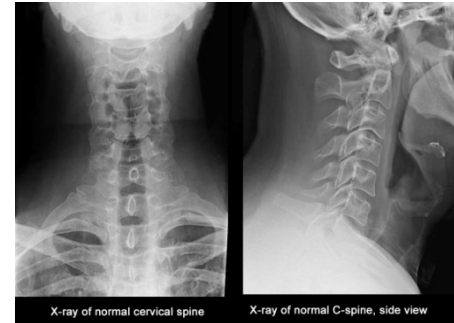& Package Generation

Informatics Implementation

- **Remote I/O in MRML Lib**
  - All Data is Loadable from URL
    - Models, Volumes, Transforms…
    - Scenes
  - All Storable Data can be Pushed to Web Services
    - XNAT, HTTP…
- **FetchMI Module**
  - Tagging, Searching
  - XNAT Web Services
- **Created Under mBIRN, Clinically Applied via Harvard Catalyst CTSC**
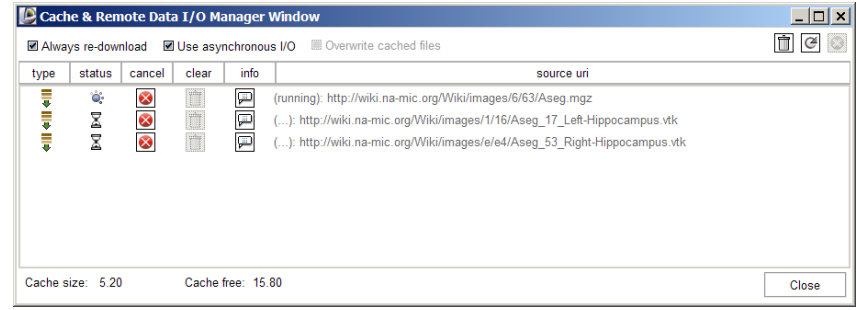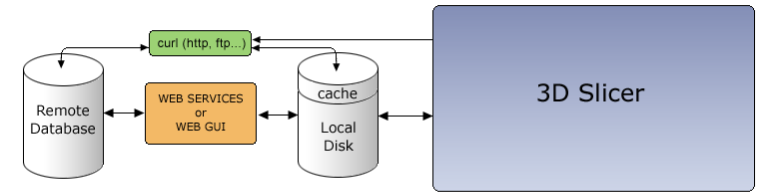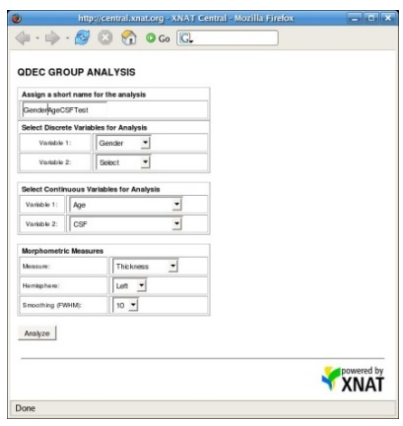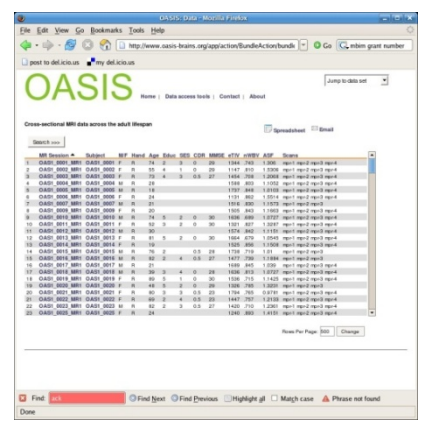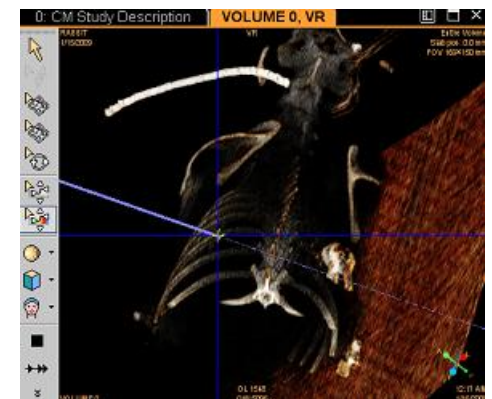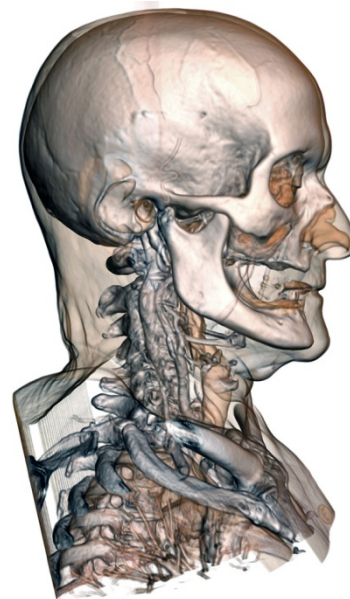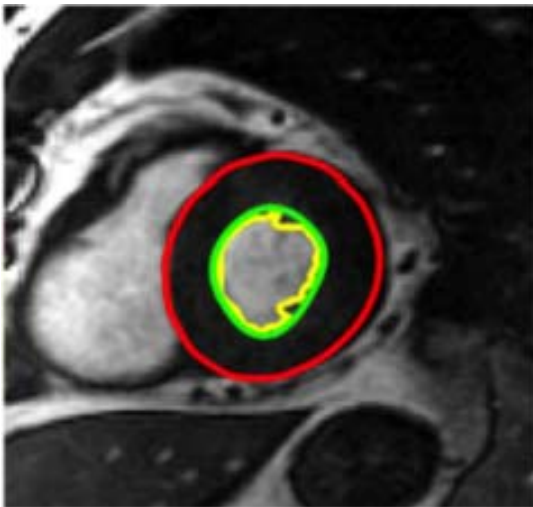
Medical Images
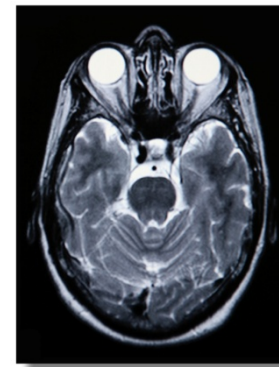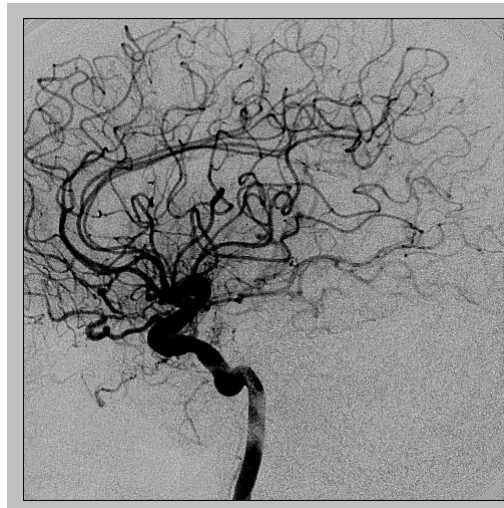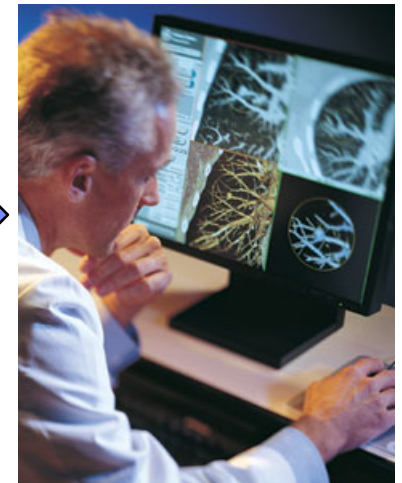
Medical Image Analysis - increase the efficiency and accuracy of radiologists and clinicians, thus improve healthcare

- Automated or Semi-automated analysis of n-dimensional medical images.
- Visualization, *annotation*, and interaction with n-dimensional medical images.
- Image Guided Diagnosis and Therapy.

