

Linked Vitals

A Linked Data Translation Approach to Semantic Interoperability

November 12, 2014 Dataversity Webinar

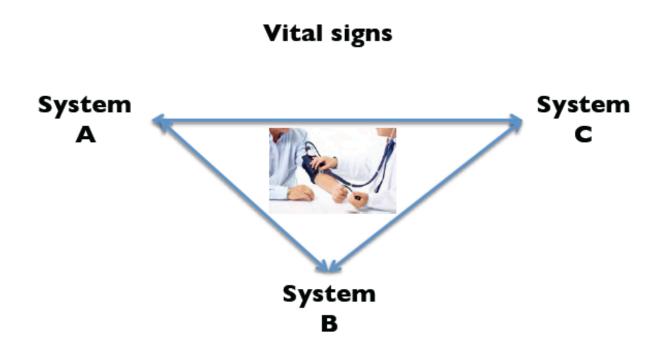
Rafael M Richards MD MS Physician Informaticist Veterans Health Administratioan U.S. Department of Veterans Affairs

Problem Statement: General



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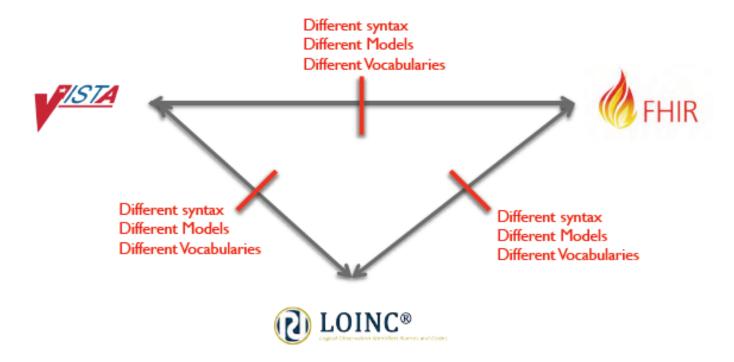
How does one semantically integrate data such as vital signs between different patient information systems?



Problem Statement: Specific



How does one integrate vital sign data between VA VISTA electronic health record (EHR) system and a potential exchange partner using the HL7 FHIR standard?



Language barriers to exchange

Approach: Linked Data Foundation



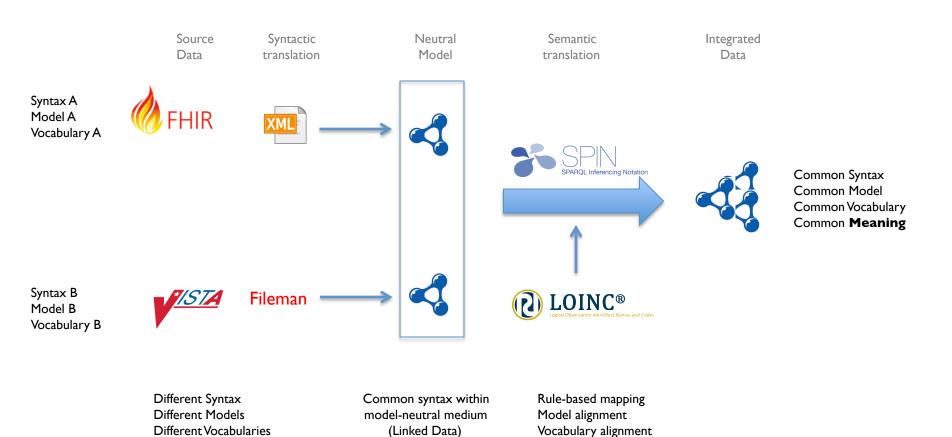
One step towards minimizing data friction between systems is to provide common model-neutral expression language such as RDF.



