Quantitative Image Informatics for Cancer Research (QIICR)

Motivation, Overview and Deliverables

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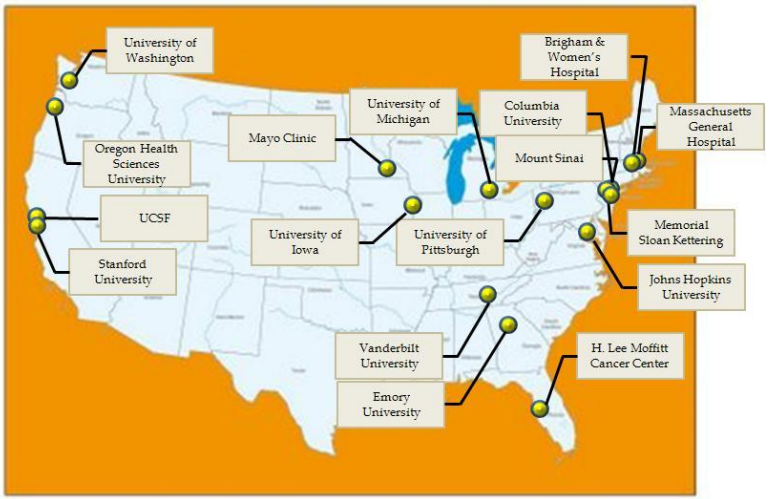
quantitative image informatics
QIICR
for cancer research

Background: Quantitative Imaging Network

- Aug 2008: NCI PAR-08-225
- Development and adaptation of tools for assessment of treatment response in clinical trials
- 17 imaging centers across US
- variety of modalities and cancer types
- collaborations with industry partners encouraged



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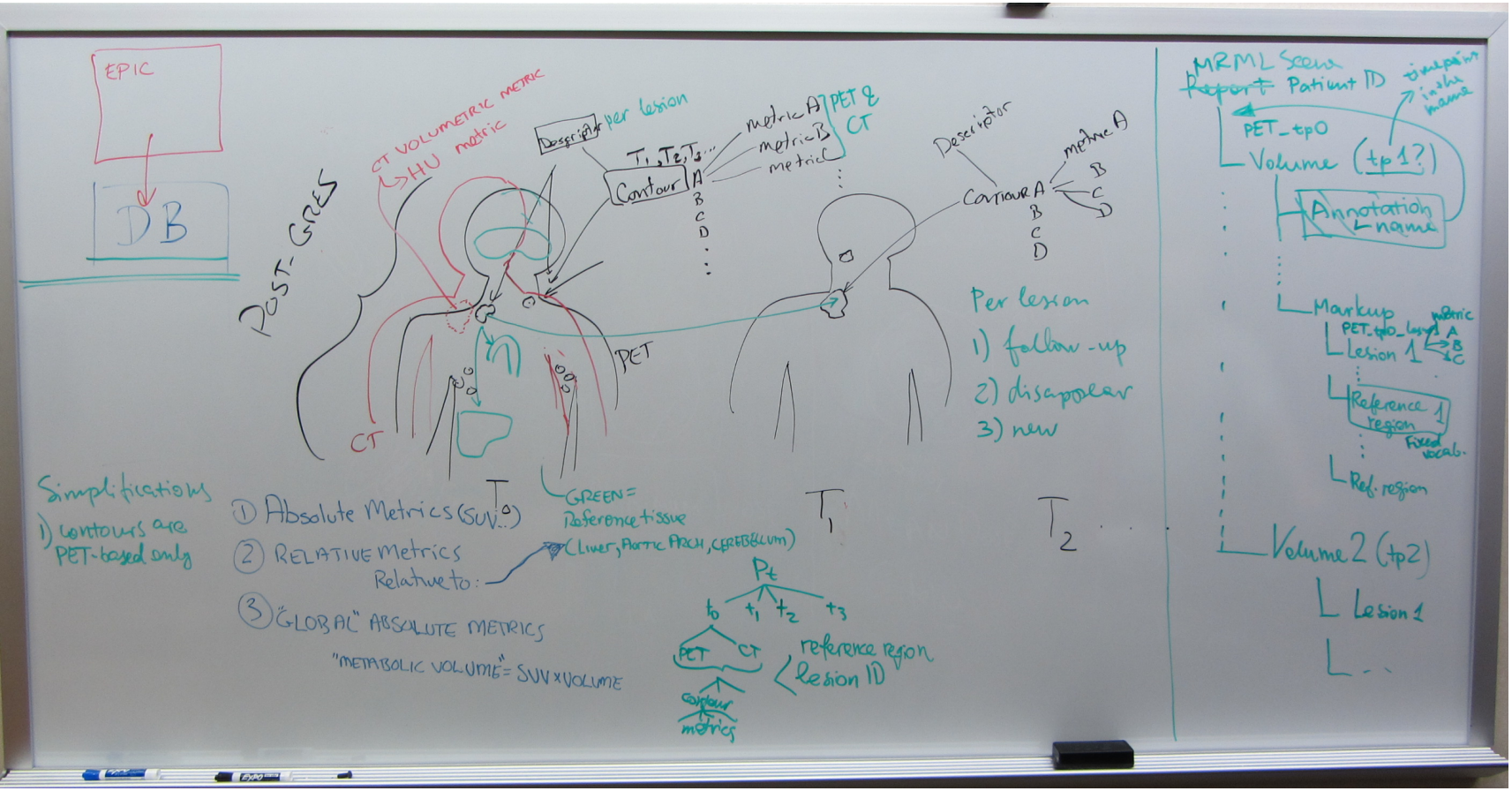
QIN Priorities

