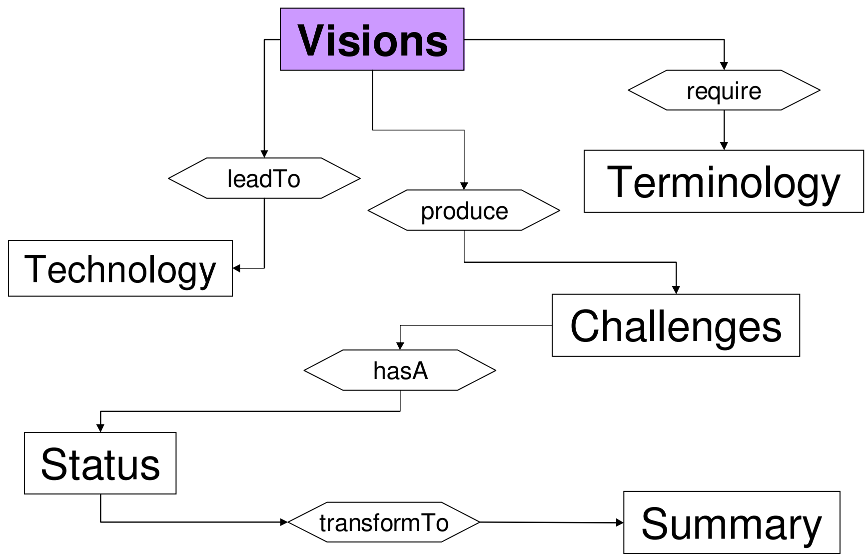
The Semantic Web and Java

September 16, 2010

David Read

Semantic What?

Topics



The Semantic Web[1]

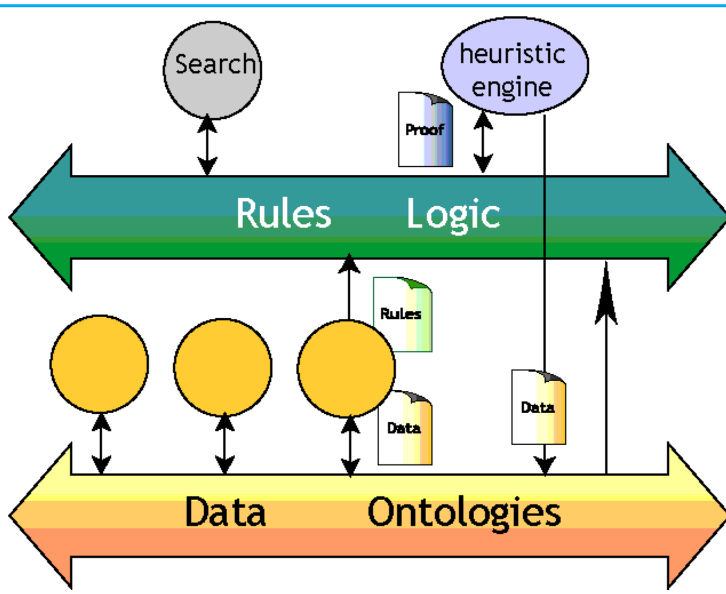
- Philosophy – “Web”
  - URI->Resource static mapping
  - Creates navigable "space"
  - Shared space = new genre of communication
  - Self-describing documents
  - URIs as identifiers not recipes
- Philosophy – “Semantic”
  - Machine processable
    - not natural language, human inference
  - For data: what you can do with it
  - For the future: conversion
  - Declarative (Statements)
  - Relationships