Medical Image Annotation - Daily Clinical Practice

- to capture information latent in the scans.
- to support efficient storage in modern databases.
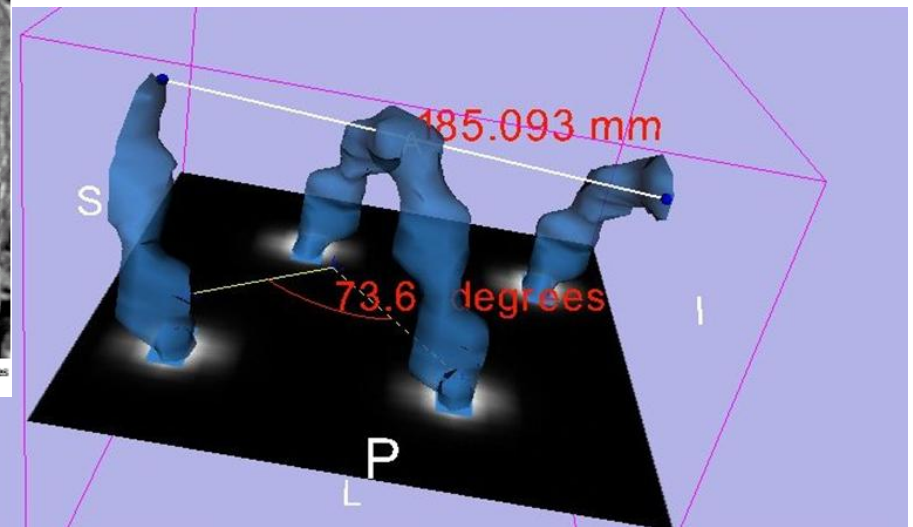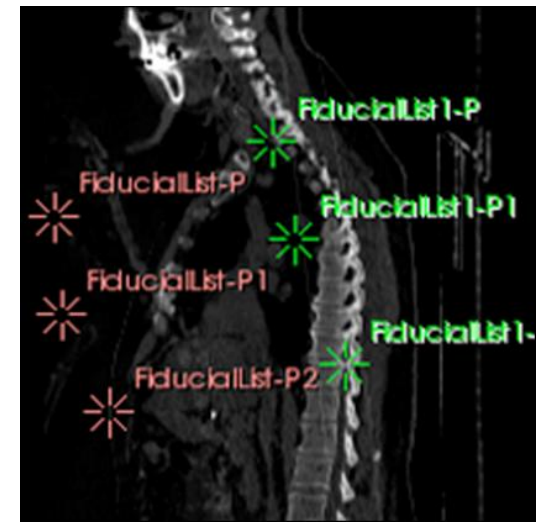- to enhance communication between experts.

A stenosis, or mostly blocked coronary artery, from images taken of the same patient.

OLDER METHOD:
DIAGNOSTIC ANGIOGRAM

NEW METHOD:
MULTIDETECTOR CT SCAN
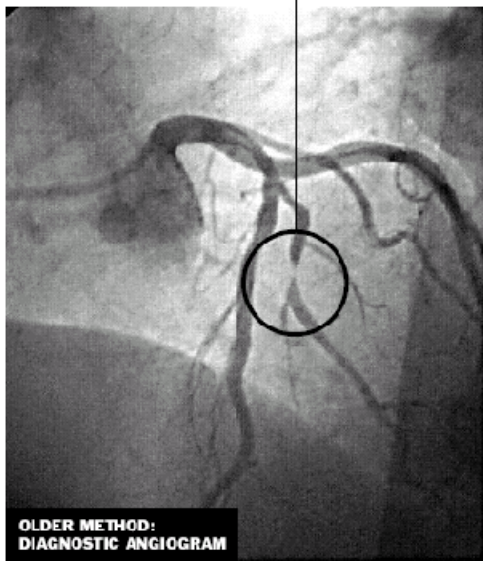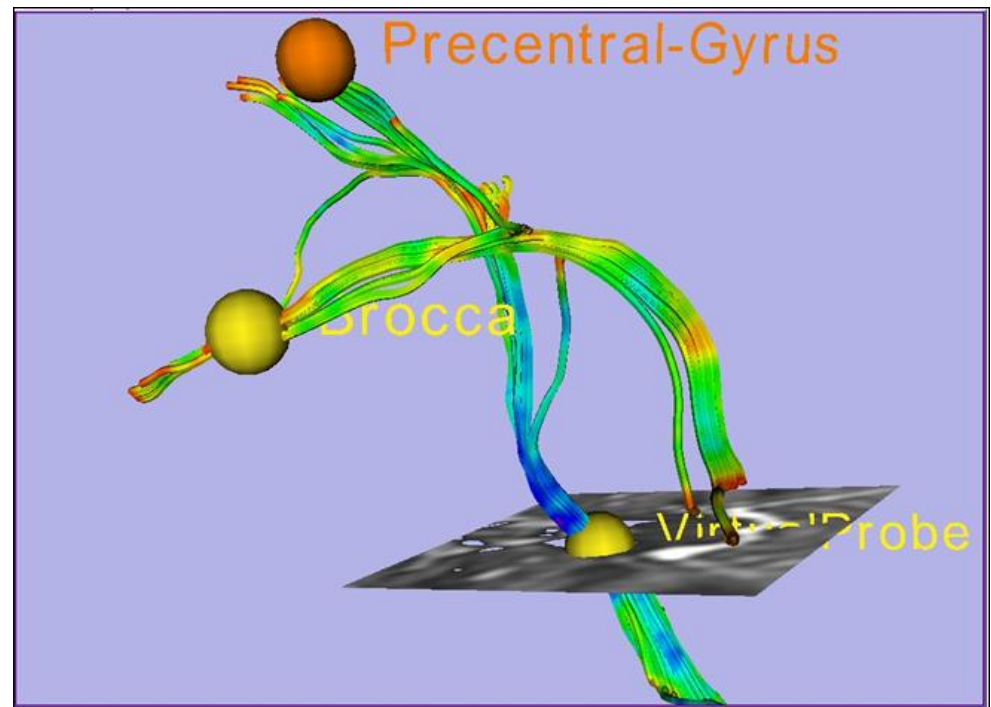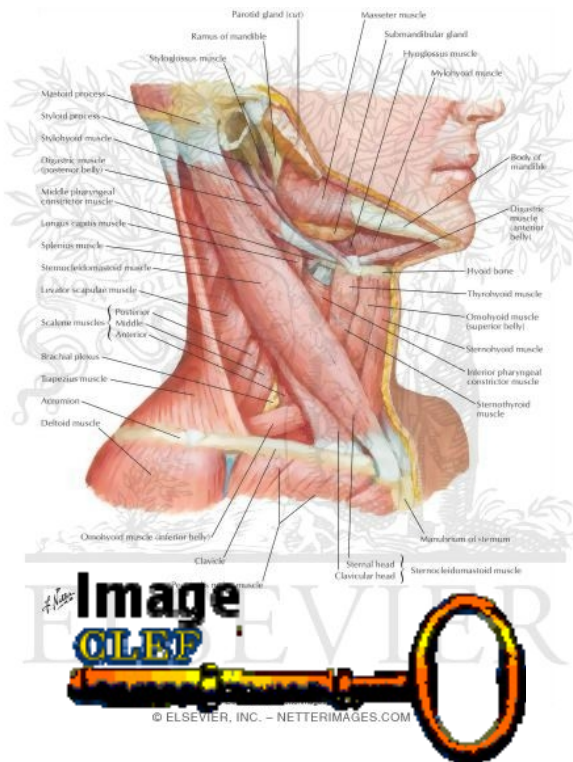
Source: Dr. Mario J. Garcia, Cleveland Clinic
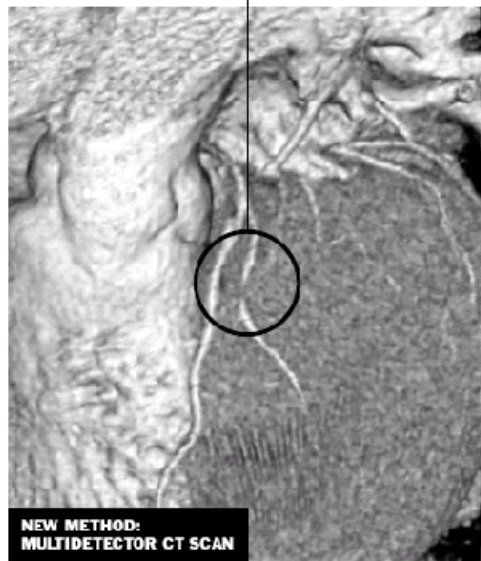
The New York Times