- Development of consensus on quantitative imaging methodology
  - evaluation and comparison of methods and tools
  - public data repositories
  - consensus metrology approaches
- Practical tools for the oncology community
  - software to support decision making
  - integration and evaluation in clinical trial setting

Data sharing challenges



QIN Challenges

- Data sharing
  - Site-specific solutions
  - Limited support of common formats
    - no agreement what that format should be
  - No repositories of annotated image data
- Tool sharing
  - Tools are generally developed for internal use
  - Different levels of maturity
  - Not always open source
- *Individual sites are not tasked with the development of the platform to facilitate sharing*

NCI ITCR initiative http://itcr.nci.nih.gov/

Informatics Technology for Cancer Research

2012: portfolio of technology oriented FOAs

- “Central mission is to promote research-driven informatics technology development”
- ”Funds requested must be used to support informatics technology development instead of research”
- “This FOA encourages applications that involve the development of innovative and user friendly informatics technologies of significant value to the whole spectrum of cancer research from bench to bedside“

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Photo credit http://www.betterphoto.com/uploads/processed/0912/0903160809491light_at_.jpg

QIICR Grand Idea

- Based on the needs of 3 specific QIN projects:
  - identify the image informatics needs
  - implement support for derived data and software tool sharing
  - converge on a format used for data sharing
  - facilitate adoption of the toolset
  - demonstrate by example what is feasible, what is missing
- Use DICOM as much as possible, consider improvements as needed
- Free open source

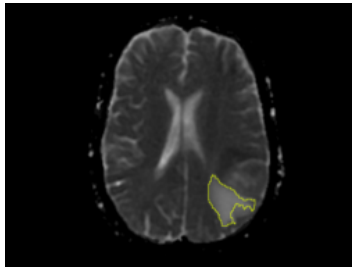
QIICR Aims

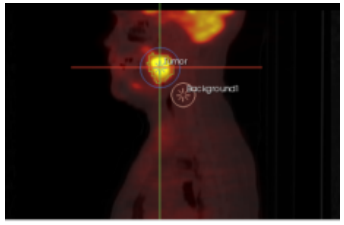
Aim 1: Workflows and tools for analyzing longitudinal imaging and derived data

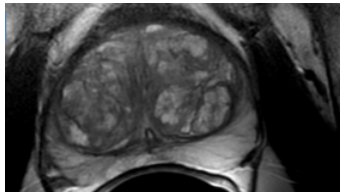
Aim 2: Standards-based structured reporting and representation of quantitative analysis results