Tim Berners-Lee, 2000

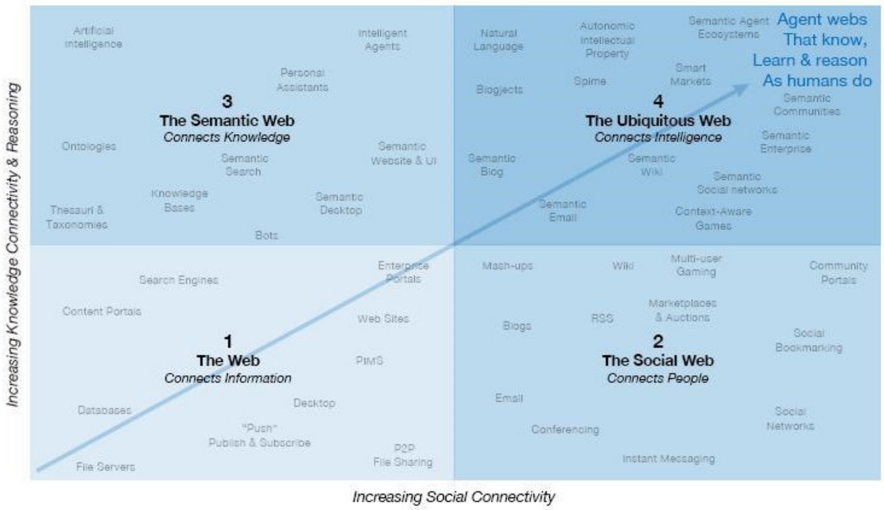
Vision for Sharing Data

- Machine readability
- Reduced data friction
- Robust data failure management
- Unique, resolvable names
- Dynamic and flexible data
  - use inferencing to figure things out and create additional data

Semantic Web Bus[1]

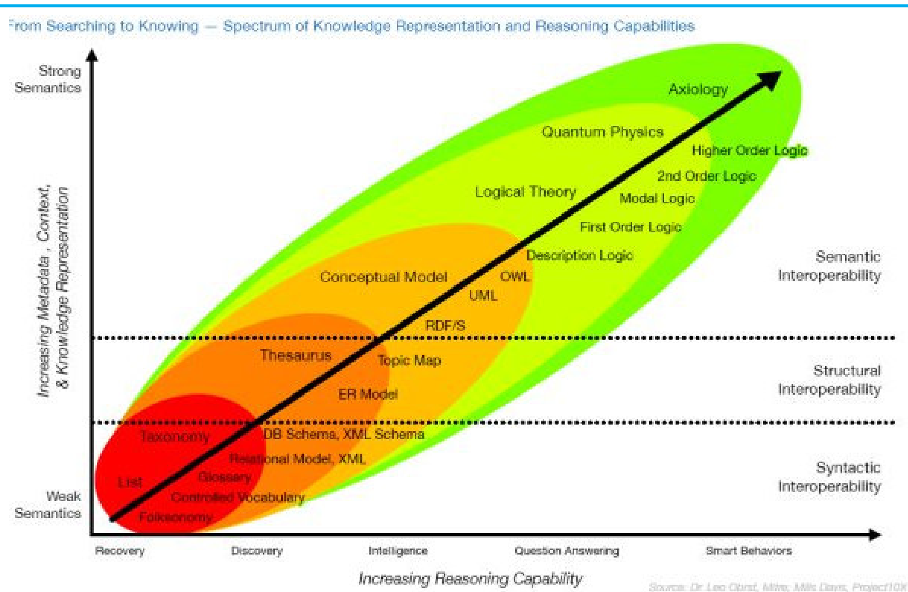


Semantic Web Evolution (Web 3.0 - 2020)[2]

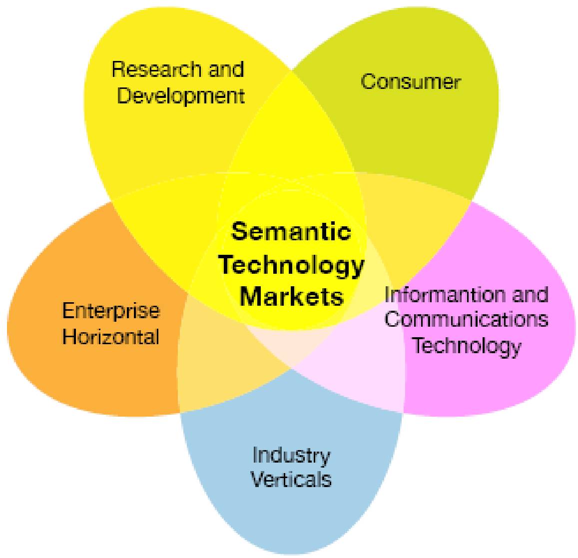


Mills Davis, 2008

Path from Data to Reasoning[2]