A common exchange language

Summary of Linked Data Translation





VISTA: Overview



- Veterans Information Systems and Technology Architecture
- Information system of all VA hospitals
- Foundation of several public healthcare systems
 - VA (VISTA): 1200+ care sites
 - DoD(CHCS): 900+ care sites
 - IHS (RPMS): 500+ care sites
 - NY State: 24 hospitals
- Most familiar EHR in U.S.
 - Over 60% of U.S.-trained physicians have used VISTA
- Open source
 - Deployed in many other settings in U.S. and internationally
 - Many developments by open source community

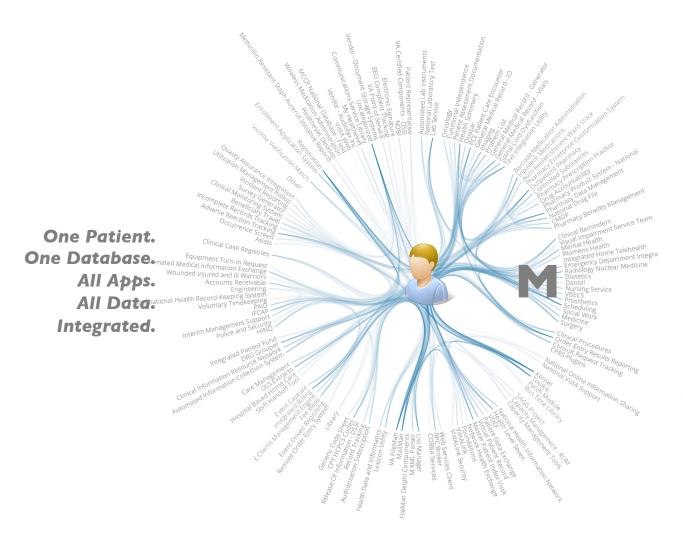
VISTA deployments in the U.S.





VISTA: A Patient-Centric EHR





VISTA is an integrated patientcentric EHR.

The data architecture of VISTA consists of over I 50 applications for clinical care integrated within a single common multidimensional database (M DB).

In VISTA both business logic (Applications) and data (Database) are managed with within the M data engine, which provides the tight integration of applications to each other and to shared data.

The data flow and integration agreements between VISTA applications (outer ring) is visualized as blue lines.

VISTA Data Model

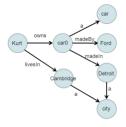


VISTA is based on a hybrid NoSQL database. Unlike some NoSQL stores, VISTA is schema-driven, not schema-less.

Inside every VISTA is File Manager (Fileman), a hybrid hierarchal-graph data store, which is overlaid on top of the M multidimensional store. A comprehensive definition of the types of data stored in every VA FileMan represents the VA's Enterprise Data Model.

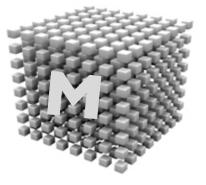
With an exposed data model, VISTA's native schema be rendered in a standard definition format and analyzed for use and improvement. A schema-flexible information model representation language that is fully machine-processable such as RDF provides such capability.

FM



Fileman: hierarchical-graph store

M



M: Multidimensional NoSQL data engine

VISTA Data Model



FileMan Schema Browser

Populated Files

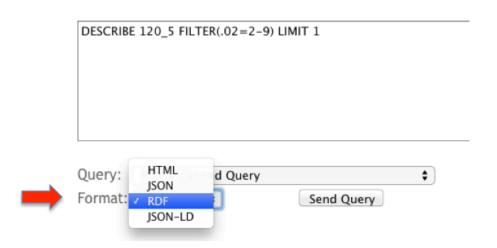
In this system 1245 out of 2356 have entries.