Medical Image Annotation - Biomedical Research

- to design ontology and semantic-based annotation techniques for information retrieval.
- To reduce the wealth of information latent in the scans to more explicit features useful in clinical decision-making.
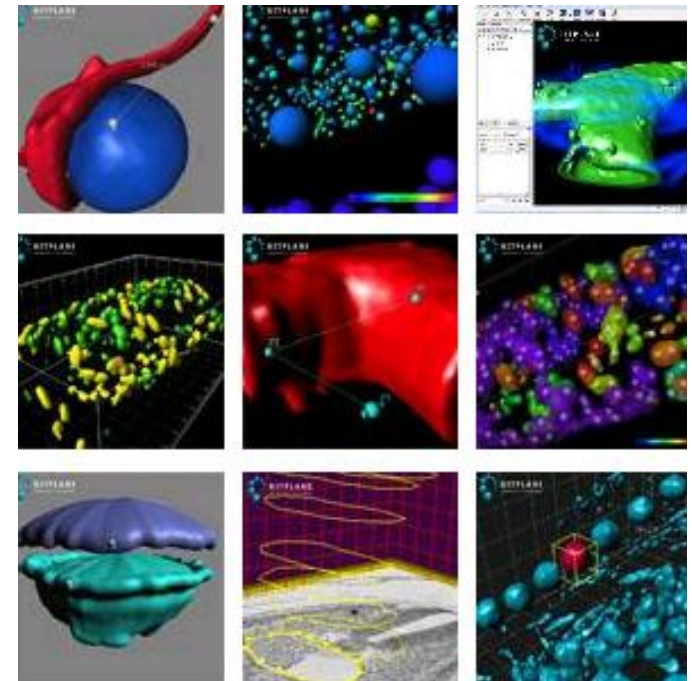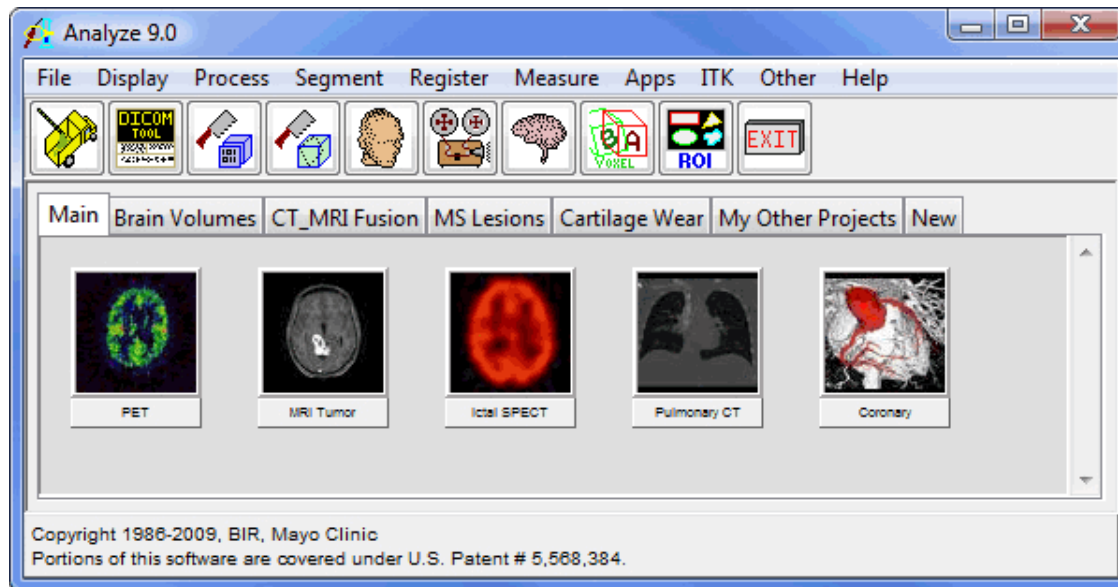
Current Annotation Tools – Vendors Medical Scanners

- Only tuned to the specific medical imaging workstations.
- Not trivial to compare annotation by different workstations.
- Not simple to share the annotation.

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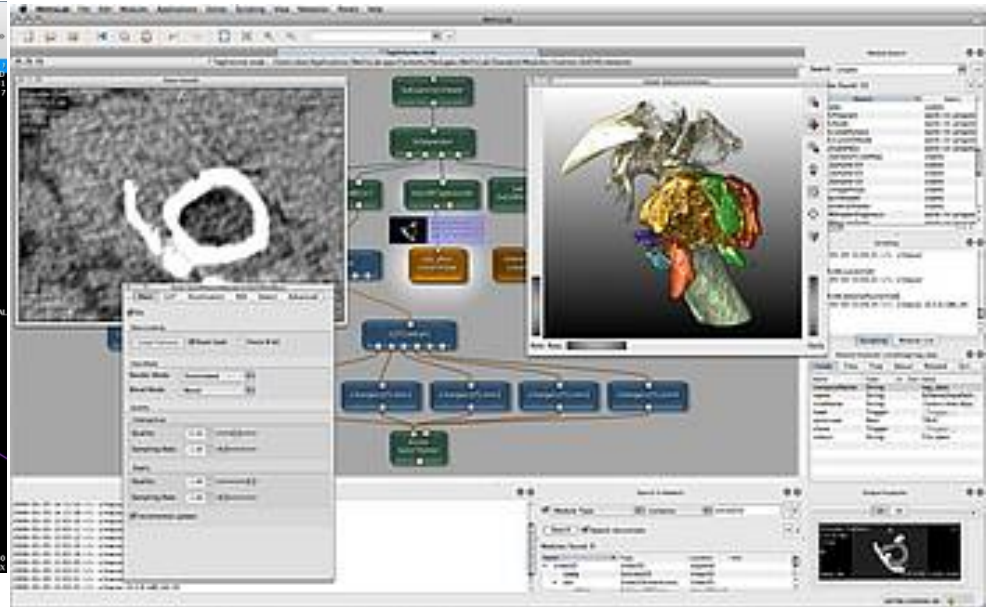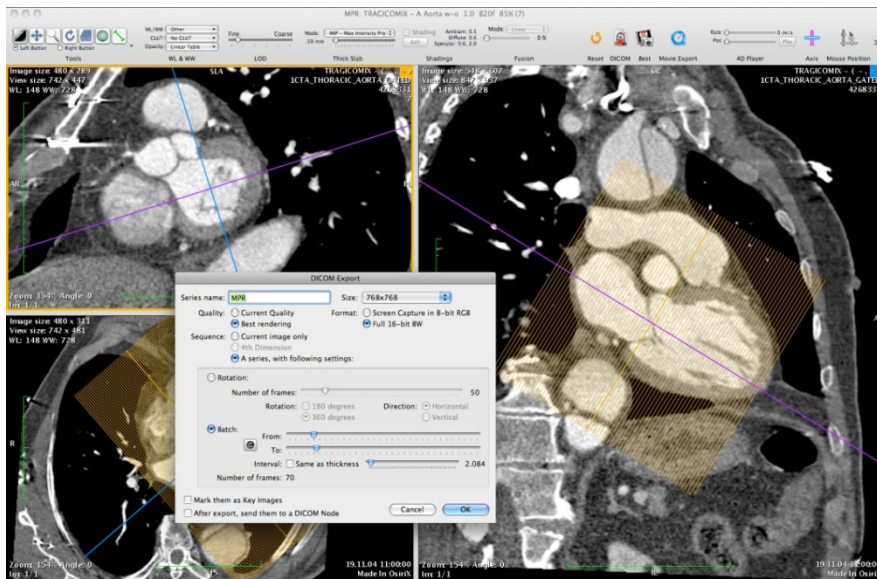
Current Annotation Tools – Non Vendors Software

- provide more flexibility.
- the source code is not publicly available.