Semantic Wave Markets[2]

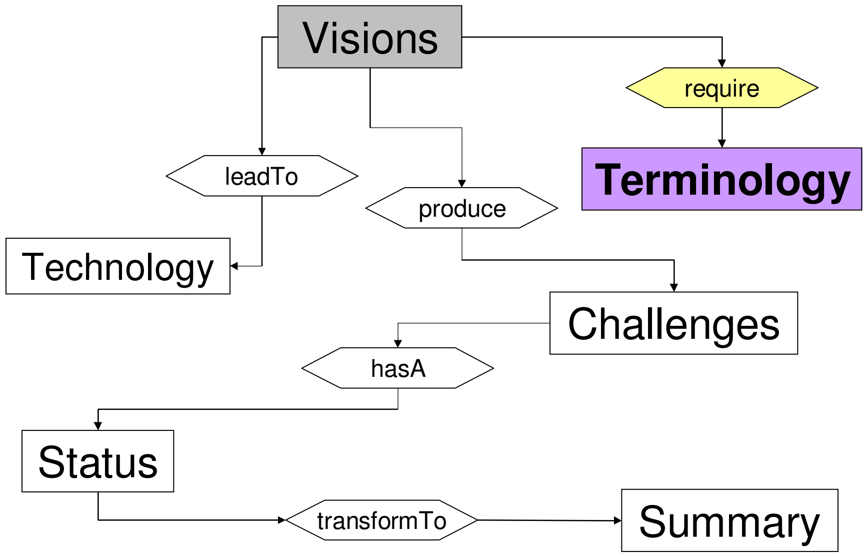


Dublin Core Metadata Initiative[20]

Levels of Interoperability

- 4: Description Set Profile Interoperability
  - Shared formal vocabularies and constraints in records
- 3: Description Set syntactic interoperability
  - Shared formal vocabularies in exchangeable records
- 2: Formal semantic interoperability
  - Shared vocabularies based on formal semantics
- 1: Shared term definitions
  - Shared vocabularies defined in natural language

Topics



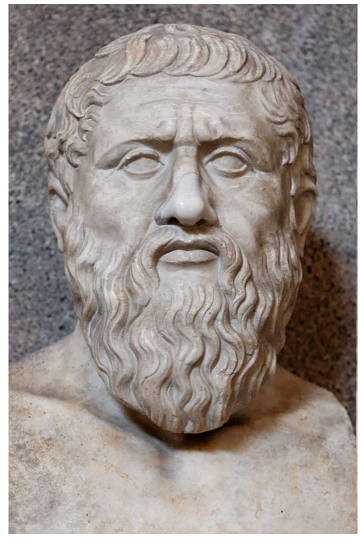
Formal Disciplines Form Basis for Semantic Web

- Graph Theory
  - 1736, Leonhard Euler, “The Seven Bridges of Konigsberg”
  - Nodes and relationships
- Description Logic
  - 1980s
  - Derived from first-order logic
  - Produce decideable (versus undecidable) knowledge representations
    - Doesn’t say how long it will take to “decide”

Semantics

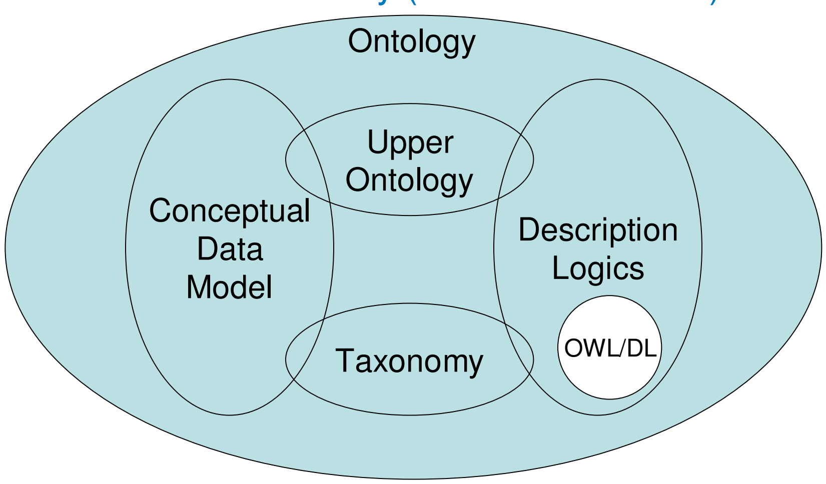
- The study of meaning
- Cratylus of Plato (427-347 BC)