#	Name	Global	Count
.11	INDEX	^DD("IX",	644
.31	KEY	^DD("KEY",	64
.4	PRINT TEMPLATE	^DIPT(1234
.401	SORT TEMPLATE	^DIBT(773
.402	INPUT TEMPLATE	^DIE(1519
.403	FORM	^DIST(.403,	144
.404	BLOCK	^DIST(.404,	519
.44	FOREIGN FORMAT	^DIST(.44,	11
.5	FUNCTION	^DD("FUNC",	169
.7	MUMPS OPERATING SYSTEM	^DD("OS",	7
.81	DATA TYPE	^DI(.81,	11
.84	DIALOG	^DI(.84,	2574
.85	LANGUAGE	^DI(.85,	11
1	FILE	^DIC(2356
1.2	ALTERNATE EDITOR	^DIST(1.2,	4
2	PATIENT	^DPT(40
3.07	PROGRAMMER MODE LOG	^%ZUA(3.07,	930

VISTA's native data model is comprised of hierarchical files and subfiles, each which addresses a specific M Global storage.

VISTA Query: Fileman Query Language





FMQL is the Fileman Query Language that leverages the native hierarchical-graph model of VISTA. This provides real-time web-based query access to the entirety of VistA's data.

This exposes the native hierarchical data model of Fileman in web standard forms including HTML, JSON, and RDF.

HTML: Hypertext markup language (visual document markup)

JSON: Javascript object notation (data serialization / packaging)

RDF: Resource description framework (linked data / semantics)

JSON-LD: JSON-like serialization of Linked Data (RDF)









VISTA Query: HTML output



Fileman query of VistA for vital signs with output in HTML.

DESCRIBE 120_5 FILTER(.02=2-9) LIMIT 2			
Query: Pick a Canned Query \$ Format: HTML \$ Send Query			
1. GMRV VITAL MEASUREMENT > 2005-09-01T13: date time vitals taken	→	HTML	HTML output: Human-readable
NEW PERSON/NOTHER, NADA (LOCAL) rate 150/10 entered in error true			

Rafael Richards MD MS 2014

reason entered in error

VISTA Query: RDF output



Fileman query of VistA for vital signs with output in RDF.



<vs:entered in error-120 !</pre>





Linked Data: What is it?





The World Wide Web Consortium (W3C) standard for semantic information integration for the Internet of Data.



HTML (hypertext markup language)
For **humans** to exchange information



Linked Documents (Document Web)



RDF (resource description framework)
For **computers** to exchange information



Linked Data (Semantic Web)



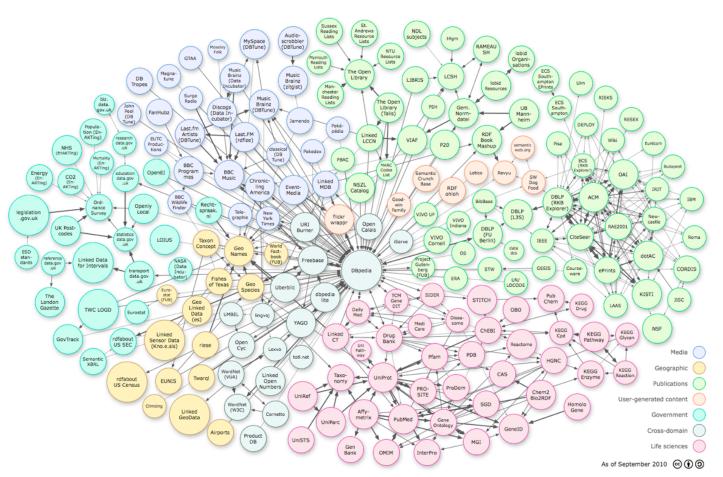
"The Semantic Web [Linked Data] provides a common framework that allows data to be shared and reused across application, enterprise, and community boundaries."

Tim Berners-Lee, MIT Professor and Inventor of the World Wide Web (HTML and RDF protocols)

Linked Data and the Internet of Data



Linking media, geographic, publications, government, and life sciences....





This represents over 300 linked data sources and databases, comprising billions of data elements and millions of semantic links.

