



CVRG

Facilitating Research on Heart Disease Through Software as a Service



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Heart Disease: Mortality and Health Care Costs



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- Leading cause of death in the US



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Heart Disease: Mortality and Health Care Costs

- Leading cause of death in the US
- ~ 600,000 deaths in 2010, 24% of all deaths
- ~ 50% of deaths are sudden
- Health care cost - \$273B/Year, 17% of total costs



Longitudinal Studies of Disease Risk Factors Funded by NHLBI

- *Framingham Heart Studies* (~ 65 years, 3rd generation)
- *Multi-Ethnic Study of Atherosclerosis* (~7,000 subjects, 13 years)
- *Coronary Artery Risk Development in Young Adults* (~5,000 subjects, 27 years)
- *Atherosclerosis Risk in Communities* (~16,000 subjects, 25 years)
- *Pediatric Heart Network* (~3,000, 11 years)



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Limitations: Study Design, Data Silos, IT



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Multiple Field Sites
All sites use same protocols





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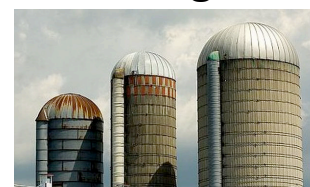
MR Reading Center



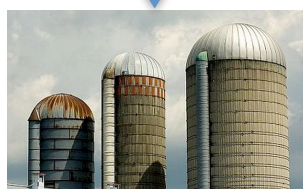
Echo Reading Center



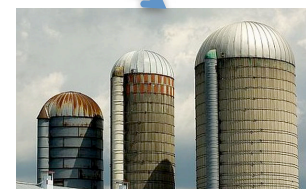
CT Reading Center



ECG Reading Center



Central Laboratory



Data Coordination Center



CVRG

Limitations: Study Design, Data Silos, IT

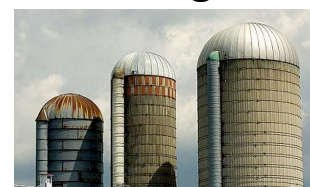
MR Reading Center



Echo Reading Center



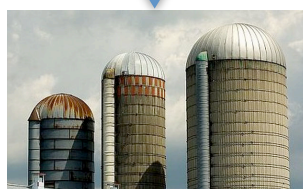
CT Reading Center



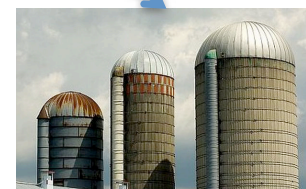
Limited IT



ECG Reading Center



Central Laboratory



Data Coordination Center



- NHLBI Resource (R24HL085343)
- Mission:
Serve the needs of cardiovascular researchers by providing seamless, customized, secure access to study datasets and analysis tools
- Web Site www.cvrgrid.org, Wiki wiki.cvrgrid.org



The Team

- **The Johns Hopkins University Institute for Computational Medicine**
 - M. Miller, R. Winslow (PI), L. Younes
- **Emory University Center for Comprehensive Informatics**
 - J. Saltz, A. Post
- **Wake Forest University Translational Sciences Institute Biomedical Informatics Center**
 - J. Carr, Y. Ge
- **University of Chicago Computation Institute**
 - I. Foster, R. Madduri



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Why Apply SaaS in CV Clinical Research Studies?



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Why Apply SaaS in CV Clinical Research Studies?

Motivated by the needs of CV Researchers



Why Apply SaaS in CV Clinical Research Studies?