Aim 3: User- and developer-level interfaces to data archives

Driving QIN projects







Attribute	MGH QIN Site	Iowa QIN Site	BWH QIN Site
Cancer target	Glioblastoma Multiforme	Head and Neck Cancer	Prostate Cancer
Underlying biological process	Angiogenesis, membrane permeability, hypoxia	Tumor glycolysis, hypoxia	Angiogenesis, membrane permeability
Quantitative Imaging Biomarker	Pharmacokinetic response, tissue diffusivity	SUV-derived values	Pharmacokinetic response, tissue diffusivity
Clinical Outcome / Standard of Care	Progression free survival, Macdonald, RANO Criteria	Metastatic proliferation, survival, PERCIST	PSA, histopathology (Gleason)
Longitudinal Relationships, Timepoints	up to 30 timepoints	2 to 7 timepoints	2 to 3 timepoints
Imaging	MR: T1, T2, DWI, DSC, DCE, DTI, BOLD	PET/CT	MR: T1, T2, DWI, DCE
Post-Processing	K^{trans},v_e, v_p, TTP, ADC, rCBV, rCBF…	SUV	K^{trans}, TTP, ADC…
Segmentation Image	GBM, Necrosis, Edema. Vessel (AIF)…	Tumor, Lymph Nodes, Reference Anatomy	Prostate Gland (Central and Peripheral Zones), Tumor, Normal Tissue, Vessel (AIF)
Registration	Distortion Correction, Motion Correction, Longitudinal Alignment	Longitudinal Alignment	Distortion Correction, Motion Correction, Longitudinal Alignment
Markups	Manual initialization Macdonald Criteria Measurements	Manual Segmentation Reference, Manual initialization (Seed, Sphere)	Manual Segmentation Reference
Display	Lightbox axial mode, statistical overlay, multivolume timecourse	Volume rendering compare view, statistical overlay	Lightbox MPR, statistical overlay

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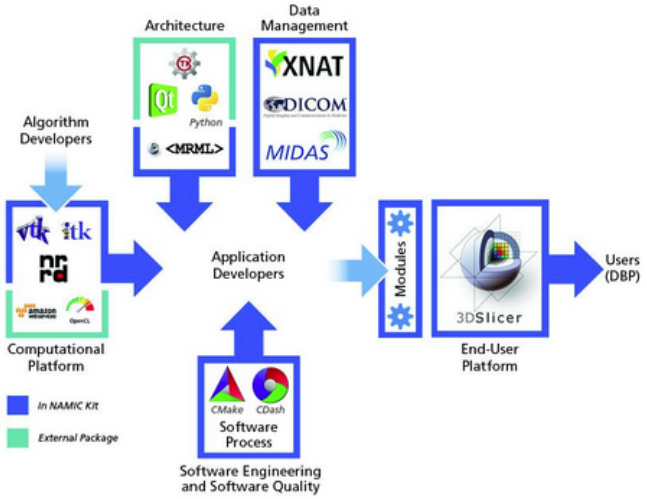
QIICR Aim 1: Tools

Understanding the applications and the user needs:

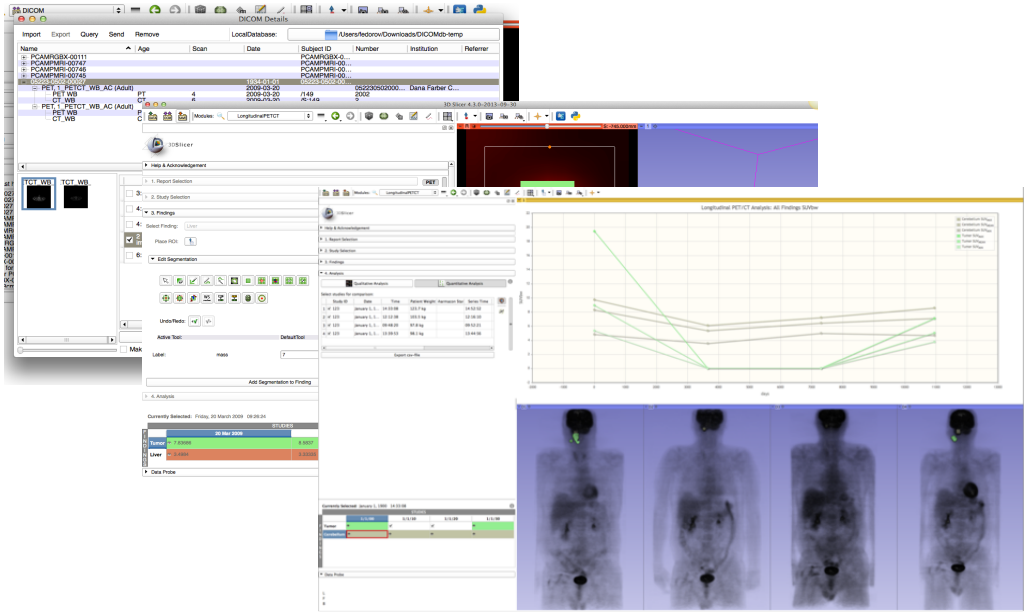
- user-level workflows (in 3D Slicer) integrating analysis tools
- data structures and information modeling
- improved provenance infrastructure in 3D Slicer