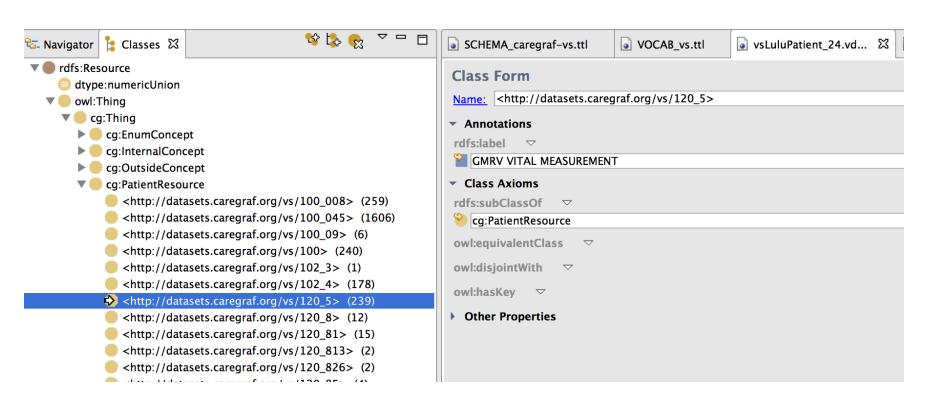
Each on of these circles represents a data source, which is semantically linked to other data sources, creating one virtual federated queryable web of data.

Wikipedia is one of the resources converted to Linked Data, and is called DBpedia (center circle).

Why not link healthcare?