Motivated by the needs of CV Researchers

- Federate data ~~data silos~~
- Support queries ~~not interactive~~
- Browser access ~~limited IT~~

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SaaS in Industry



THE NATIONAL CENTER FOR
BIOMEDICAL ONTOLOGY

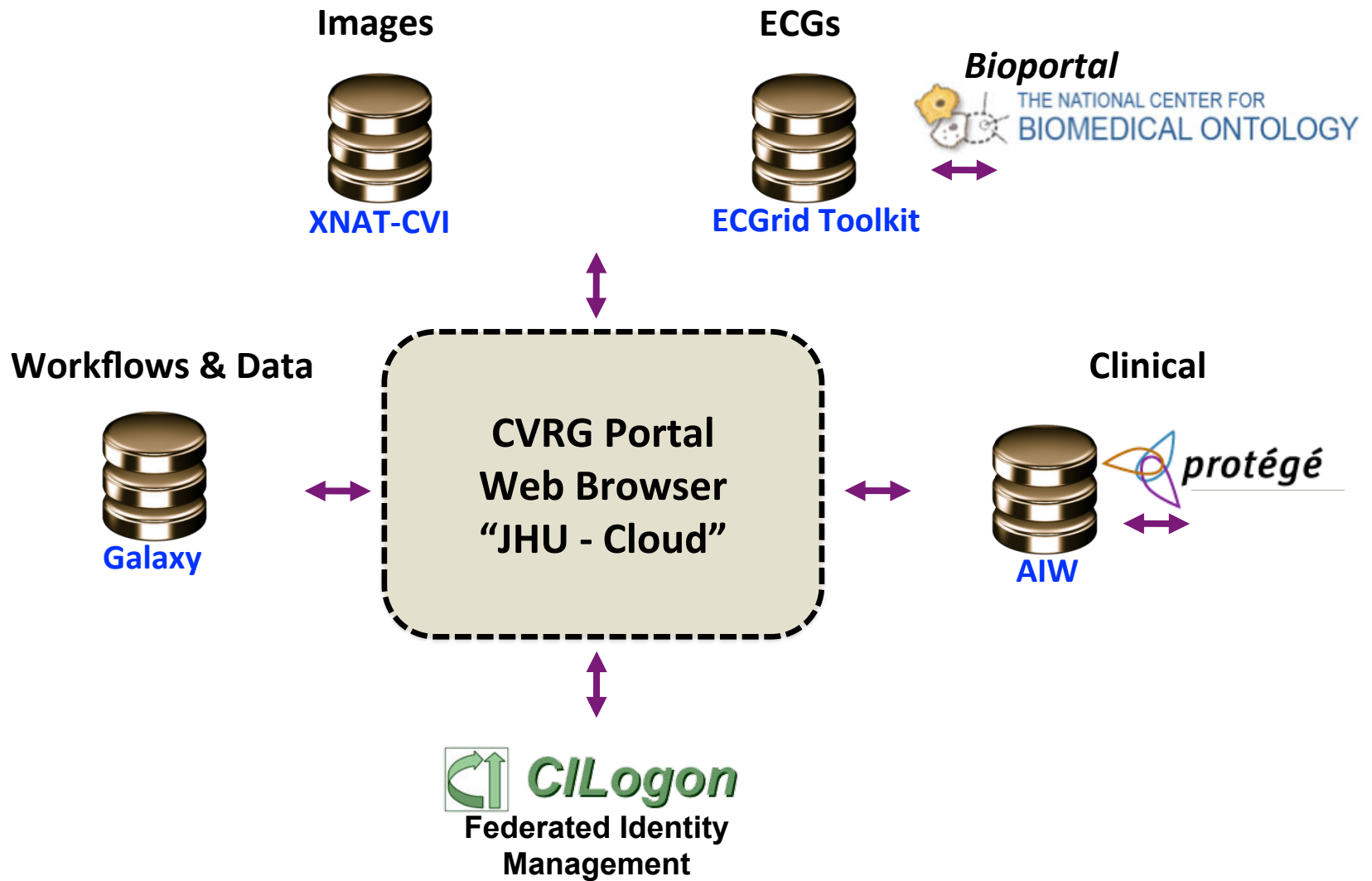


SaaS in Research



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CVRG Web Services





CVRG

Federated Identity Management



CardioVascular Research Grid

[Sign In](#)

