NCI Funding for Radiomics

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AAPM July 2016

In memory: Larry Clarke, 1944-2016

Colleague, friend, mentor

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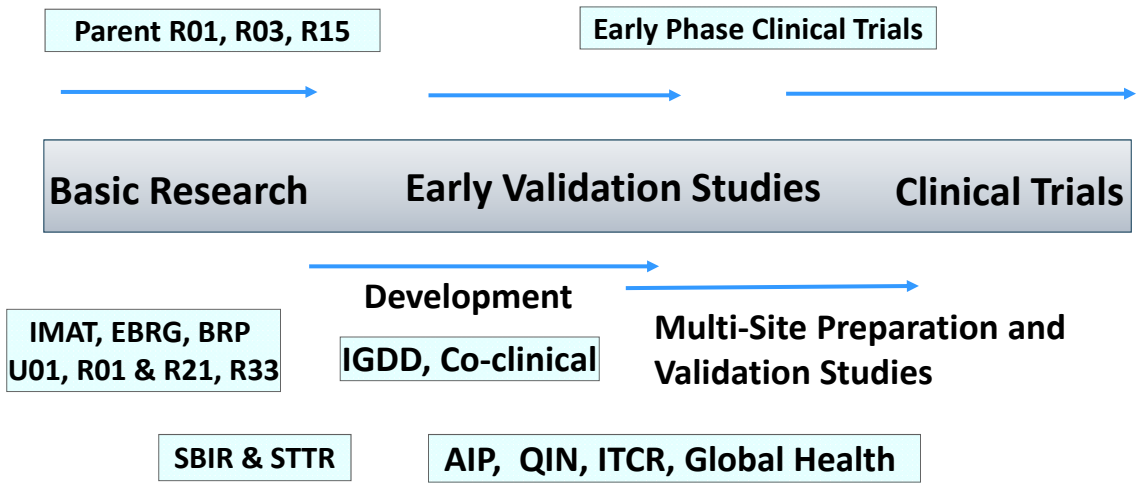
Technology Development: Basic Research to Clinical Trials



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General Funding

- Funding Opportunities and Notices- NIH & NCI
  - http://grants.nih.gov/grants/guide/
  - http://www.cancer.gov/researchandfunding/funding/announcements
- Common types of grant
  - Parent Announcements– R01, R21, R03, etc.
  - Request for applications (RFA) Set aside funds
  - Program announcement (PA/PAR) R01, R21, U01, etc.
  - SBIR/STTR

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Funding Initiatives that support Technology Development

- Innovative Molecular Analysis Technologies in Cancer Research (IMAT)
- Bioengineering Research Partnership and Grants
- Nanotechnology
- Quantitative Imaging
- Academic Industrial Partnerships
- Information Technology for Cancer Research
- Technologies for Global Health
- SBIR/STTR

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Quantitative Imaging Network

Quantitative Imaging for Evaluation of Responses to Cancer Therapies: U01

PAR 14-116

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Rationale

- Multi-center clinical trials need validated imaging tools to measure therapy response
  - Improve evaluation of therapies with quantitative imaging
  - Reduce response variability to increase power
- Validate quantitative imaging techniques on commercial platforms to support multi-center multi-platform trials
- Collaborative efforts include multi-site algorithm challenges with shared data

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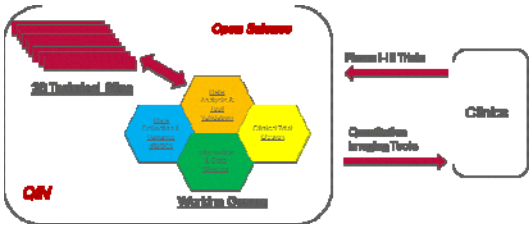
Quantitative Imaging Network

- A cooperative agreement (U01) grant
- Develop, test, and validate quantitative imaging methods for evaluating response to therapies
- Managed as a network
  - Trans-institution working groups
  - Some data sharing between groups required



- All data and algorithms will be public eventually

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QIN tools Reaching Clinical Workflow

Institution	Concept	Development	Testing & Optimization	Clinical Testing	Commercialization	Clinical Workflow	
Brigham & Women's Hospital							
3-D Slicer for Medical Image Visualization	■	■	■	■	■	■	**Open Source**
Brigham & Women's Hospital							
mpReview: Annotation for multiparamagnetic MRI	■	■	■	■	■	■	**Open Source**
Brigham & Women's Hospital *							
OncoQuant: DCE-MRI Analysis	■	■	■	■	■	■	**Not yet publically available**
Stanford University **							
ePAD Clinical Viewer	■	■	■	■	■	■	**Open Source**
*** with GE Global Research**	**Basic Research**			**ClinicalResearch**		**Community**	