VISTA Vitals in RDF

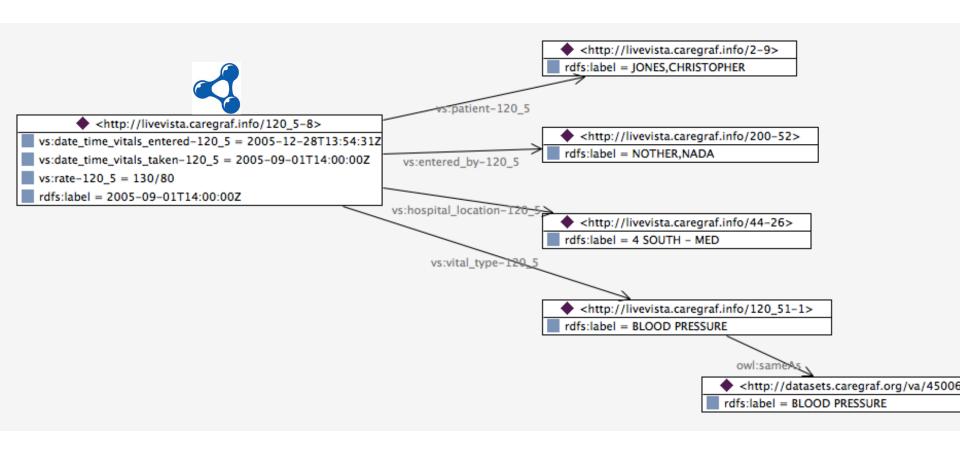




239 instances in the sample dataset

VISTA Vitals in RDF





FHIR: Native model





FHIR • FHIR - Observation



specimen: Resource(Specimen) 0..1
performer: Resource(Practitioner|Device|

Organization) 0..*

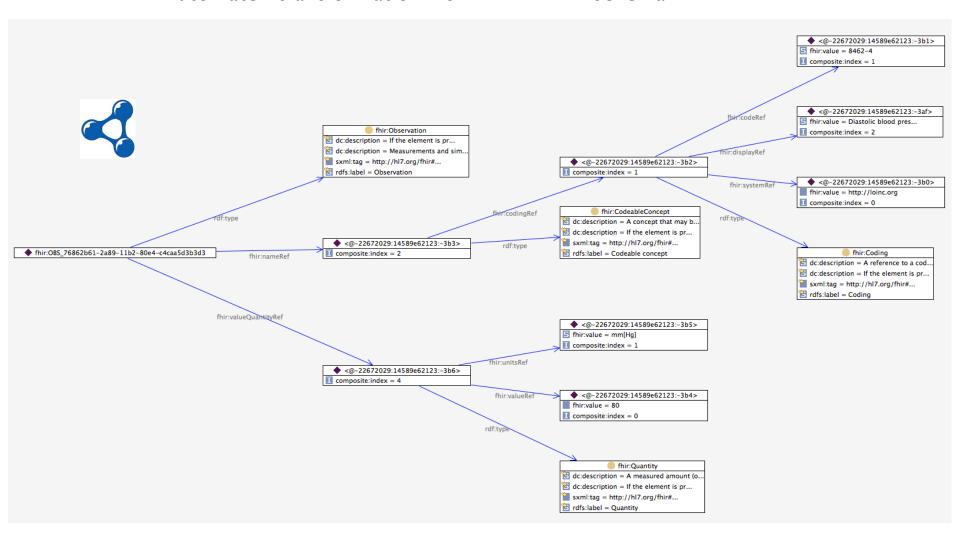
XML model in XML Schema

4.15.3 Resource Content 6 Observation (Resource) name: CodeableConcept 1..1 << ObservationType>> value[x]: Quantity | CodeableConcept | Attachment | Related Ratio | Period | SampledData | string 0..1 type: code 0..1 << ObservationRelationshipType>> interpretation: CodeableConcept 0..1 << ObservationInterpretation>> target: Resource(Observation) 1..1 comments: string 0..1 related applies[x]: dateTime | Period 0..1 issued: instant 0..1 ReferenceRange status: code 1..1 << ObservationStatus>> referenceRange 0..* reliability: code 1..1 << ObservationReliability>> low: Quantity 0..1 bodySite: CodeableConcept 0..1 << BodySite>> high: Quantity 0..1 method: CodeableConcept 0..1 << ObservationMethod>> meaning: CodeableConcept 0..1 << ObservationRangeMeaning>> identifier: Identifier 0..1 age: Range 0..1 subject: Resource(Patient|Group|Device|Location) 0..1

FHIR in RDF



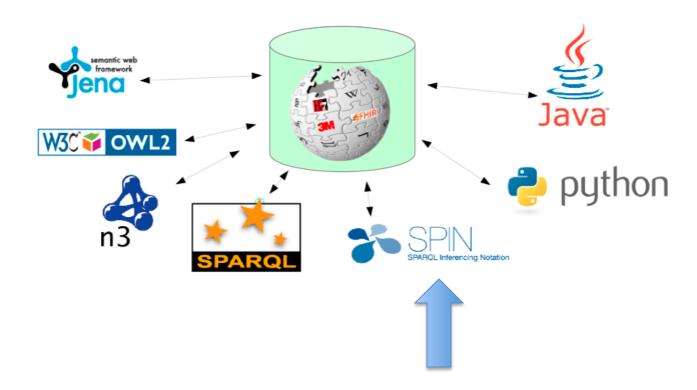
Automated transformation from FHIR XML Schema -> RDF



RDF Translation Rules options



There are many options for RDF translation. For this case study we will use the SPARQL Inferencing Notation (SPIN) because it is a W3C standard.



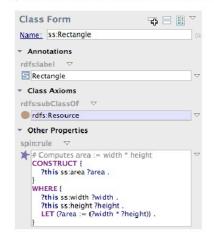
SPIN: SPARQL rules language



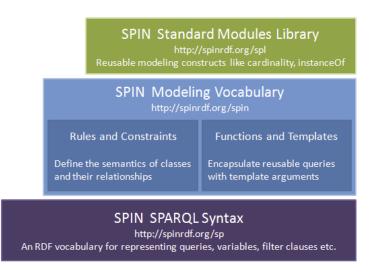


SPIN is a SPARQL Rules Language

The property spin:rule can be used to link a class with SPARQL CONSTRUCT queries that define inference rules for the members of the class



Natural object-oriented way of modeling SPARQL is very expressive Rules can be natively executed by SPARQL engines of the database Easy to combine with other SPARQL rule bases like OWL RL