Welcome

Galaxy Demo

ECGrid Toolkit Demo

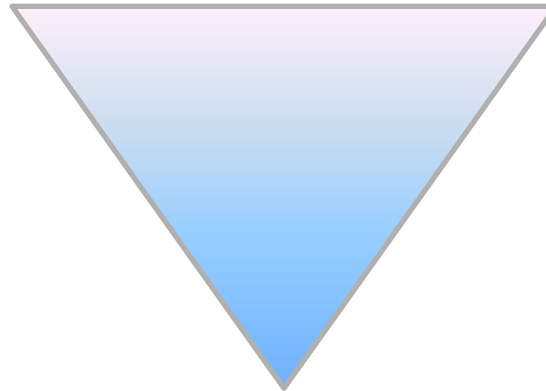
XNAT-CVI Demo

CVRG Registry Demo

Tutorials

CVRG Portal

<https://portal.cvrgrid.org>



Federated Identity
Provider CILogon
(Globus Nexus, etc.)

Select An Identity Provider:

Indiana University
Internet2
Iowa State University
Johns Hopkins

Search:

Remember this selection: ☐

Continue

JOHNS HOPKINS

LOGIN

Please enter your Login ID and Password

[First Time JHED Users Click Here](#)

Login ID:

Password:

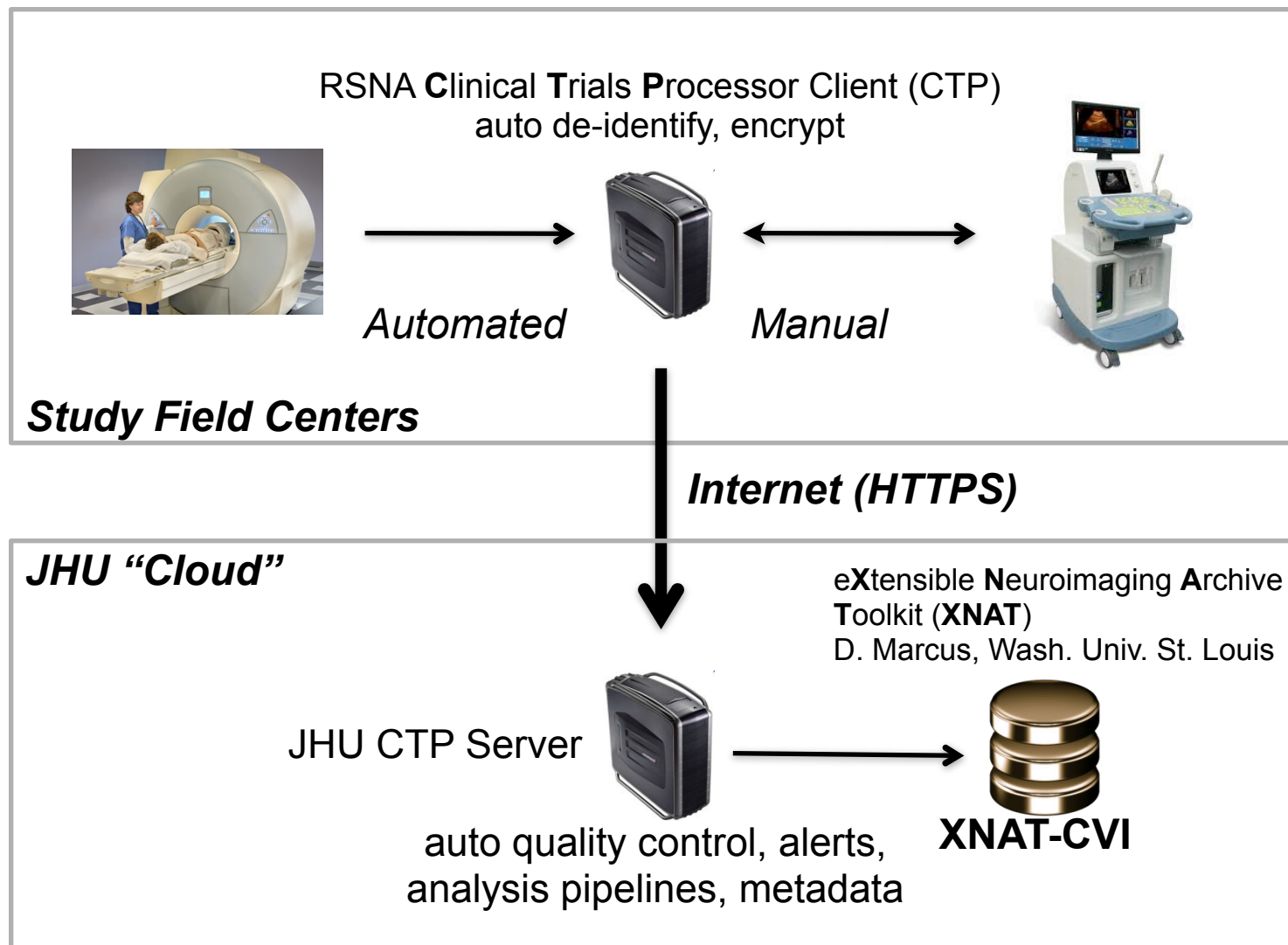
[Forgot Password?](#)

