

A National Center for Biomedical Computing



# i2b2 Clinical Research Chart

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#### The National Center for Biomedical Computing entitled Informatics for Integrating Biology and the Bedside (i2b2) Clinical Research Chart, what is it?

- Explicitly organized and transformed person-oriented clinical data optimized for clinical genomics research
- An architecture that allows different studies to come together seamlessly
- An integration of clinical data, trials data, genotypic data, and knowledge annotation
- A portable and extensible application framework



Set of patients is selected through Enterprise Repository and data is gathered into a data mart



# **Research Silos**



#### Project data can be added back to the RPDR



# Enterprise-wide repurposing and distribution of medical record data for research



- Enable high performance collection of medical record data for querying and distribution
  - Enterprise web client
- Enable discovery within data on enterprise wide scale
  - Relationship networks
  - Pharmacovigilance

#### **Enterprise web client**







**Relevance Networks – unsupervised learning techniques** 

Sub-phenotypes cluster into novel diagnostic categories, APOE epsilon 4 allele determines risk of seizures after trauma



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#### Centrally supported Automated Discovery Projects Clinical trials performed in-silico

- Performing an observational, phase IV study is an expensive and complex process that can be potentially modeled in a retrospective database using groups of patients available in the large amounts of highly organized medical data.
- Fundamental problems complicate this approach:
  - Patients drift in and out of the system. Sophisticated statistical models using adequate control populations are necessary to compensate.
  - Confounding variables are not found in the database. Sophisticated natural language processing is needed to extract the confounders from textual reports to allow these confounders to be controlled.
  - Missing data disrupts typical statistical approaches

#### Repurpose medical record information for research studies

- I2b2 Workbench
- Natural language processing
- Enable genomic studies
  - Tissue/blood selection
  - Data integration



Use of medical record data in clinical studies focused upon genomics and pharmacology

# i2b2 Cell: Canonical Hive Unit





# I2b2 Workbench carries hive activity into a detailed patient view for Investigator

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# **Natural Language Processing Cell**

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No Known Allergies ADMIT DIAGNOSIS: asthma PRINCIPAL DISCHARGE DIAGNOSIS ;Responsible After Study for Causing Admission) Asthma exacerbation OTHER DIAGNOSIS;Conditions,Infections,Complications,affecting Treatment/Stay SEASONAL ALLERGIES; CLUSTER HA; ANEMIA WALDENSTROM'S MACROGLOBULINEMIA	
OPERATIONS AND PROCEDURES: OTHER TREATMENTS/PROCEDURES (NOT IN O.R.) cardiac MIBI exercise tolerance test BRIEF RESUME OF HOSPITAL COURSE: xx y F c h/o asthma, HTN p/w SOB x 1 day 	
This pt was in her USOH until 2 days PTA when she developed cough productive of tan sputum, mild SOB and mild wheezing. She felt as though she 'had a cold'. No F/C. <u>She is a smoker.</u> Sx initially responded to inhalers, and were stable until day of admission when she developed worsening wheezing and SOB. No CP, orthopnea, edema, PND. In ED: peak flow 190. Pt felt better p nebs, but pk flow unchanged. In the ED she received Predisone 60 and Guaifenesin. Pt then c new ST depressions in anterolateral leads in the setting of HR > 100s with bronchodilator use	
Hospital Course by System 1. CV: Ischemia: Patient w/ peak Troponin of 0.45 and was started on Lopressor, ASA and Lovenox; likely has rate-related demand ischemia seen on EKG in the anterolateral leads, unclear if these were old (but had similar intermittent changes in 8/00). Remained chest pain free; subsequent sets of enzymes were nl. Echocardiogram showed no wall motion abnormalities and EF=55-60%. ETT MIBI nl. Dc'd on ACEI + BB only for BP control. 2. Pulm: The nt presented with asthma exacerbation improving with	
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# **NLP Cell Architecture**



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<result_status></result_status>	
<status type="DONE">NLP Processing completed</status>	
<message_body></message_body>	
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<ns2:observation_set></ns2:observation_set>	
<pre><observation></observation></pre>	
<pre><event_id>1000001</event_id></pre>	
<patient_id>1234567</patient_id>	
<concept_cd>DSG-NLP:current_smoker</concept_cd>	
<start_date>2008-04-04T17:03:15.701-04:00</start_date>	
<pre><observation_blob></observation_blob></pre>	
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Using the Crimson system, tissues of the patients can be made available for analysis



i2b2 query internally produces identifiers and feeds them to Crimson











# **Data integration – Genotype / Phenotype**



# **Upcoming Enhancements of Core Cells**

AJAX Web Client Support for Queries and Analysis

- light client implementation for enterprise exposure of i2b2 Hive
- Query by Values
  - Query tools in the workbench to support the ability to find specific values in labs or gene expression.
- Upload data through i2b2 Workbench
  - Preformatted text files with medical record numbers can be used to update the data and file repository.
- Workflow for selecting and reviewing patients for studies
  - New workplace interface to store custom, project-related results as part of plan to progress towards full workflow management application.
- Integration of several data export and analysis tools in i2b2 Workbench
- Support for multiple platforms and database brands
  - SQL Server database support (aside from Oracle) and limited core functionality implemented in cells written in C# programming language (aside from Java)

# Query by values

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• i2b2 Workbench for Asthma Test Group		Wensong Pan Status:
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<ul> <li>Acid Phosphatase (Group:ACIDPHOS)</li> <li>Albumin (Group:ALB)</li> <li>Aldolase (Group:ALDOL)</li> <li>Ammonia (Group:NH3)</li> <li>Ammonia (Group:ALD) (Group:NH3UG)</li> <li>Amylase (Group:AMY)</li> <li>Calcium, (Group:CA)</li> <li>Calcium, ionized (Group:IONCA)</li> <li>Calcium, ionized (mEQ/L) (Group:ICA)</li> </ul>	Query Name:       Calcium (Group:@03:28:30         Group 1       X       Group 2       X       Group 3       X         Dates       Occurs > 0x       Exclude       Dates       Occurs > 0x       Exclude         Calcium (Group:CA)>10.6       Dates       Occurs > 0x       Exclude       Dates       Occurs > 0x       Exclude	Reset Groups
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# Query by values

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# Query by values

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	Patient Set: Patient Set: 2606 patients	<ul> <li>&lt;&gt; start: 1 increment: 10 </li> </ul>

# Upload data through i2b2 Workbench

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	000	i2b2 Workbench			
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#### **Workplace Interface**



# **Selecting and Reviewing Patients for Studies**

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# Integration of several data export and analysis tools in i2b2 Workbench





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## Support for multiple platforms and database brands



# **Upcoming Release of New Cells**

### Correlation analysis Cell

 An i2b2 Workbench plug-in and server side code that utilizes a cluster to perform calculations that find correlations within the data using relevance networks

# File Repository Cell

A core cell that manages files using the i2b2 Workbench, allowing large file storage (images and microarray results) and referencing by the clinical research chart.

#### Image Annotation Cell

Infrastructure to allow image viewing and annotation in the clinical research chart



A National Center for Biomedical Computing



# i2b2 Clinical Research Chart

Shawn Murphy MD, Ph.D. Griffin Weber MD, Ph.D. Michael Mendis Vivian Gainer MS Lori Phillips MS Rajesh Kuttan Wensong Pan MS Henry Chueh MD Isaac Kohane MD, Ph.D.