# Current Annotation Tools – Open Source Software

- Limited to certain operation systems.
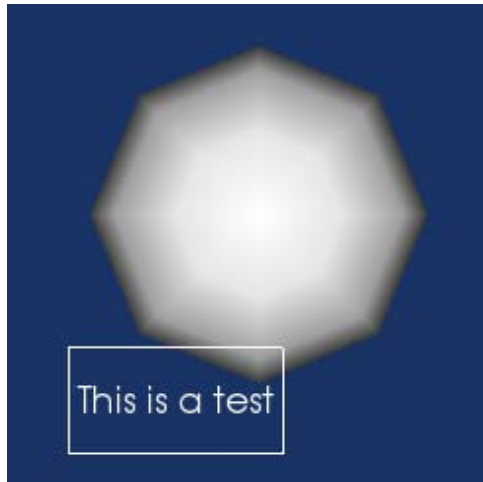- Missing features often found in other commercial products.

Our Solution – miAnnotation Open Source Tool

- Is open source
- Supports multiple operating systems
- Has similar annotation functionalities to commercial systems
- Is integrated into 3D Slicer
- Is easy to be customized
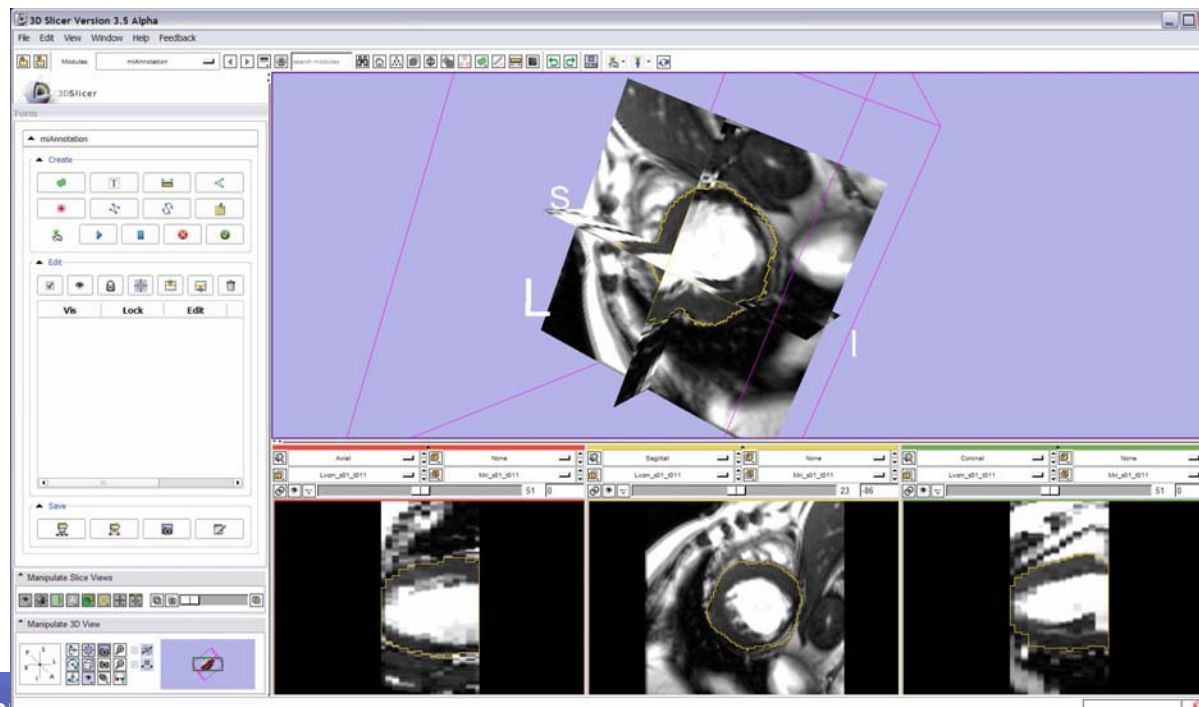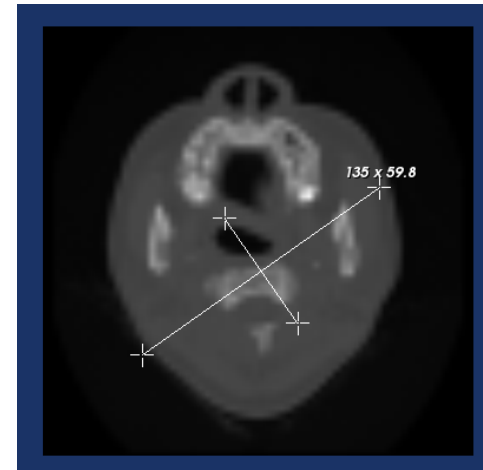
Annotation Types