Login

Institutional Identity
Provider



Imaging Data Flow





Examples

Echo Images

PHN, CARDIA,...



UCLA

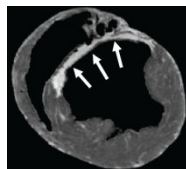


CTP

~ 2GBs/4D image

MR Images

MESA (MR),...



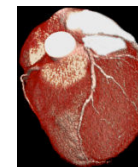
Columbia



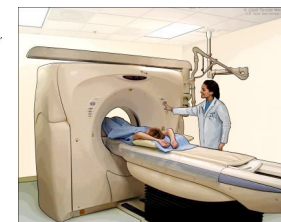
CTP

CT Images

Jackson Heart,...



CTP



Wake Forest

~ 800 MBs/4D image



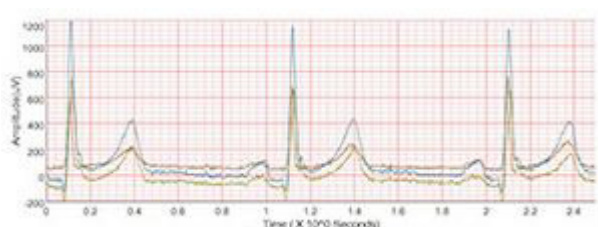
**JHU
CTP**



JHU XNAT-CVI

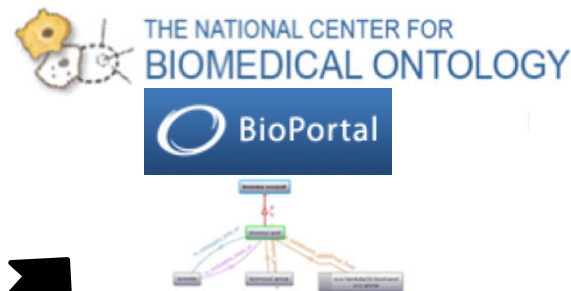


ECG Data & Analysis Workflow



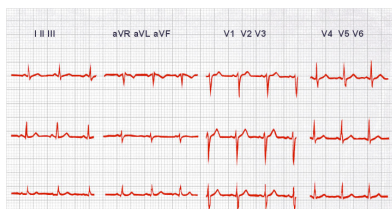
Storage & Visualization

ECGrid Toolkit



Ontology & Annotation

ECG Datasets



Automated Analysis

Feature Extraction



Analysis



CVRG

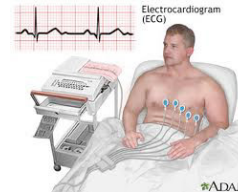
Large-Scale ECG Screening to Identify Patients at Risk of SCD