** Active User's Group

Examples of Radiomics in QIN

Gillies, Moffitt

Aerts, Dana Farber

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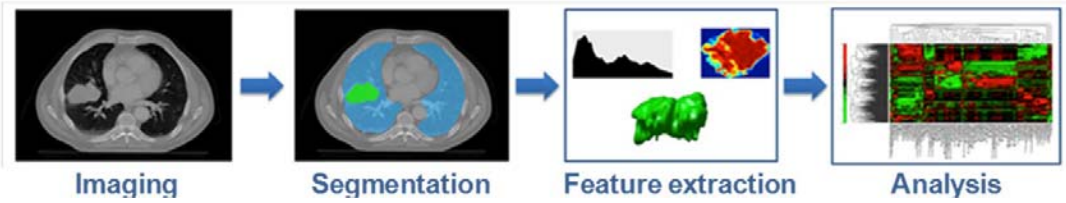
The Pipeline for Radiomic Image Processing



- Assemble cohorts of high-quality images with matching outcome data
- Segment lesions
- Extract regions of interest and process data from them:
  - Semantic features: e.g. size, shape, location
  - Agnostic features: e.g. wavelet parameters, histogram skewness
- Data mining, combining imaging information with clinical information

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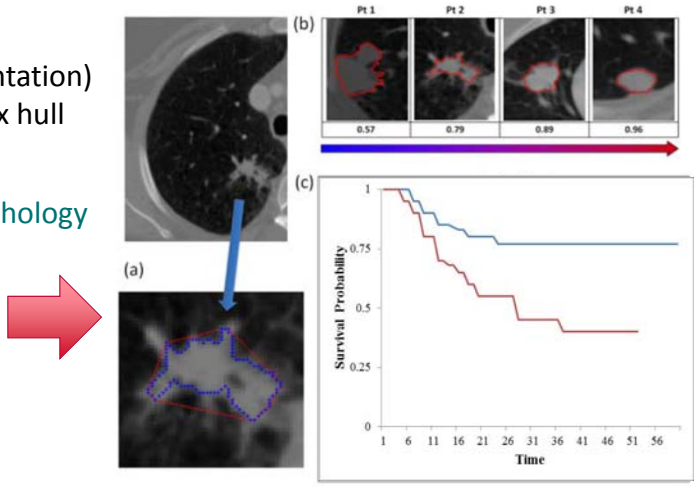
A Feature Example: Convexity

Convexity is the ratio of the tumor border (from segmentation) to the perimeter of a convex hull surrounding the tumor.

Convexity tracks tumor morphology

Here, the blue is the tumor border and red is the convex hull perimeter



Convexity is predictive of patient overall survival when dichotomized at the median value.

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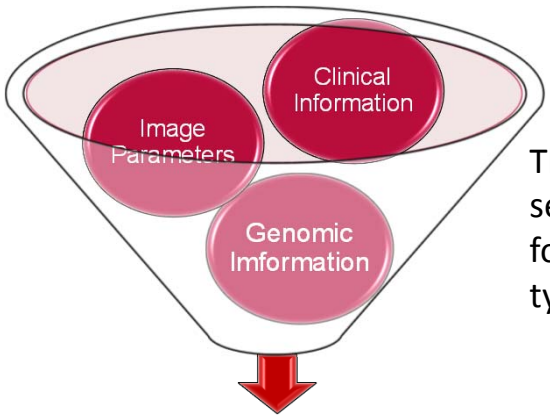
Feature Size Reduction

As many as 400 to 500 features are first considered



The reduced feature set will be different for different tumor types and organ sites.

Through data mining and analysis in specific cancer studies, 4 to 7 parameters may prove to be sufficient for therapy response