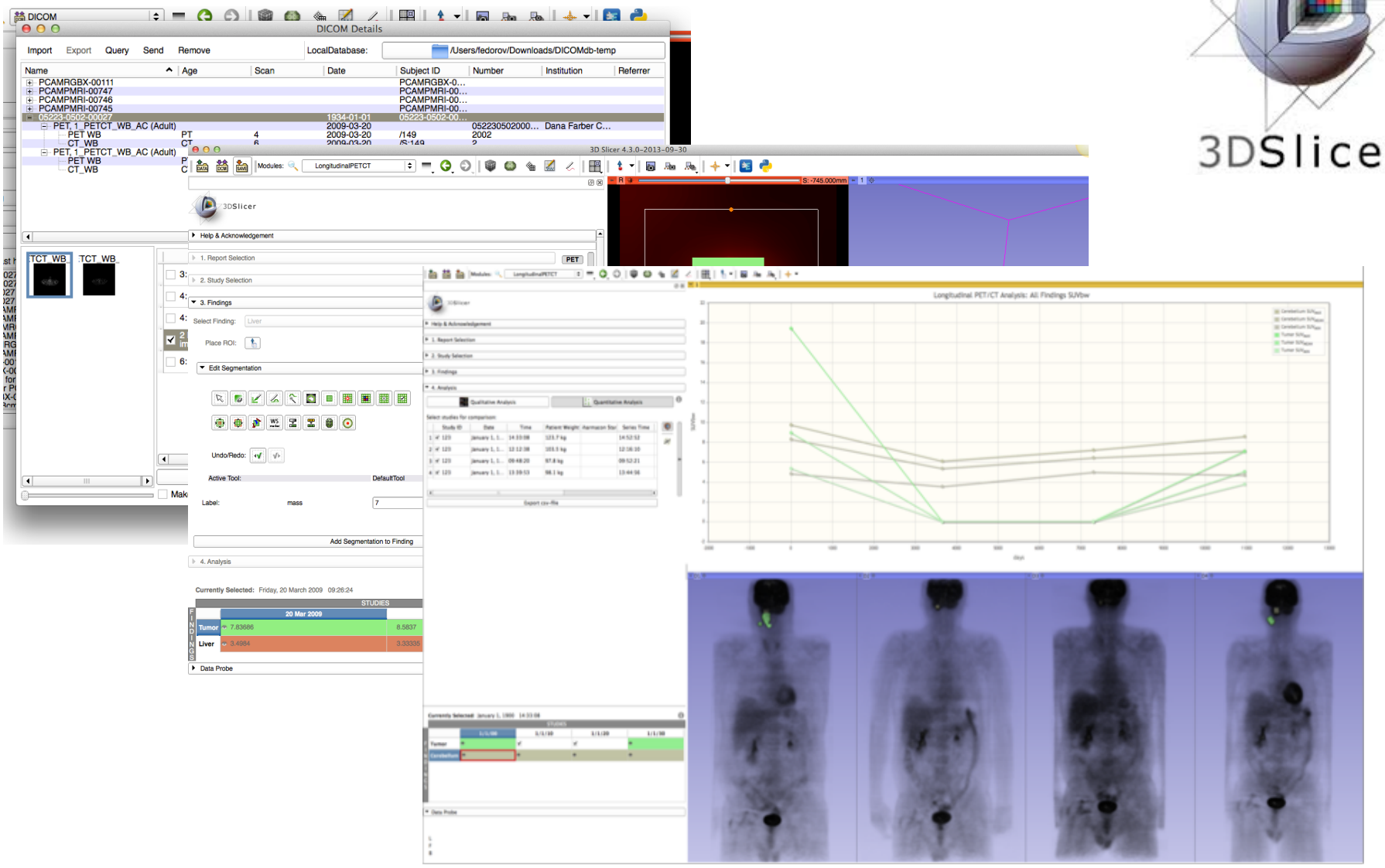
QIICR Aim 1: Tools

Interactive analysis workflows

- input data interpretation
- processing steps
- visualization
- quantification
- serialization