JHU



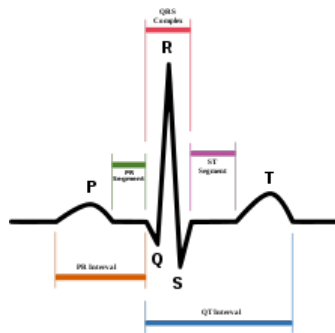
UPenn



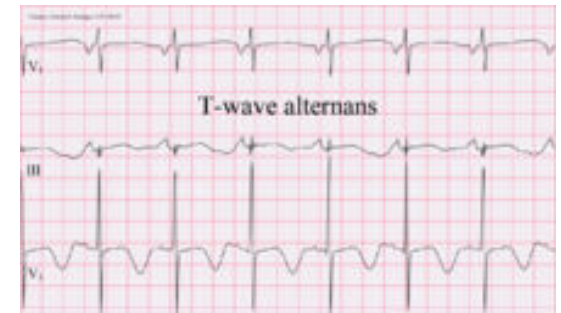
Cedar-Sinai



Beth-Israel



QRS Score

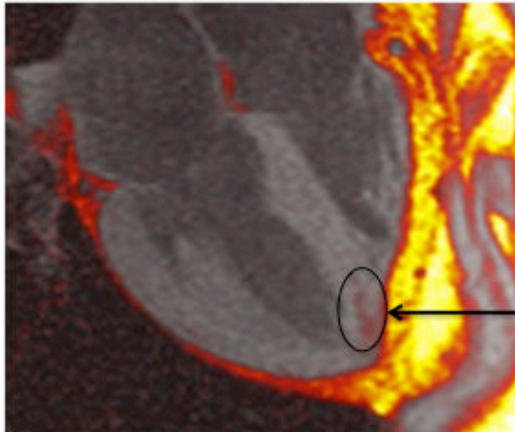
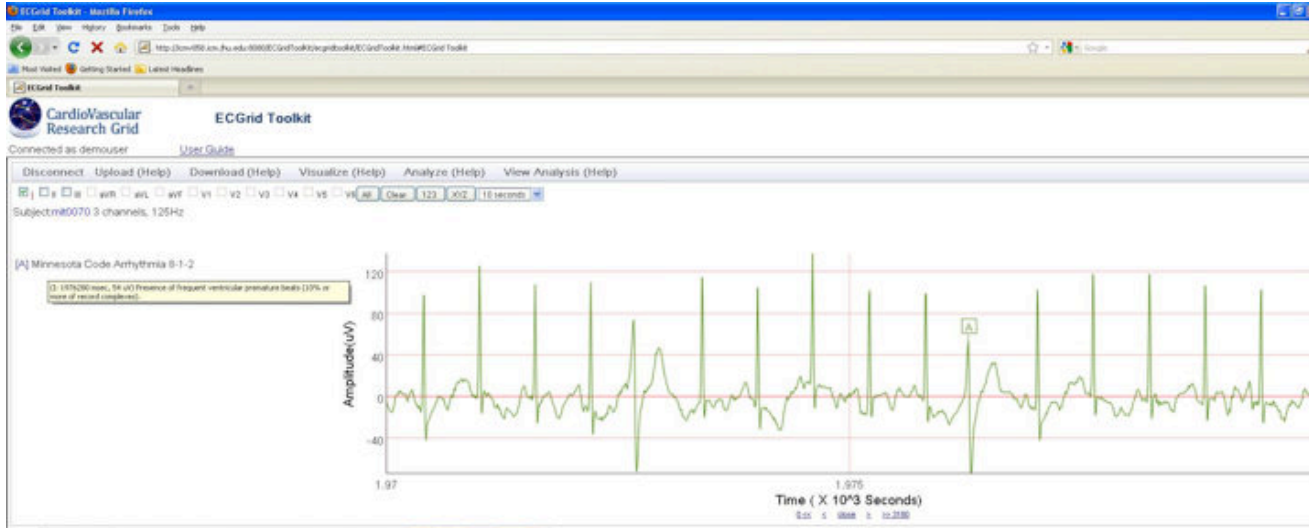