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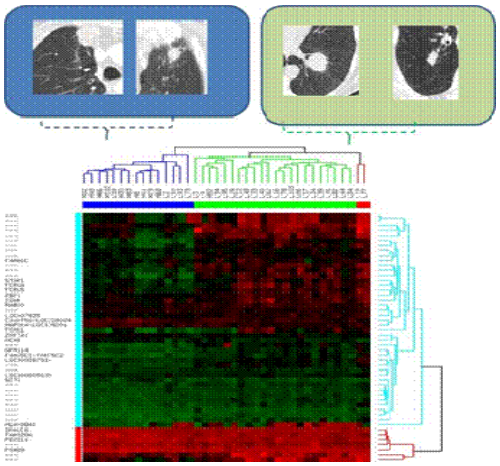
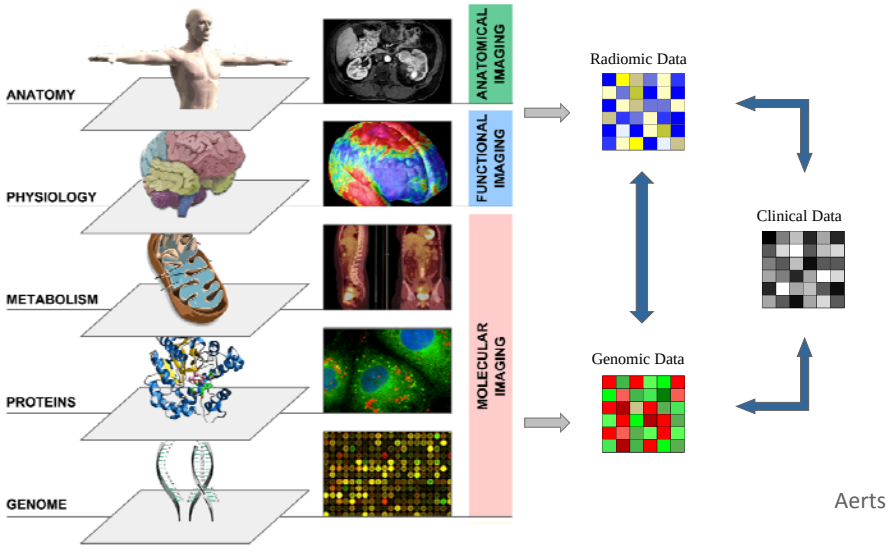
Heat Map Clustering: Imaging Traits & Gene Expression

Clustering showing significant correlation between gene expression patterns and pleural attachment in lung adenocarcinoma



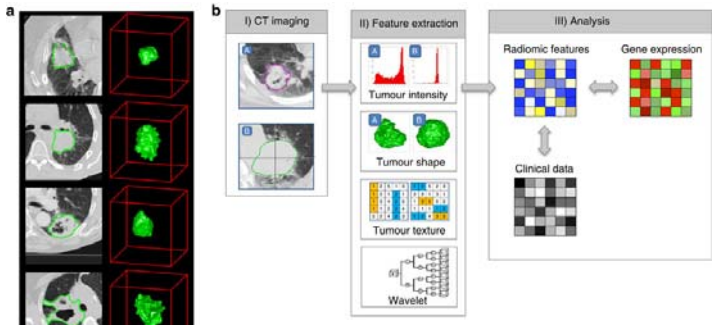
Data from Moffitt Cancer Center 2016

Multilevel Data



Aerts

Imaging-Genomics across cancer types



nature COMMUNICATIONS

*Aerts *et al.* Nature Comm. 2014

- Radiomics analysis on CT imaging of >1000 patients with Lung or H&N cancer
- Developed and Validate a prognostic radiomics signature that can be applied across cancer types
- Imaging-Genomics analysis showed strong correlations between radiomics and genomics data

Academic-Industrial Partnerships for Translation of Technologies for Cancer Diagnosis and Treatment

R01: PAR-15-075

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Rationale

- There is a constant need for adaptation, optimization and validation and eventual commercial dissemination of novel imaging technologies.
- These imaging methods need to be fully integrated into commercially supported imaging platforms.
- Research partnerships between academic and industry are therefore a critical on-going requirement for imaging research.
- Academic-Industrial Partnerships for Translation of Technologies for Cancer Diagnosis and Treatment (R01): PAR-15-075

AIP
Program Structure

- **Research and Innovation:** Clear translational research strategy for proposed technology.
  - Focuses on cancer detection and diagnosis, prediction and measurement of response to therapy, including image guided interventions.
- **Project oriented toward clinical use:** Should include physicians as key participants to provide essential expertise in oncology, pathology and/or other clinical science and practice appropriate to the planned outcome.
- **Project oriented toward pre-clinical use:** Translations of technologies to enhance the research performance of existing systems or provide new methods for a targeted cancer research problem.
  - Focus on the optimization of advanced prototype imaging technologies and methods across pre-clinical and clinical applications.
- **Partnership Structure:** Partnerships for academic and industrial collaboration with translational research goals. Must include at least one lead academic and one lead industrial organization
- **Foreign Institutions:** Eligible to apply.