Interactive analysis workflows



3DSlicer

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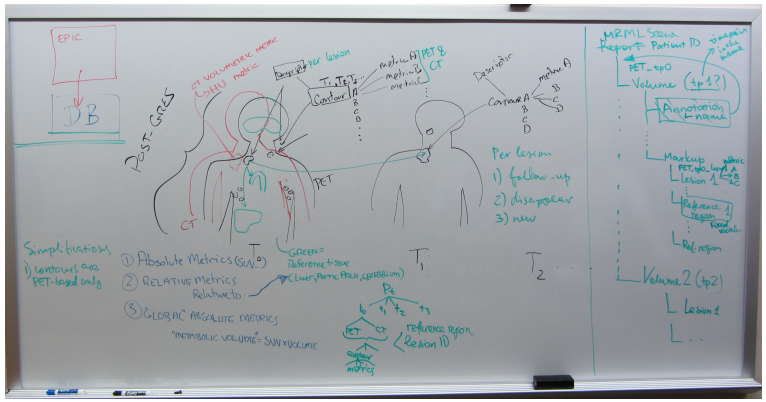
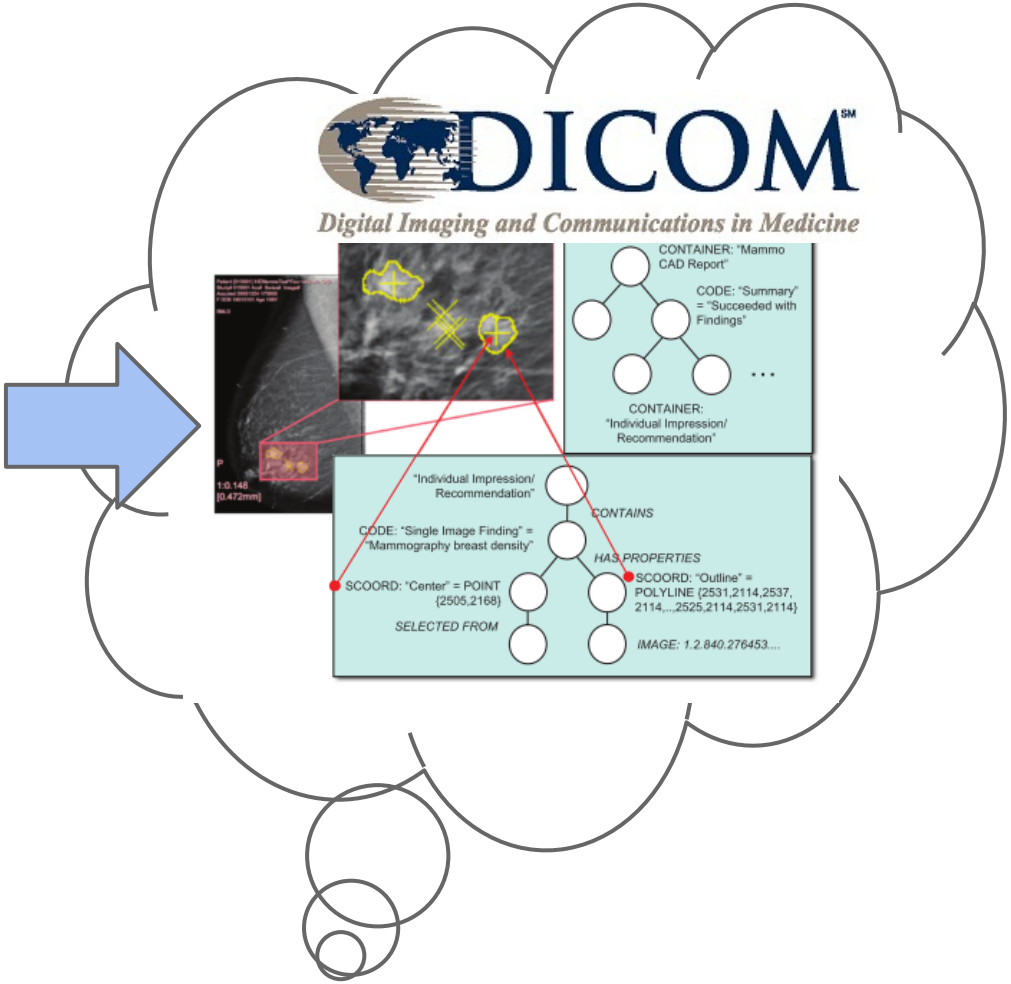
QIICR