Overlay Text Annotations

Sticky Note

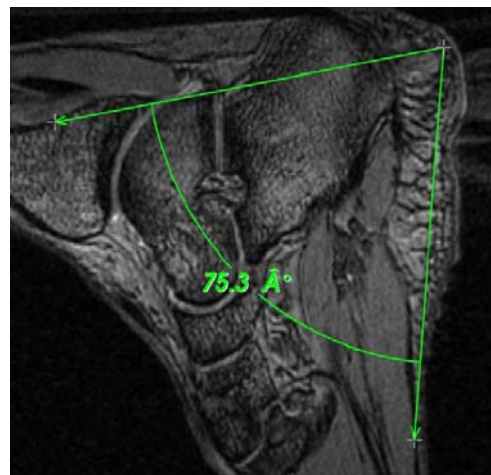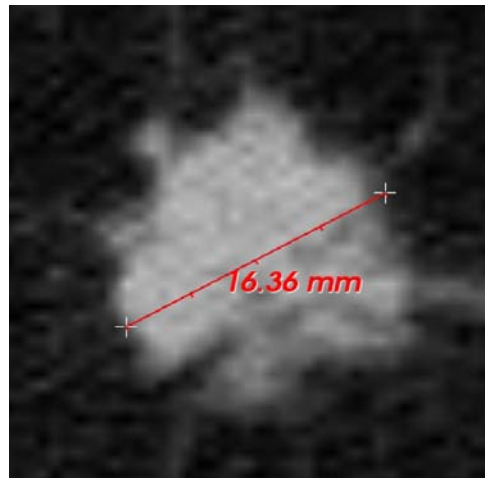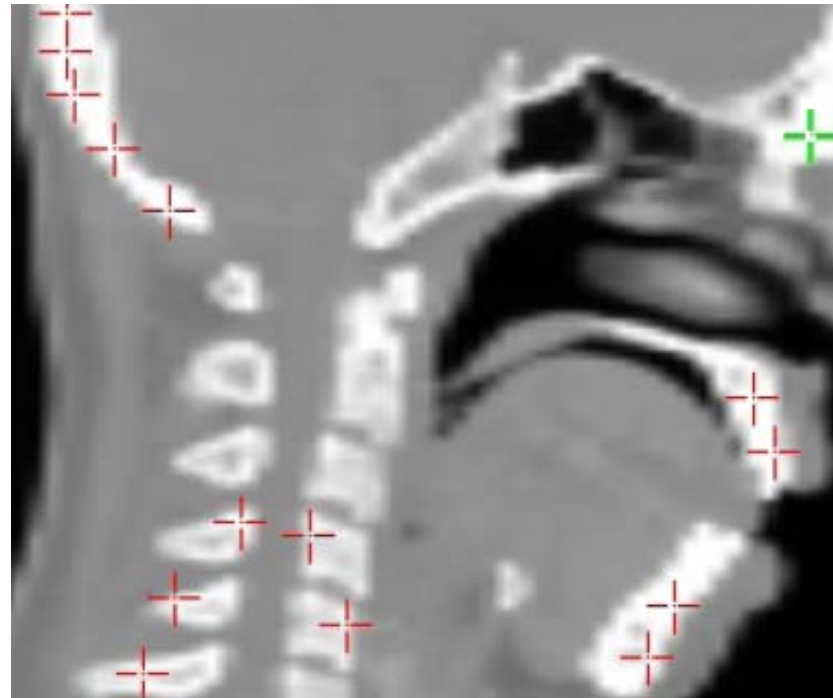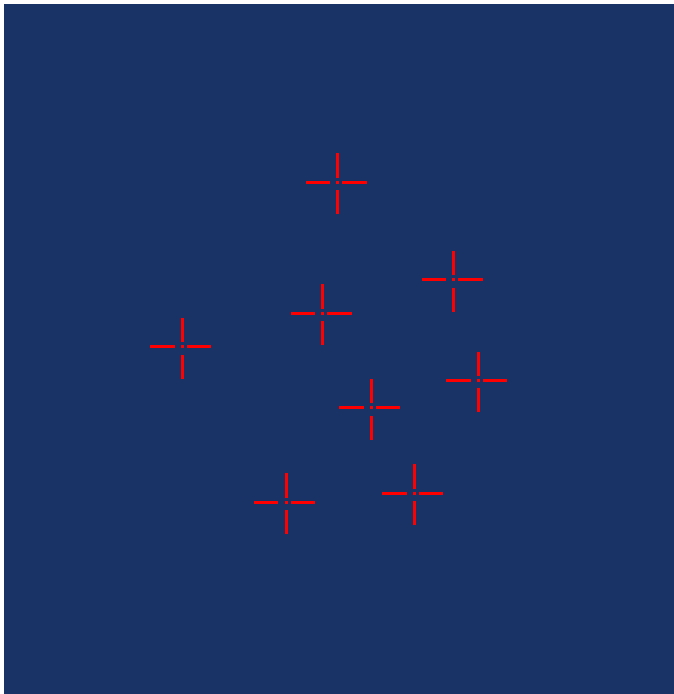**IBM Almaden Research Center** © 2009 IBM Corporation

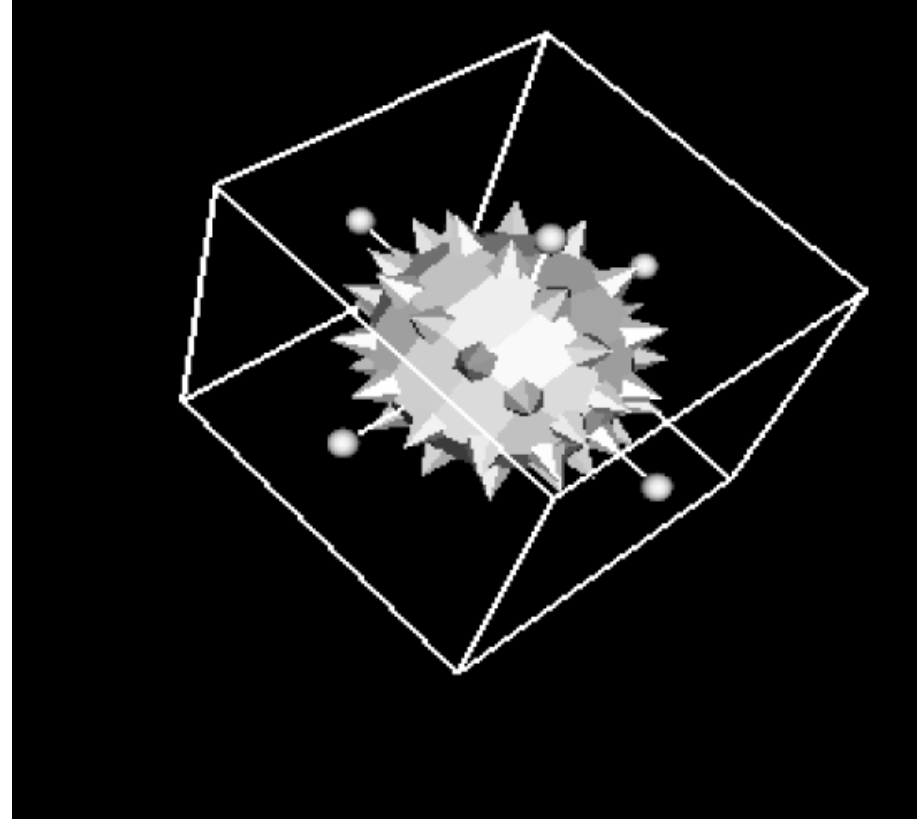# Measurement Annotations
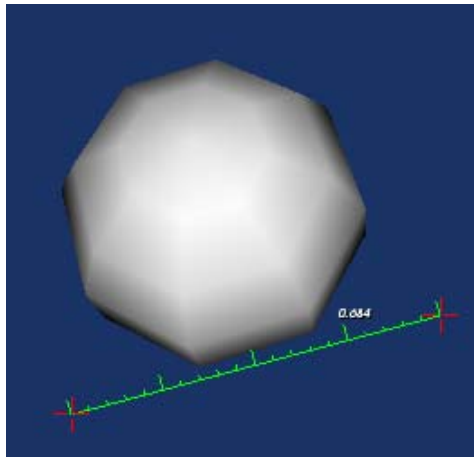
Ruler
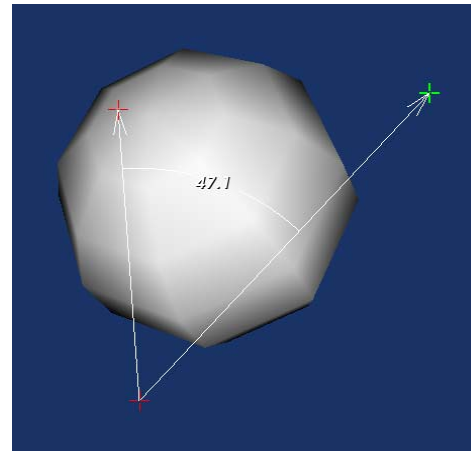
Angle

BiDimensional
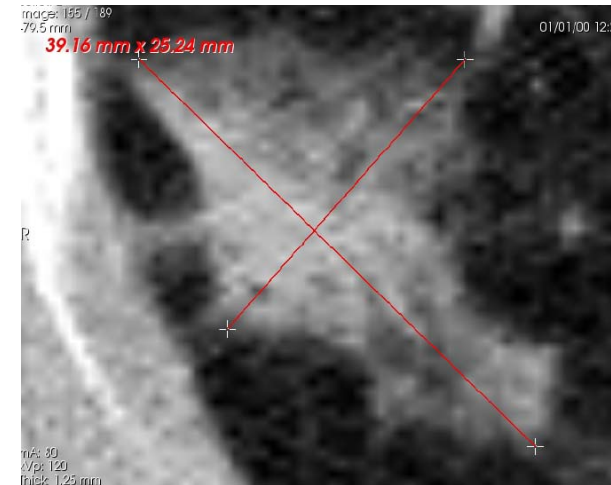
Fiducials (Seeds)

