Substitutable Medical Applications and Reusable Technologies

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A Related Project ...

As part of the Strategic Health IT Advanced Research Projects (SHARP) program and the Substitutable Medical Apps Reusable Technologies (SMArt) initiative, a SMArt-enabled i2b2 cell is being developed to expose a common API for SMArt-applications to interact with health data within the i2b2 analytics platform.
Questions at the beginning ..

- What is the SMART project about?
- How does SMART fit into i2b2?
- What new capabilities will i2b2 gain from this project?
- What will be added to i2b2 architecture?
- What other exciting paths could this lead us to?
What is the SMART project about?

- Substitutable Medical Apps, reusable technologies

- Provides a unified mechanism for diverse apps to interact with medical record data – An iPad kind of App that fits into AJAX model of web browsing

- Enables **SMART Apps** built against a **SMART API** to be embedded within any **SMART Container**

- A **SMART Container** can be an EMR system used by physicians, or a PHR system used by patients…or a data-analytics platform such as **i2b2** used by researchers
How does SMART fit into i2b2?
SMART Container in i2b2
SMART Container in i2b2
Message Architecture: SMART i2b2 Cell (REST & OAuth)

1. A SMART app can run inside the new web client plugin and access the SMART API via SMART Connect
   1. SMART Connect

2. A SMART app can also access the SMART API directly via REST calls
   2. SMART REST
1. SMART Connect

New “SMART Dashboard” i2b2 web client plug-in

Load a SMART app using SMART Connect
1. SMART Connect

SMART Dashboard

Bloodwork Cardiology Result

Patient info
NAME: i2b2 Patient Num 1000000008
GENDER: M AGE: 45 DOB: 1986-12-16

1 About this test
This report evaluates your potential risk of heart disease, heart attack, and stroke.

2 Your Results

Total cholesterol level

Low risk
Average
High risk of cardiovascular disease

Desirable
Borderline
High

130

LDL 'bad' cholesterol
100

Note: these results are valid for non-diabetics.

- Current smoker?
- Family history of heart attack?
- Systolic blood pressure
2. SMART REST

A SMART app can access a resource directly via REST URLs:

http://smarti2b2.org/records/100000012/medications/
  • App sends its OAuth credentials in Authorization part of request to the SMART cell

GET /records/100000012/medications/ HTTP/1.1
Host: smarti2b2.org
Authorization: OAuth realm="SMART",
  oauth_consumer_key="dpf43f3p214k3101",
  oauth_token="nnch734d00s12jdk",
  oauth_signature_method="HMAC-SHA1",
  oauth_timestamp="123456789",
  oauth_nonce="JKFJxn",
  oauth_signature="MdpQcU8iPSUjWoN%2FUDMsK2sui9I%3D"

Currently, not all SMART REST apps will work against i2b2 without further configuration. The REST apps currently make reference to the Sandbox environment at smartplatforms.org with their usable tokens. REST apps can be configured to work in i2b2, though, like RxMinder.
Current Status of “SMART i2b2” Query Tool

SMART Challenge Apps in new toolbar

DxSocial matches you to the local healthcare providers who’ve seen the most patients like you. Our unique solution spares you the expensive trial-and-error process typically required to find the right doctor.

Benefits:
- Find doctors who’ve seen the most cases like yours
- Meet patients with similar problems, lab work, and meds
- Share insights with a community that understands you
- Exchange provider reviews with patients like you
- All data is verified by the electronic medical record
Demo by Nich Wattanasin

http://smarti2b2.org/
What new capabilities will i2b2 gain from this project?

- Recruit Patients for Clinical Trials – Capitalizing on SMART
  - Find cohort and save patient set
  - Create a project for the study
  - Review patients one by one in the project
    - Need contact demographics
    - Need patient-by-patient optimized views
    - May need very current enterprise data
- Coordinating center manages and recruits patient by institutions set of rules
What will be added to the i2b2 architecture?

1. SMART Cell sends *request* to i2b2 hive to get problems on patient 1000000012.
   - Receives *response* as an i2b2 PDO.

2. For concepts in PDO, *request* local codes to be mapped to needed code (ICD9 → SNOMED).
   - Receives *response* as i2b2 message containing mapped code in SNOMED.

3. XSL transforms i2b2 message into SMArt RDF.
   - Receives response as RDF.
Messages

1. An individual’s problems as represented in an i2b2 XML message:

   - `<ns2:concept_set>
     - `<concept>
       - `<concept_path>`i2b2\Diagnoses\Circulatory system (390-459)\Hypertensive disease (401-405)(401)
         Essential hypertension\(401-9) Unspecified essential hypertension</concept_path>
       - `<concept_cd>`ICD9:401.9</concept_cd>
       - `<name_char>`Hachard’s disease</name_char>
     </concept>
     - `<concept>
       - `<concept_path>`i2b2\Diagnoses\Digestive system (520-579)\Oral cavity diseases (520-529)(523)
         Gingival and periodontal diseases\(523-6) Accretions on teeth</concept_path>
       - `<concept_cd>`ICD9:523.6</concept_cd>
       - `<name_char>`Dental plaque</name_char>
     </concept>
     - `<concept>
       - `<concept_path>`i2b2\Diagnoses\Digestive system (520-579)\Oral cavity diseases (520-529)(523)
         Gingival and periodontal diseases\(523-9) Unspecified gingival and periodontal disease</concept_path>
       - `<concept_cd>`ICD9:523.9</concept_cd>
       - `<name_char>`Unspecified gingival and periodontal disease</name_char>
     </concept>
   - `<concept>
     - `<concept_path>`i2b2\Diagnoses\Genitourinary system (580-629)\Nephritis, nephrotic syndrome, and nephrosis (580-589)(585)
         Chronic renal failure</concept_path>
       - `<concept_cd>`ICD9:585</concept_cd>
       - `<name_char>`Chronic renal failure</name_char>
   </concept>