Beth Israel/T-wave Alternans Analysis

Test Against Image Based Risk Factors



Results - QRS Score



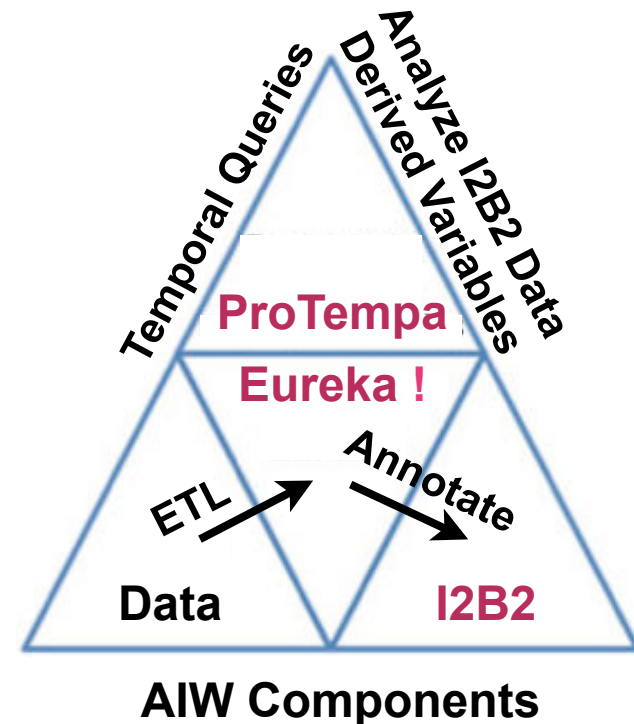
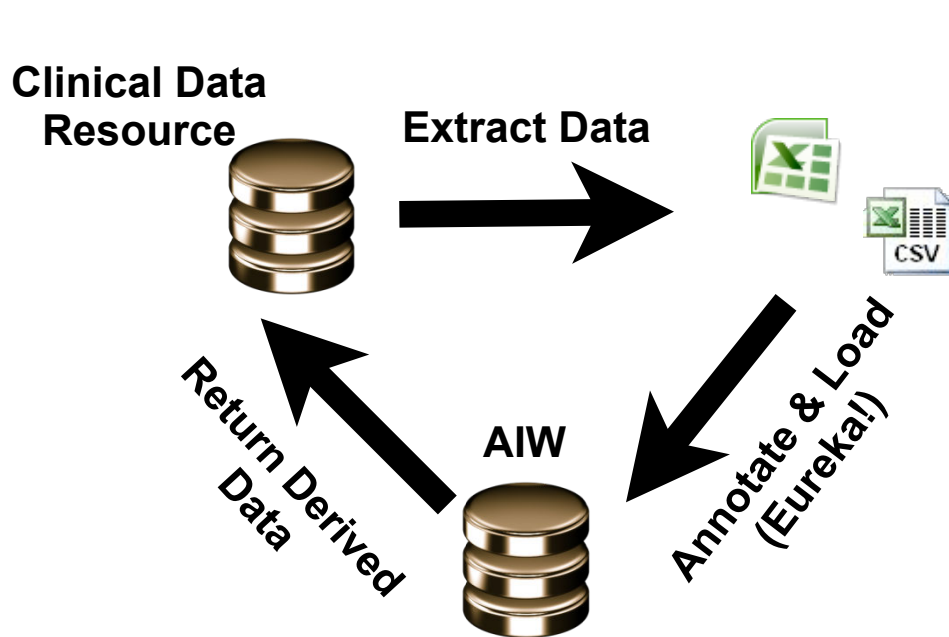
Scar

- ~46,500 subjects
- QRS Score > T, ~ 14% 1 - year mortality
 < T, ~ 5% 1 - year mortality
- LVEF < 35% in only 17% of the SCD pool
- Score predicts myocardial scarring