QIICR Aim 1: Tools





Clunie, D. A. (2007). DICOM Structured Reporting and Cancer Clinical Trials Results. Cancer Informatics, 4, 33–56.

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QIICR Aim 2: DICOM

Focus on interoperability, structured organization:

- reporting templates
- coded terminologies
- support of relevant parts of the DICOM standard
- go beyond support in 3D Slicer

QIICR Aim 2: DICOM

Specific parts of DICOM to support quantitative image analysis for treatment response assessment:

- Segmentation Objects
- Registration Objects
- Real World Value Mapping
- parameter maps
- Structured Reports (+ new specialized templates)

QIICR Aim 3: Sharing

Simplify interaction with public repositories to facilitate sharing of the analysis results:

- focus on 2 most popular repositories:
  - NCI TCIA
  - XNAT Central
- integrate developer API into 3D Slicer
- provide user-level “data browsers”
- support 2-way communication

Multi-tier support of imaging research

- Institution level
  - improve usability of tools
  - facilitate integration with clinical workflows
- Multi-site projects level - QIN
  - enable sharing, demonstrate by example
  - a resource to the QIN community
- Medical image computing community
  - reach out beyond QIN and clinical research domains
  - demonstrate advantages to encourage adoption

Deliverables

- Tool sharing:
  - Specialized 3D Slicer extensions for 3 QIN projects
- Data sharing:
  - Reporting templates, documentation, tools and working examples based on DICOM
  - Structured datasets from 3 QIN projects
- Comparison, validation and secondary analysis:
  - Support of public repositories
  - 3D Slicer interactive tools to interface repositories

Our team

Leadership

- Ron Kikinis, MD - Brigham and Women's Hospital, Boston
- Andrey Fedorov, PhD - Brigham and Women's Hospital, Boston

Driving Biological Projects

- Quantitative MRI of Glioblastoma response: Massachusetts General Hospital
  - Jayashree Kalpathy-Cramer, PhD
  - Elizabeth Gerstner, MD
  - Karl Helmer, PhD
- Head and Neck cancer response assessment with PET/CT: University of Iowa
  - Reinhard Beichel, PhD - Iowa University
  - Milan Sonka, PhD - Iowa University
- Quantitative MRI of prostate cancer: Brigham and Women's Hospital
  - Fiona Fennessy, MD, PhD
  - Andrey Fedorov, PhD