**Case:** We require diagnoses to be coded in SNOMED, but we only have ICD9 codes.

**Action:** Send an XML request to the Mapping Cell with the desired ICD9’s (above) to be mapped to SNOMED (e.g. ICD9: 401.9)
2. Response from Mapping Cell contains SNOMED codes and names:

- `<mapped_concept_set>`
  - `<mapping>`
    - `<source_coding_system>`ICD9`/source_coding_system>`
    - `<source_basecode>`401.9`/source_basecode>`
    - `<destination_coding_system>`SNO`/destination_coding_system>`
    - `<destination_basecode>`38341003`/destination_basecode>`
    - `<destination_name>`Hypertensive disorder, systemic arterial (disorder)`/destination_name>`
  - `<mapping>`
    - `<source_coding_system>`ICD9`/source_coding_system>`
    - `<source_basecode>`523.6`/source_basecode>`
    - `<destination_coding_system>`SNO`/destination_coding_system>`
    - `<destination_basecode>`17552000`/destination_basecode>`
    - `<destination_name>`Dental calculus (disorder)`/destination_name>`
  - `<mapping>`
    - `<source_coding_system>`ICD9`/source_coding_system>`
    - `<source_basecode>`523.9`/source_basecode>`
    - `<destination_coding_system>`SNO`/destination_coding_system>`
    - `<destination_basecode>`2556008`/destination_basecode>`
    - `<destination_name>`Periodontal disease (disorder)`/destination_name>`
  - `<mapping>`
    - `<source_coding_system>`ICD9`/source_coding_system>`
    - `<source_basecode>`585`/source_basecode>`
    - `<destination_coding_system>`SNO`/destination_coding_system>`
    - `<destination_basecode>`90688005`/destination_basecode>`
    - `<destination_name>`Chronic renal failure syndrome (disorder)`/destination_name>`

The mapping cell returned the mappings for the ICD9’s sent from the previous slide (e.g. SNOMED of 38341003 mapped to ICD9: 401.9)
3. i2b2 “Mapped PDO” is transformed into RDF in SMArt Cell

- <sp:Problem>
  - <sp:problemName>
    - <sp:CodedValue>
      <dcterms:title>Hypertensive disorder, systemic arterial (disorder)</dcterms:title>
    - <sp:codeProvenance>
      - <sp:CodeProvenance>
        <sp:sourceCode rdf:resource="http://smart.i2b2.org/concepts/code#ICD9:401.9"/>
        <dcterms:title>Huchard's disease</dcterms:title>
      </sp:CodeProvenance>
    </sp:codeProvenance>
  </sp:CodedValue>
</sp:problemName>
<sp:onset>2005-10-31</sp:onset>
<sp:resolution>2007-10-31</sp:resolution>
</sp:Problem>
Providing mappings using NCBO services

Mapping cell

- Need for mapping different site-specific ontologies in cross-institutional settings. (SNOMED_CT ↔ ICD-9, RxNORM ↔ NDC)
- First look for locally mapped data
- Then seek mappings through NCBO services.

http://bioportal.bioontology.org/mappings/service/1101/

Request to map local code

ICD9 → SNOMED_CT

Locally Mapped data

Mapper Cell

NCBO REST XML
Workflow stimulates development of IM Cell
Identity Management Cell

Main functions

- Converts MRNs to i2b2 patient nums
- Holds demographics in tables which themselves do not contain clinical data
- Links to enterprise services and converts custom enterprise output to i2b2 standards
- Lists of patients with real identifiers are managed and linked to a project
Introduction of demographics into IM cell

Demographics are in IM database, but for most current may need to use Enterprise Service.
Most current data is sent to CRC from IM cell with Encrypted MRNs and back to SMART cell, copy sent to CRC, last update date in CRC set.

Old data is obtained from CRC and merged with service data.
The job of the SMART cell is to do most of the heavy lifting to convert SMART queries into serviceable i2b2 queries and convert i2b2 responses to SMART RDF responses that can be consumed by the SMART apps.
What other exciting paths could this lead us to?

- Create a client to optimize EMR-View of patient
- Allow recruitment across several sites with common coordinating center
  - Find cohort
  - Recruit doctors at other institutions for a clinical trial
  - Create a project for the study
  - Present patients one by one using SHRINE data + contact demographics
    - Institutions may want to enforce quotas and slowly release patient data to keep contributions of patients to the clinical trial even across sites
  - Coordinating center manages and recruits patient by each institutions set of rules
Layout of editable EMR-Screen
Layout of locked EMR Screen
Layout of Patient Lookup
THANK YOU - URL’s

- http://smarti2b2.org/webclient/
  - [HTML5 = IE8+, Firefox3+, Chrome]


- http://www.smartplatforms.org/