CVRG

Clinical Data Flow: The Analytical Information

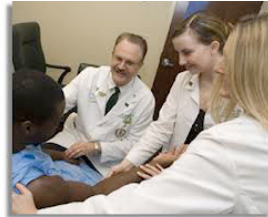




MH-Grid Clinical Data Analysis



Morehouse



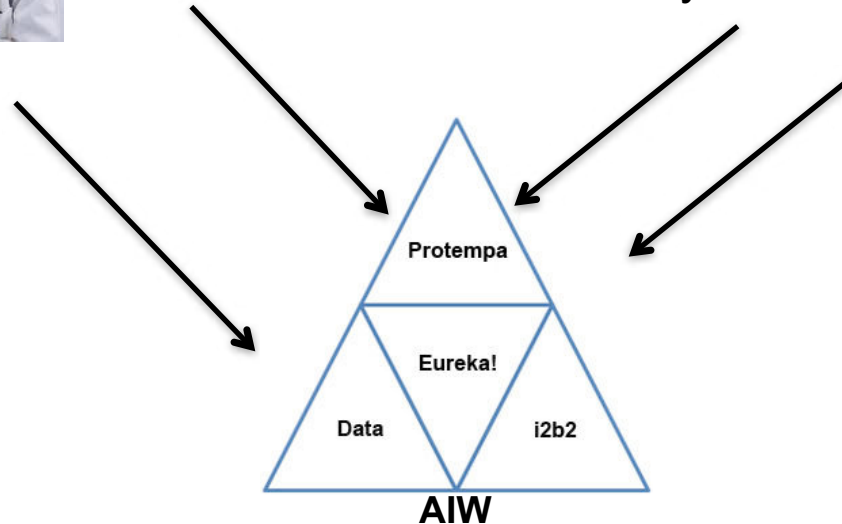
Kaiser



Grady



Jackson Hinds



- Determine common co-morbidities (diabetes - hypertension, heart failure)
- Variables derived from a combination of codes and/or laboratory test results
 - Obesity, diabetes/uncontrolled diabetes, end-stage renal disease, etc



CardioVascular Research Grid

Welcome Galaxy Demo ECGGrid Toolkit Demo XNAT-CVI Demo CVRG Registry Demo Tutorials

CVRG Demo Portal Galaxy Demo Galaxy Demo

Galaxy Analyze Data Workflow Shared Data Help User

Tools Options

- Globus
- CGA Tools
- BLAST Parser and Filtering
- NGS: BAM Tools
- NGS: Picard
- CRData
- Get Data
- Send Data
- ENCODE Tools
- Lift-Over
- Text Manipulation
- Filter and Sort
- Join, Subtract and Group
- Convert Formats
- Extract Features
- Fetch Sequences
- Fetch Alignments
- Get Genomic Scores
- Operate on Genomic Intervals
- Statistics
- Graph/Display Data