Region Of Interests (ROI) or Box Annotation

IBM Almaden Research Center © 2009 IBM Corporation
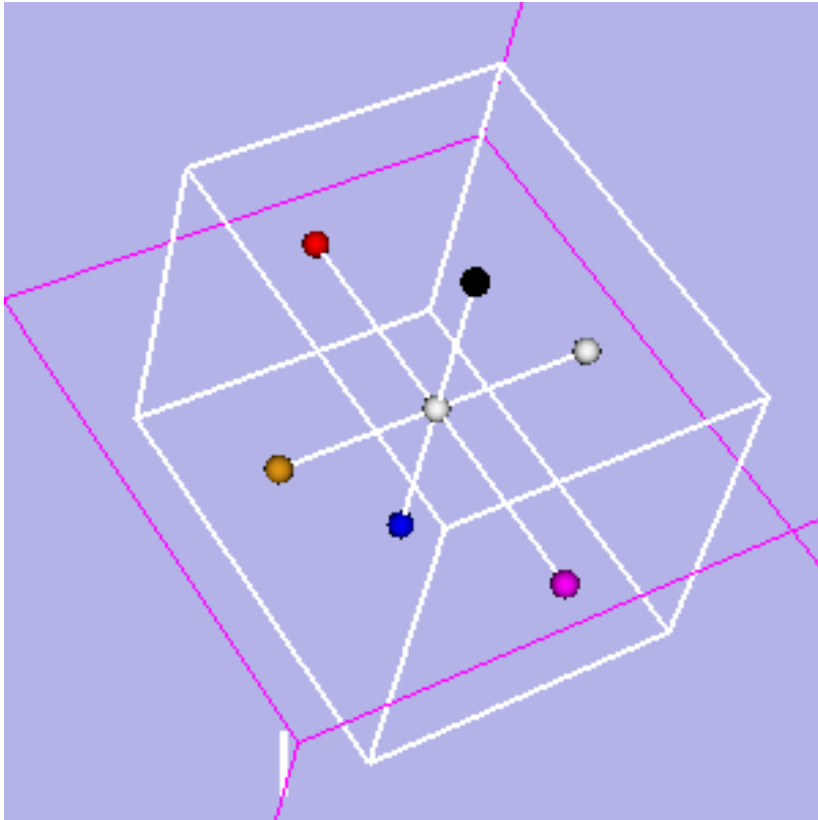
Spline Interpolator (Contour Annotation)

IBM Almaden Research Center
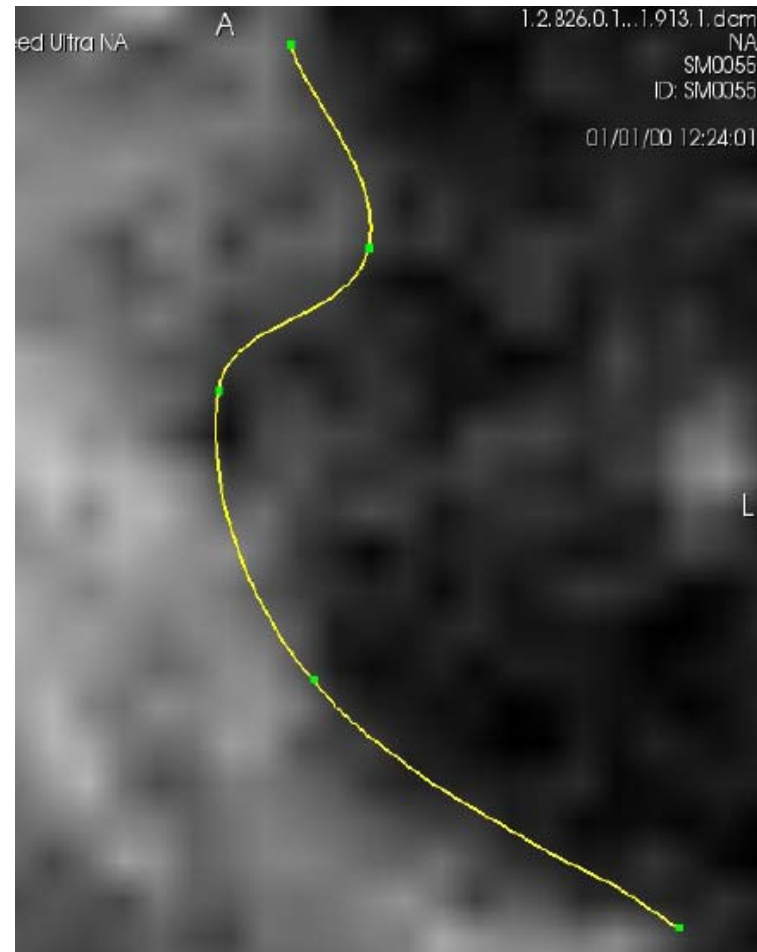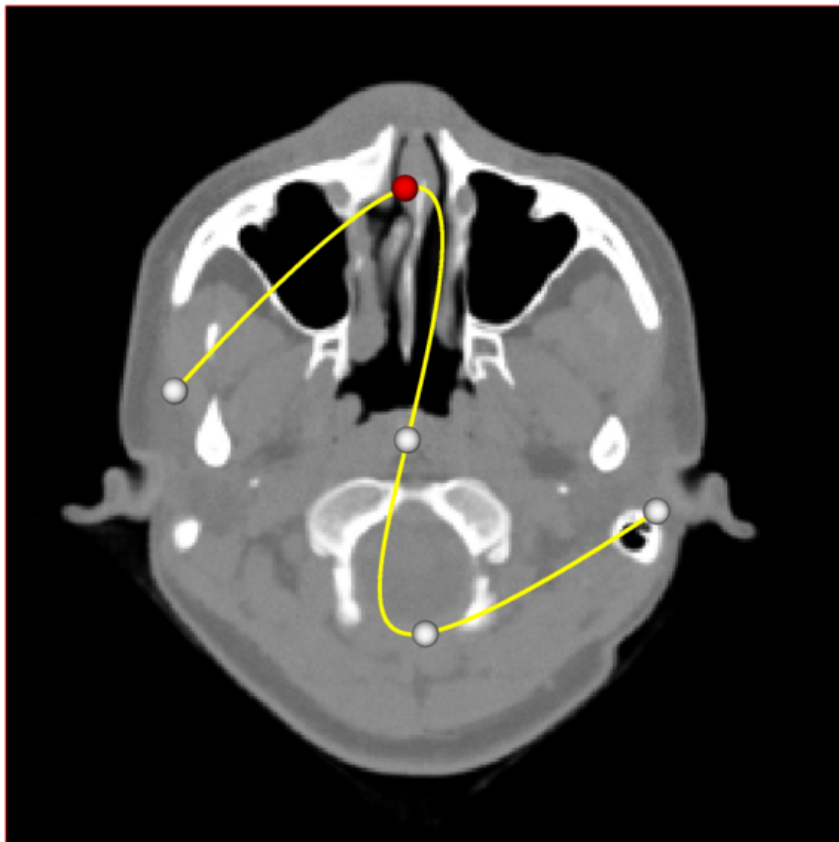
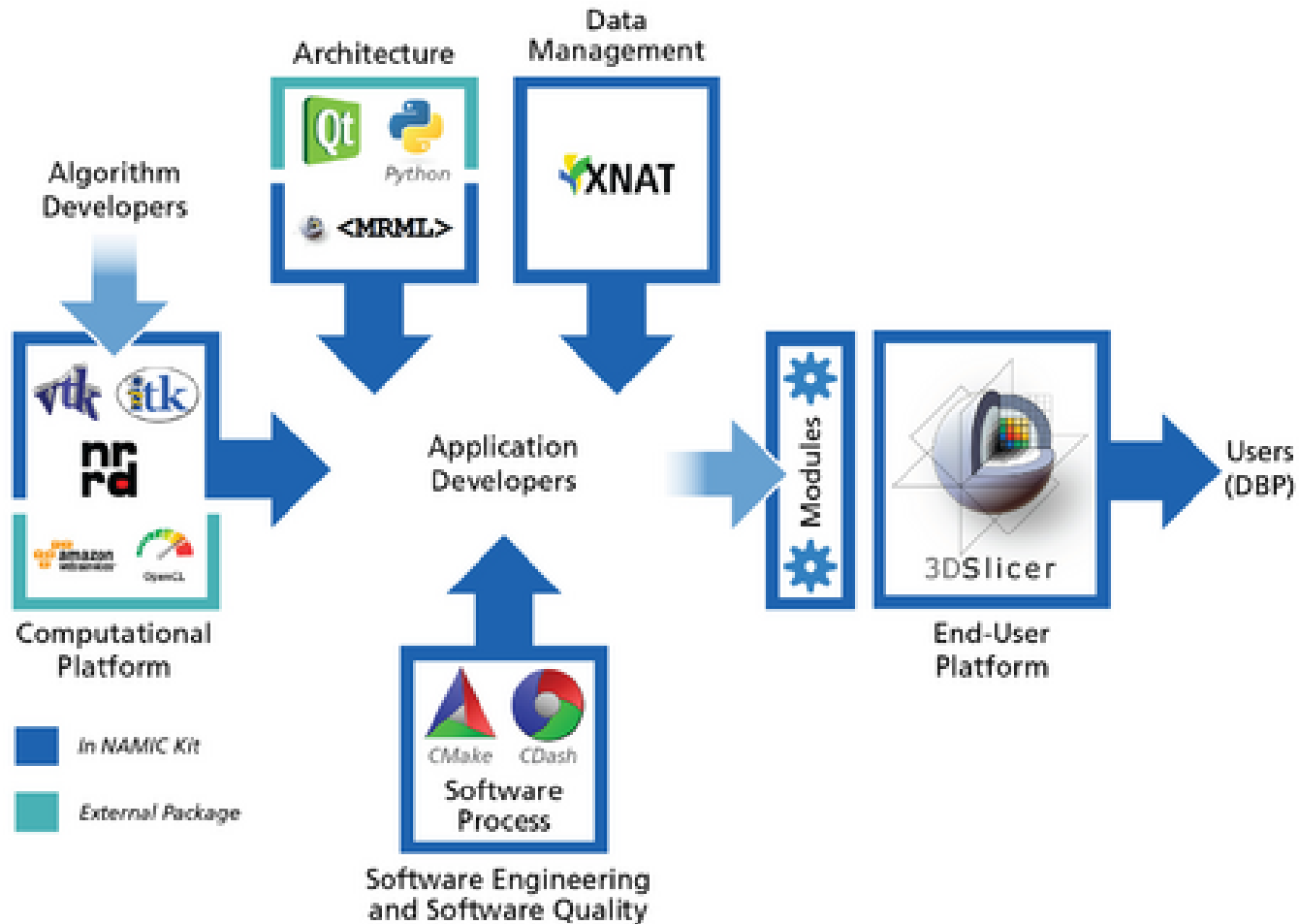# miAnnotation – Kits