SPINMap: Data mapping rules engine



Applications

Data Processing Pipelines

SPARQLMotion

Templates, UI Components
SPARQL Web Pages (SWP), SWA

Inference Engines, Data Mapping Rules TopSPIN, BackSPIN, SPINMap

ed Templates, Functions, Rules, Constraints
SPARQL Inferencing Notation (SPIN)

Query Engine SPARQL Model: Classes, Properties RDFS, OWL

Change Management

Teamworks Framework

Data Layer: Base Infrastructure, Databases
RDF

SPINMap: Data mapping rules engine

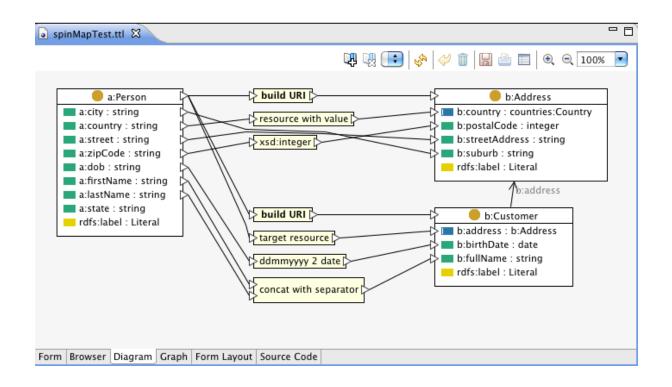


Motivation:

Simplifies mappings between different models

Key Features:

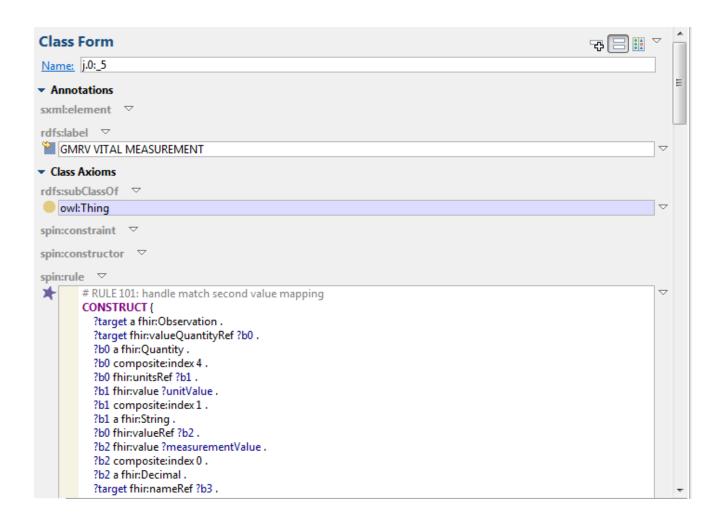
Creates executable transformations



SPINMap: Field mapping with rules

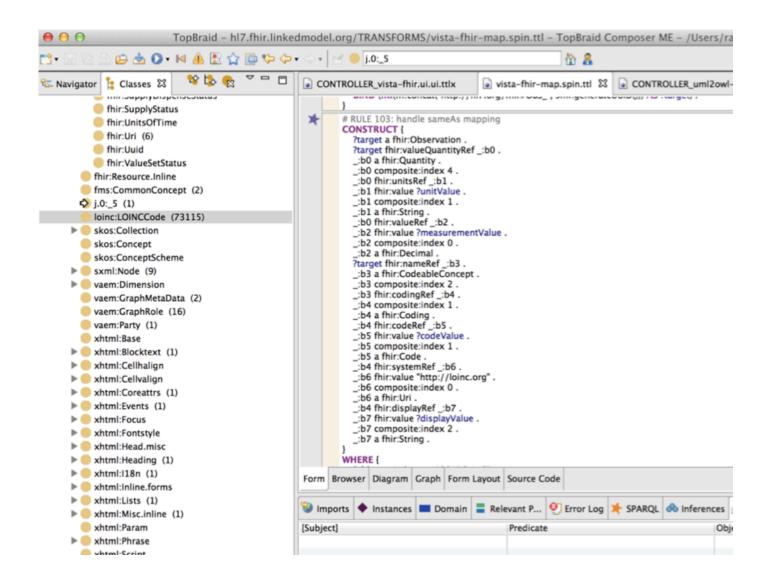


Easier to create deep nested structures in the target



SPINMap: Rules for LOINC terminology





SPINMap Output: Linked Vitals



VistA Patient Records of Interest



VistA Patient Record	Blood Pressure	
http://livevista.caregraf.info/120_5-8	130/80	