3D Slicer development technical lead

- Steve Pieper, PhD - Isomics Inc., Cambridge

DICOM technical lead

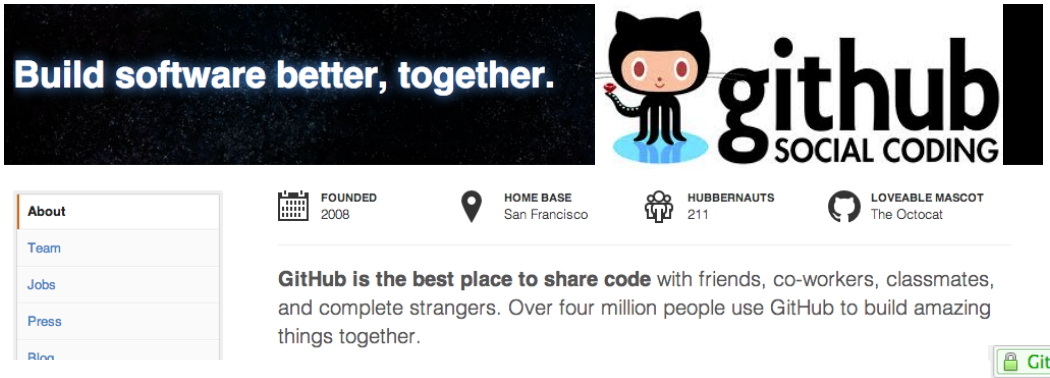
- David Clunie - CoreLab Partners, Inc. and PixelMed Publishing, LLC

Coordination and Dissemination

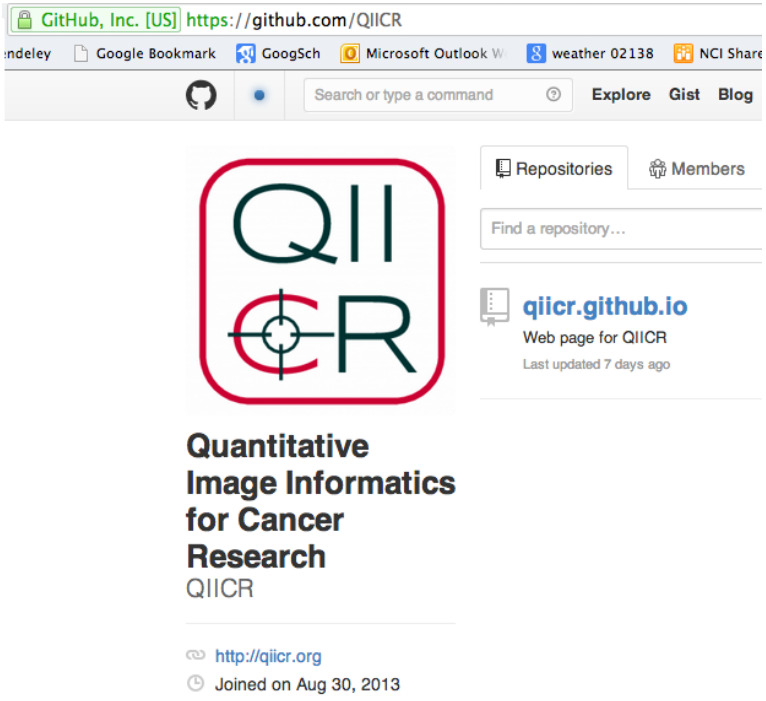
Continue the best traditions of the existing projects:

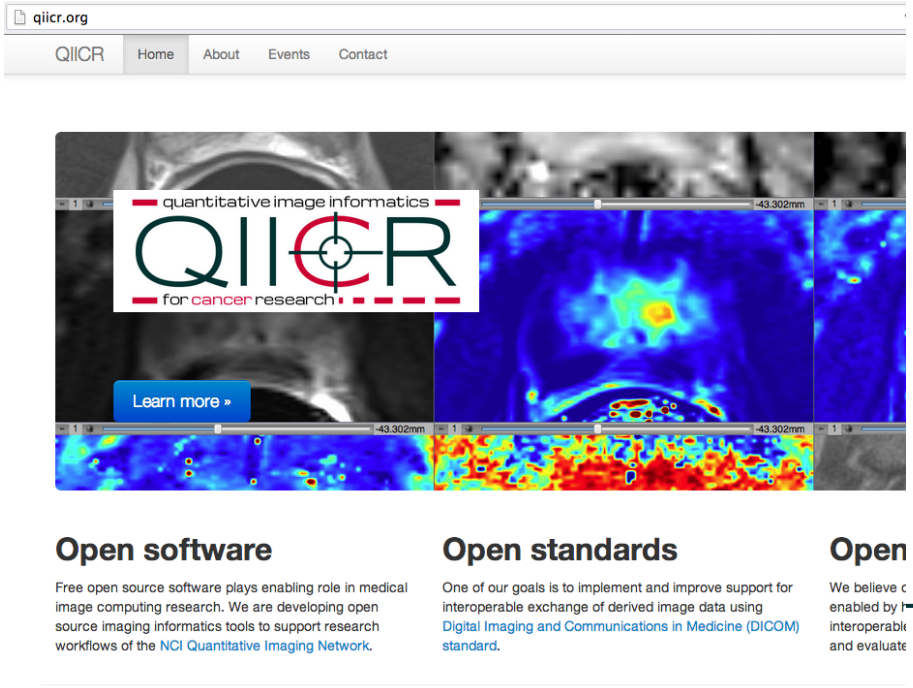
- semi-annual hands-on meetings during NA-MIC project weeks
- coordination with QIN working groups
- leverage on-going efforts of NAC, NCIGT and NA-MIC projects
- in-person and screencast training sessions and tutorials
- wiki documentation

Coordination and Dissemination



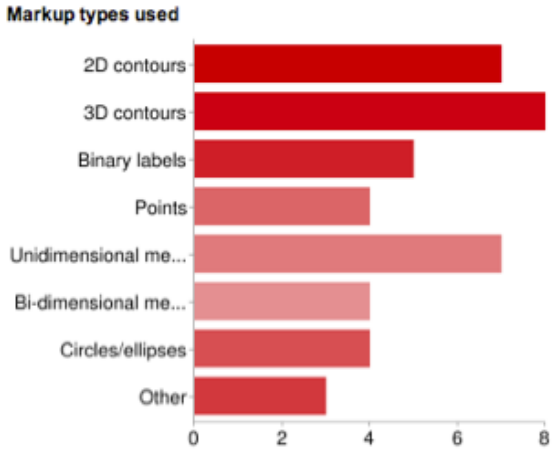
http://qiicr.org





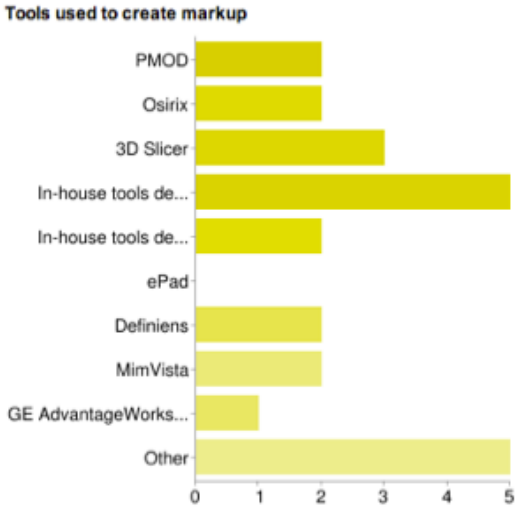
- QIICR is supported by NCI award U24 CA180918
- The contents are solely the responsibility of the authors and do not necessarily represent the official views of the NCI.

Derived data sharing: QIN site survey



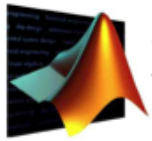
2D contours	7	70%
3D contours	8	80%
Binary labels	5	50%
Points	4	40%
Unidimensional measurements (e.g., RECIST)	7	70%
Bi-dimensional measurements (e.g., WHO/MacDonald)	4	40%
Circles/ellipses	4	40%
Other	3	30%

People may select more than one checkbox, so percentages may add up to more than 100%.



PMOD	2	20%
Osirix	2	20%
3D Slicer	3	30%
In-house tools developed in Matlab	5	50%
In-house tools developed in IDL	2	20%
ePad	0	0%
Definiens	2	20%
MimVista	2	20%
GE AdvantageWorkstation	1	10%
Other	5	50%

People may select more than one checkbox, so percentages may add up to more than 100%.



MATLAB
The Language of Technical Computing

QIN BIDS WG site survey, May 2012

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