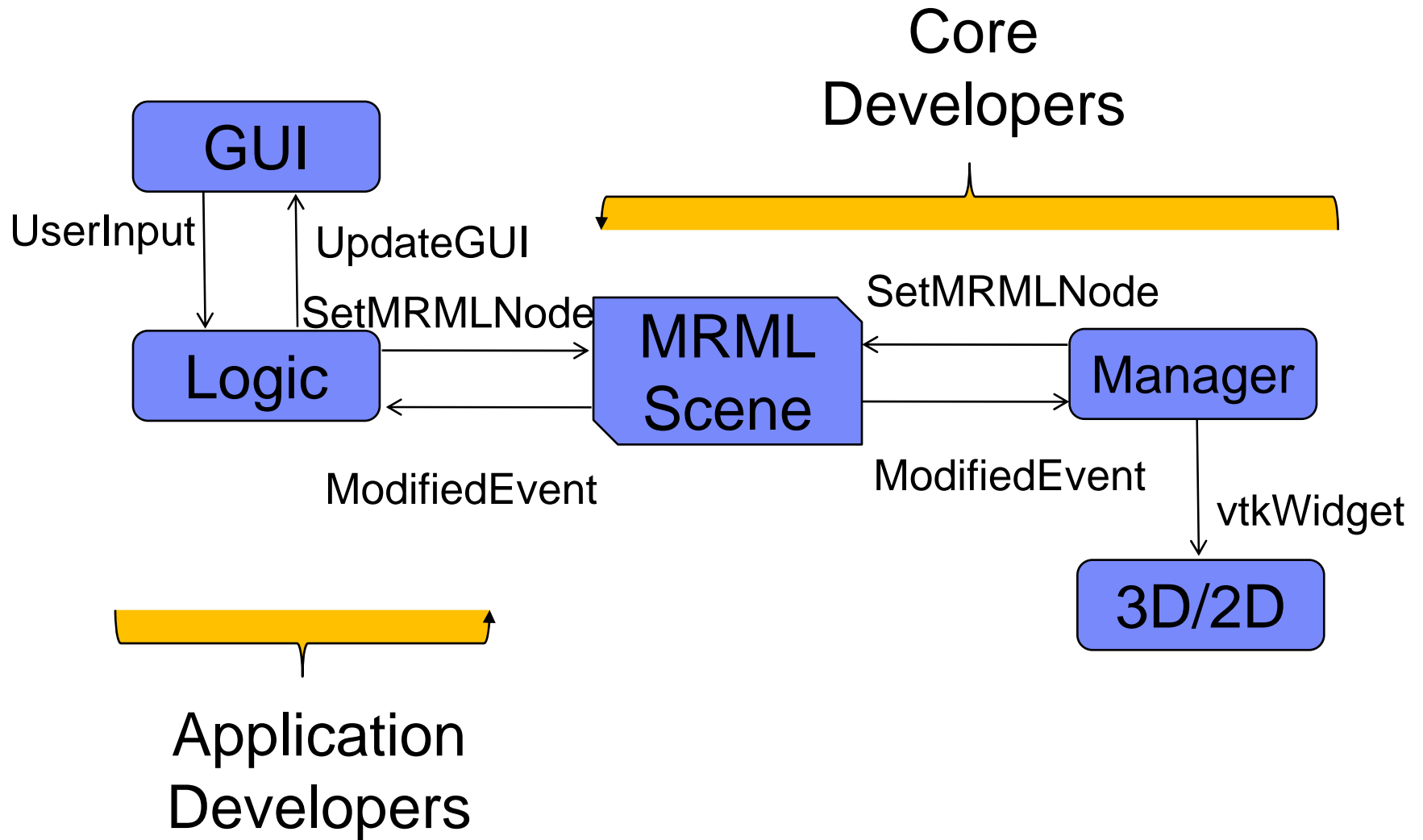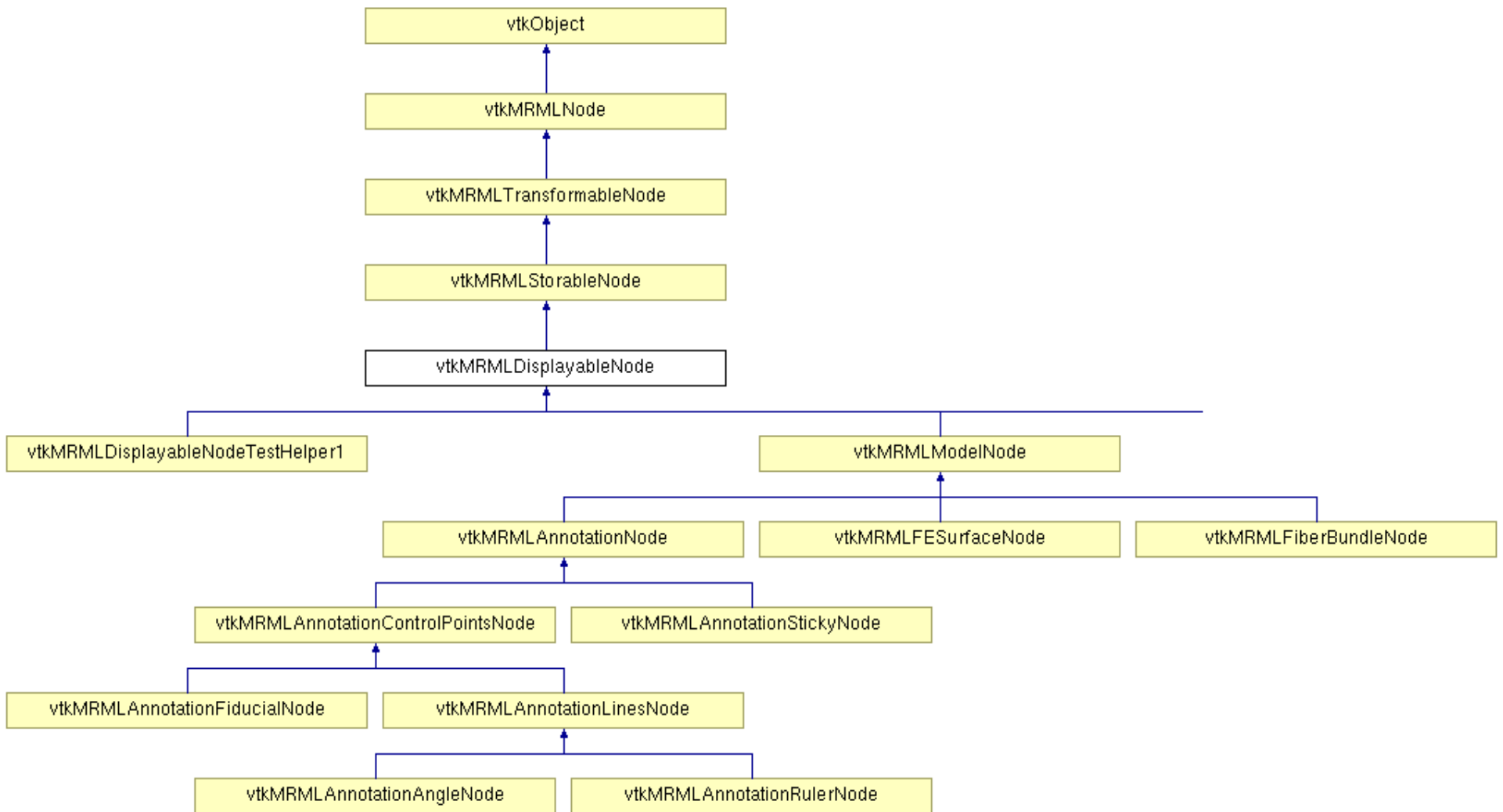| Package	Lines of code	Person years	Price tag at 100k per person year
Slicer	1,270,816	361	$36,122,644
KWW	207,208	54	$ 5,406,516
VTK	1,853,529	538	$53,808,076
ITK	848,383	237	$23,719,173
CMake / CTest / CPack	323,454	86	$8,590,888
CDash	78,226	19	$1,897,060
XNat	200,985	51	$5,149,987
Total	4,782,601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