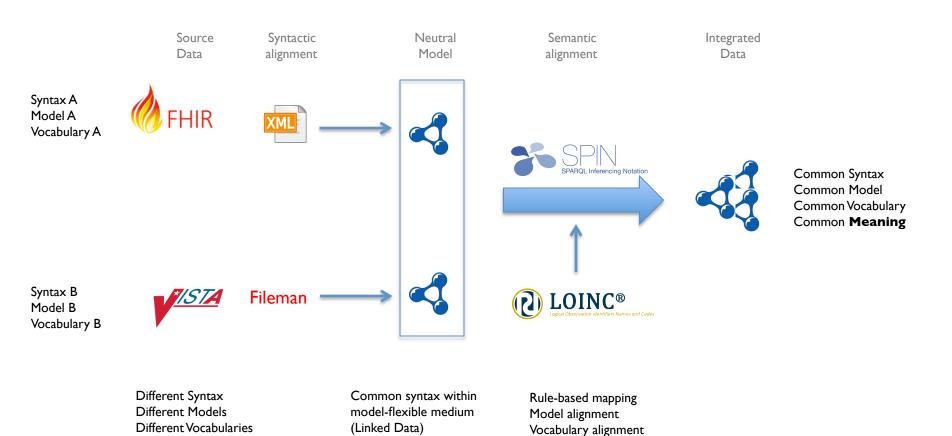
FHIR Patient Records



FHIR Patient Record	Blood Pressure	Value
http://hl7.org/fhir#OBS_cf8c9913-2aa1-11b2-80b1-f6177b67abba	Diastolic blood pressure	130/80
http://hl7.org/fhir#OBS_cf8c9912-2aa1-11b2-80b1-f6177b67abba	Systolic blood pressure	130
http://hl7.org/fhir#OBS_cf8c9909-2aa1-11b2-80b1-f6177b67abba	Diastolic blood pressure	80

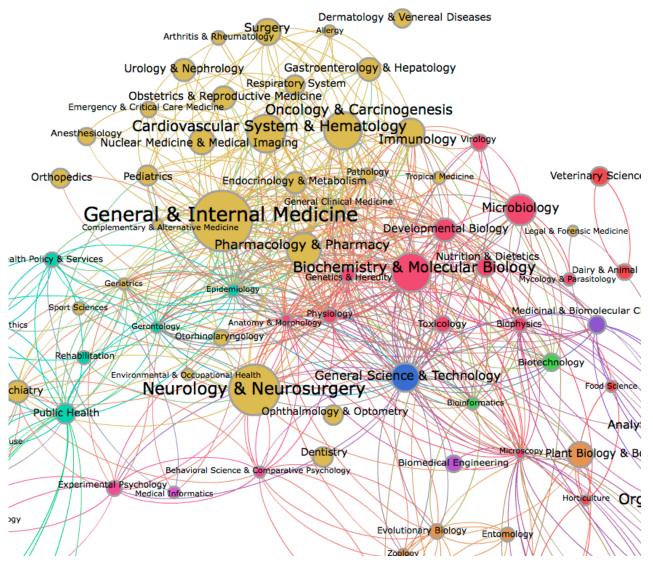
Summary of Translation Approach





Linked Vitals: A step towards Linked Health







In the works...

Web-based automation of semantic alignment

VISTA-FHIR web-based translation



The VISTA— FHIR prototype is a web-based application built with TopBraid and Semantic Web Page technology. The application demonstrates semantic data integration of VistA records and FHIR records.