History Options

Your history is empty. Click 'Get Data' on the left pane to start

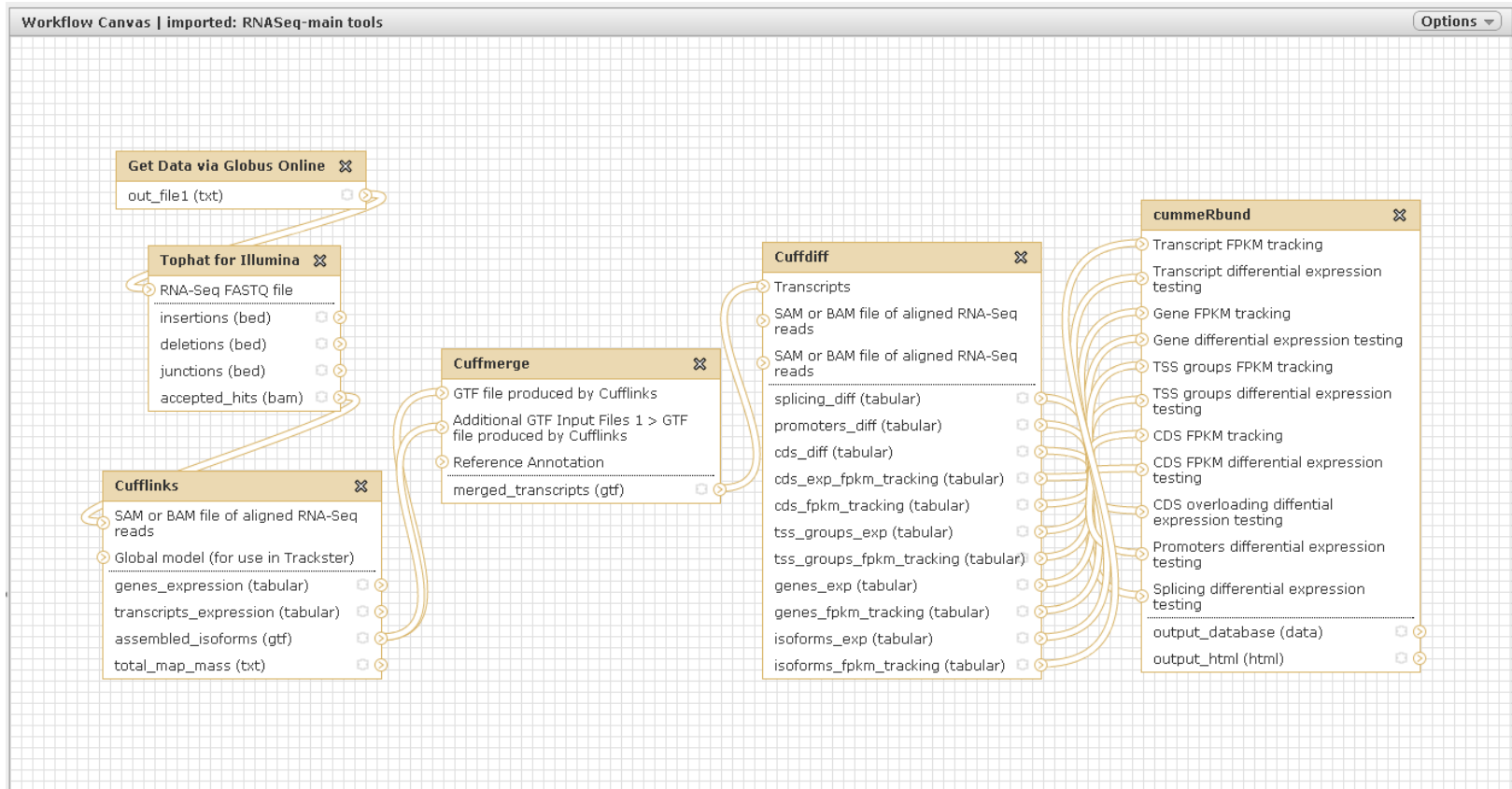
Hello world! It's running...
To customize this page edit `static/welcome.html`

WWFSMD?
grow noodly appendages...

usegalaxy.org

This project is supported in part by NSF, NHGRI, and the Huck Institutes of the Life Sciences.

- Broad range of genetic analysis tools in Galaxy
- GUI for creating workflows, analysis results have URL for reference
- Added Globus Online, Bioconductor, RNA-Seq packages to Galaxy
- Instantiated CVRG-Galaxy on Amazon EC2



RNA-Seq Analyses

Transfers data from Globus Endpoint to Galaxy

Aligns mRNA short reads with reference genome

Calculates mRNA transcript abundance

Exploration of analysis results

Future Work



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Integration of emerging Globus tools



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Galaxy Tools Supporting NHLBI GO Whole Exome Sequencing Project, GWAS Meta-Analyses



Future Work

Integration of emerging Globus tools

Galaxy Tools Supporting NHLBI GO Whole Exome Sequencing Project, GWAS Meta-Analyses

Address enhanced data security requirements of NHLBI contracts (FISMA, and other requirements)



Future Work

Integration of emerging Globus tools

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Establish resource for public release of complete NHLBI study data



Future Work

Integration of emerging Globus tools

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Thanks from the CVRG team