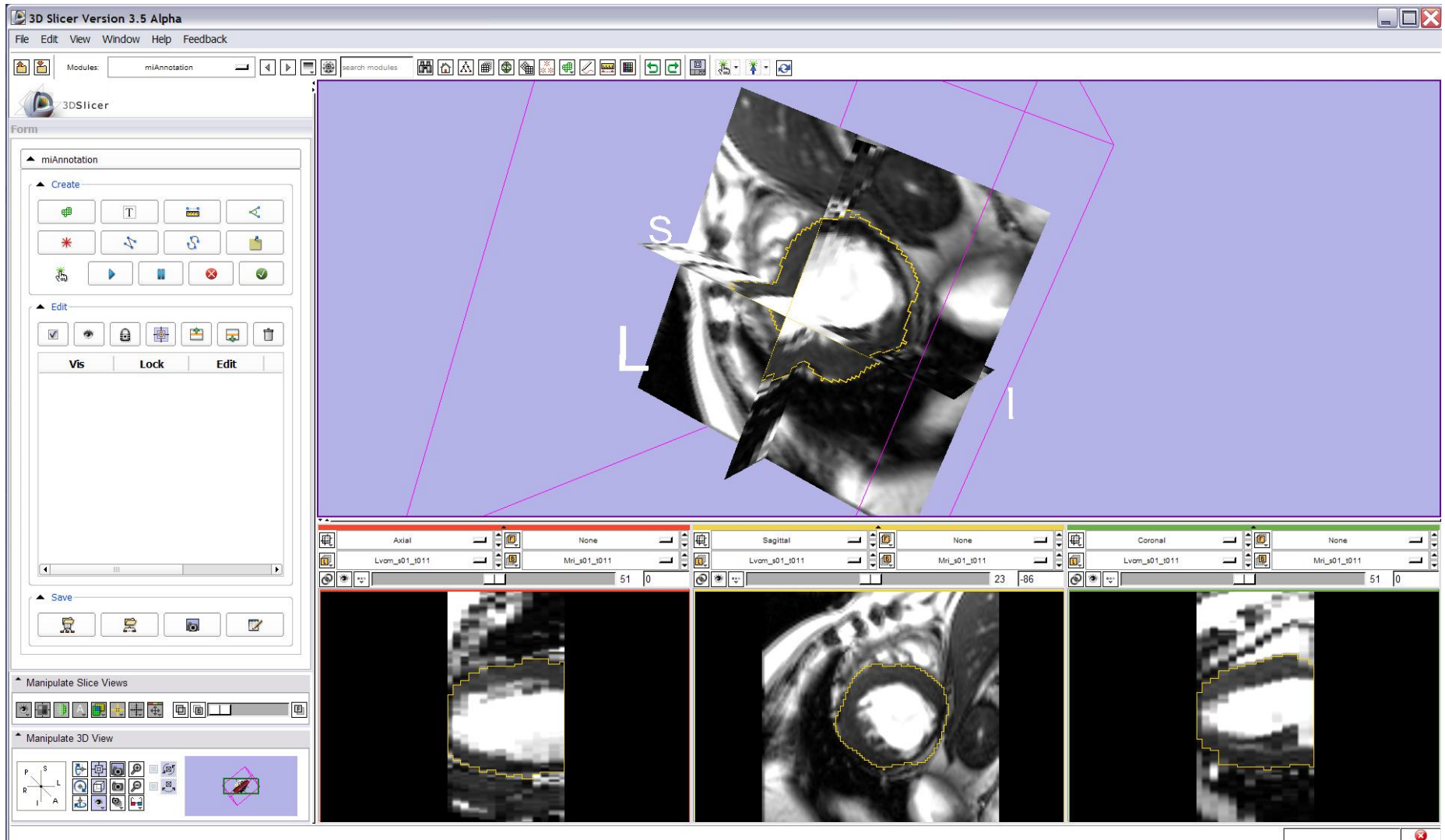# miAnnotation – Software Development

miAnnotation – Design

Core
Developers

GUI

UserInput   UpdateGUI

SetMRMLNode

SetMRMLNode

Logic

MRML
Scene

Manager

ModifiedEvent

ModifiedEvent

vtkWidget

3D/2D

Application
Developers

miAnnotation – Design (MRML Structures)

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miAnnotation – The User Interface

miAnnotation – Left Panel

- **Upper Panel** – Create
  - 8 different annotation types
  - Controls for mouse mode

- **Middle Panel** – Edit
  - A table contains all annotations
  - Edit annotation properties
  - Edit annotation table

- **Lower Panel** - Save
  - Save as text format
  - Save screen shot
  - Save entire MRML structure
  - Save report as HTML format

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miAnnotation – Input/Output

Output – MRML Scene

IBM Almaden Research Center © 2009 IBM Corporation

Output – Screen Shot

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Output – Report in HTML

Thank You

Software Demo…