Information Technologies for Cancer Research: ICTR

R21, U01, U24

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Information Technologies for Cancer Research

- **Mission:** Promote research-driven informatics technology to address priority needs in cancer research.
- **Scope:** Serve informatics needs that span the cancer research continuum and provide support for informatics resources:
  - development of innovative methods and algorithms,
  - early and advanced stage software development,
  - sustainment of high-value resources on which the research community has come to depend.
- ITCR supports a wide range of informatics tools to serve current and emerging needs across the cancer research continuum.

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ITCR PARs: Four Funding Opportunities

Supporting successive stages of informatics technology development.

- **Algorithm development (R21):** PAR-15-334: Development of Innovative Informatics Methods and Algorithms for Cancer Research and Management
- **Prototyping and Hardening (U01):** PAR-15-332: Early-Stage Development of Informatics Technologies for Cancer Research and Management
- **Enhancement and Dissemination (U24):** PAR-15-331: Development and enhancement of emerging Informatics Technologies to improve acquisition, management, analysis and dissemination of data and knowledge to support Cancer Research *(includes foreign investigators)*
- **Sustainment (U24):** PAR-15-333: Continued development and sustainment of high-value informatics research resources to serve current and emerging needs across the cancer research continuum *(includes foreign investigators)*

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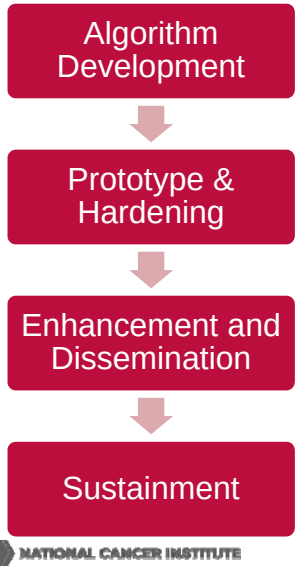
Program Structure



PAR-15-334	R21: Innovative computational research Up to $275K DC for 2 years
PAR-15-332	U01: Early stage development Up to $300K DC/year for 3 years
PAR-15-331	U24: Advanced stage development Up to $600K DC/year for 5 years
PAR-15-333	U24: Sustain highly-accessed resources No budget ceiling; up to 5 years

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Some image related ITCR grants: http://itcr.nci.nih.gov/fp

John Quackenbush, Hugo Aerts (co-PIs)	Dana-Farber Cancer Institute	Quantitative Radiomics System Decoding the Tumor Phenotype
Bruce Rosen and Jayashree Kalpathy-Cramer (co-PIs)	Massachusetts General Hospital	Informatics Tools for Optimized Imaging Biomarkers for Cancer Research & Discovery
Christos Davatzikos	University of Pennsylvania	Cancer Imaging Phenomics Software Suite: Application to Brain and Breast Cancer
Gordon Harris	Harvard Medical School	Extensible Open-Source Zero-Footprint Web Viewer for Oncologic Imaging Research
Ron Kikinis and Andrey Fedorov (co-PIs)	Brigham and Women's Hospital and Harvard Medical School	Quantitative image informatics for cancer research (QIICR)

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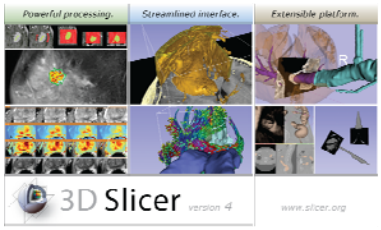
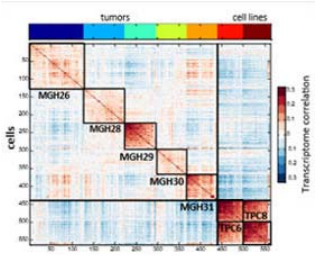
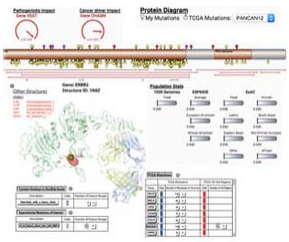
A few ITCR Tools



[3D Slicer](#)
3D Slicer is the free open source software for medical image visualization and analysis and research in image guided therapy



[Trinity](#)
De novo transcriptome assembly with downstream support for expression analysis and focused analyses on cancer transcriptomes including mutation and fusion transcript discovery, and single cell analysis.



[Cancer-Related Analysis of VAriants Toolkit (CRAVAT)](#)
CRAVAT is an easy to use web-based tool for analysis of cancer variants (missense, nonsense, in-frame indel, frameshift indel, splice site). CRAVAT provides scores and a variety of annotations that assist in identification of important variants.

Thanks for your attention

Imaging.cancer.gov *Jacobsp@mail.nih.gov*

www.cancer.gov www.cancer.gov/espanol