NCBO Driving Biological Project

Ontology-Based Annotation of Biomedical Time-Series Data

Rai Winslow & Steve Granite

Last update October 2008
Motivating Problem

- The electrocardiogram (ECG) is the most common measurement in CV research & practice
- No comprehensive ontology of ECG concepts
- Lack of standards for data management and exchange
- NCBO DBP Aims - develop:
  - ECG ontology
  - portal, data service, and XML exchange format
  - “electronic chart recorder” application
CardioVascular Research Grid: Analysis Services

- Heart Shape & Motion Analyses (LDDMM, PTA)
- Machine Learning; Rweb; geWorkbench
- CVRG Dashboard
- Workflow Access
- Other CVRG Nodes
- ECG Analysis Services
Current CVRG Architecture

<table>
<thead>
<tr>
<th>User Interface Layer</th>
<th>Web Browser</th>
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<tbody>
<tr>
<td></td>
<td>Gadget/Google Dashboard</td>
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<tr>
<td></td>
<td>Google Web Toolkit &amp; Visualization API Libraries</td>
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<tr>
<th>Middleware Layer</th>
<th>caGrid Architecture</th>
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<tbody>
<tr>
<td></td>
<td>Globus Grid Toolkit 4.x</td>
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<td>Apache Axis 2 Web Services</td>
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| Data Layer           | Open-source Databases, XML & File Systems |
Prior and New Results

- **ECG Ontology**
  - Prior work - presented a development approach
  - New work - first version available in Bioportal (will review)

- **CVRG Portal (Liferay)**
  - Prior work - portal static, hard to use, didn’t fit needs of this DBP
  - New work - CVRG Portal re-built using Google Web Toolkit and Visualization API (CVRG Dashboard)

- **“Electronic Chart Recorder”**
  - Prior work - sketched solution, showed mockup
  - New work
    * end-to-end data management, analysis, annotation nearing completion
ECG Ontology - Development

• AHA key data elements¹
• Testing ontology by defining peer-reviewed publication training and test sets
• Review by expert advisory panel
  - Ron Berger
  - Gordon Tomaselli (PROSE-ICD)
  - Ary Goldberger (Physionet)
• Managed on Bioportal
• Applications
  - MESA; completed processing of 1,171 MESA Exam 1 studies
  - CARDIA
  - PROSE-ICD; managing clinical and ECG data, 800 subjects
  - Hypertrophic Cardiomyopathy Consortium

¹Writing Committee for Electrophysiology Clinical Data Standards (2006). Circulation 114: 2534
ECG Ontology - Where We Are

A
- Thing
  - Anatomical_structure
    - Subdivision_of_cardinal_body_part
      - Limb_segment
      - Cardinal_free_limb_segment
      - Proximal_free_limb_segment
        - Arm
        - Thigh
    - ECG_Limb
      - Augmented_Limb_Lead
        - Lead_aVF
        - Lead_aVL
        - Lead_aVR
        - Lead_aVRneg
      - Limb_Lead
        - Lead_I
        - Lead_II
        - Lead_III
    - Other_Lead
    - Precordial_Lead
      - Left_Precordial_Lead
      - Right_Precordial_Lead

B
- ECG_Measurement
  - ECG_Lead_Measurement
    - ECG_Wave_Measurement
      - Maximum
      - Median
      - Minimum
      - Statistical_Mean
  - ECG_Wave
    - ECG_Delta_Wave
    - ECG_P_Wave
    - ECG_QRS_Complex
    - PQRST_Wave
    - QTU_Wave
    - Q_Wave
    - R_Wave
    - S_Wave
    - TU_Wave
    - T_Wave
    - U_Wave

C
- Electrode
  - Negative_Electrode
  - Positive_Electrode
- Minnesota_Code_Classification_System
  - MN_Code_AVConduction_Defect
  - MN_Code_Arrhythmias
  - MN_Code_High_Amplitude_R_Waves
  - MN_Code_J_Point_and_ST_Segment_Depression
  - MN_Code_Miscellaneous_Items
  - MN_Code_QRS_Axis_Deviation
  - MN_Code_Q_and_QS_Patterns
  - MN_Code_ST_Segment_Elevation
  - MN_Code_T_Wave_Items
  - MN_Code_Ventricular_Conduction_Defect
- Placement
  - Lead_Placement
  - Region_Of_Interest
    - Fully_Specified_Region_Of_Interest
    - Partially_Specified_Region_Of_Interest
NCBORetriever

• Uses NCBO ontology, search and concept
  - Representational State Transfer (REST) services
• Follows Minimal Information to Reference External Ontology Terms (MIREOT)
• Cites the source ontology, extracts definition from source & notes the time of the extraction
• Similar functionality to Ontofox
  - http://ontofox.hegroup.org
• Exports concepts in OWL for immediate import into Protege
• Available at http://128.220.76.202:8080/NCBORetriever/
Welcome to the Pre-existing Concept Search/Extraction Tool for NCBO BioPortal Ontologies

It's easy to search all of BioPortal's Ontologies for Pre-Existing Concepts & their Definitions using this tool

Search Ontologies
CVRG ECG Gadget & Dashboard

• Dashboard
  - Accessible from anywhere with a web browser
  - More user control over components than web portal
  - Interface for Federated Querying, integrating Clinical, ECG and Imaging data

• Gadget
  - Lightweight - 200 MBs software
  - “Load and Go” and you are a CVRG node
  - Cross-platform compatibility
  - Ability to run on a G3 phone
Demo - ECG Gadget

CVRG ECG Widget

User ID

Password

Instructions

English | 中国版 | German | 日本 | Spanish
Future Work

- Continue ontology development, more extensive testing
  - Conducting expert review now

- Enhance ECG gadget
  - better term search capabilities
  - easier method for selecting annotation time location

- Integrate gadgets into CVRG dashboard

- Advertise to the community
  - target entire AHA Clinical & Basic Research Councils

- Collaborative Protege