  Words → things[3]

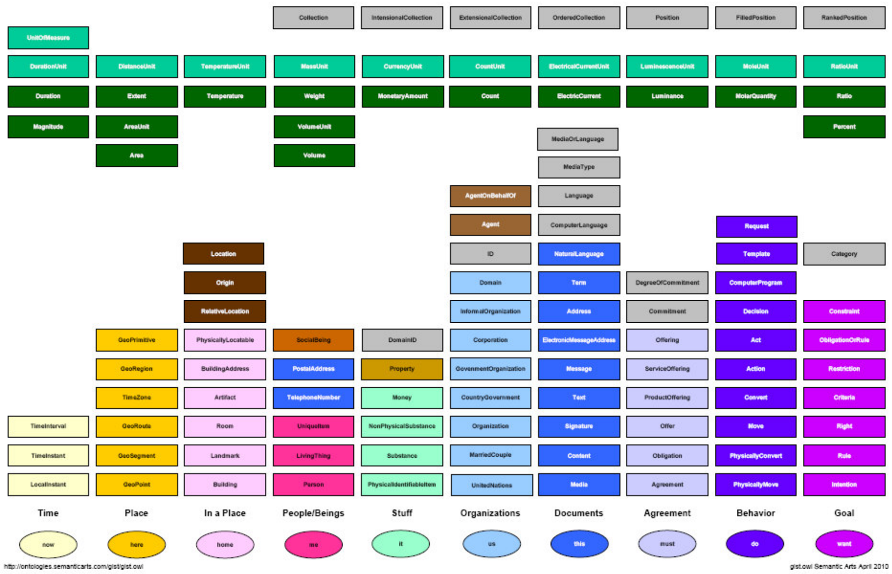


Ontology

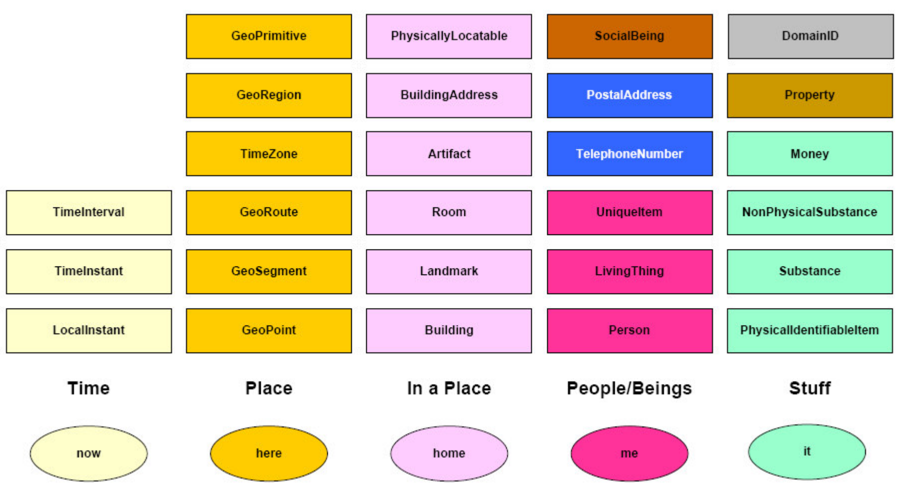
- A formal organization of a body of knowledge
  - A domain vocabulary (with domain rules)



Referents from an Upper Ontology (gist)

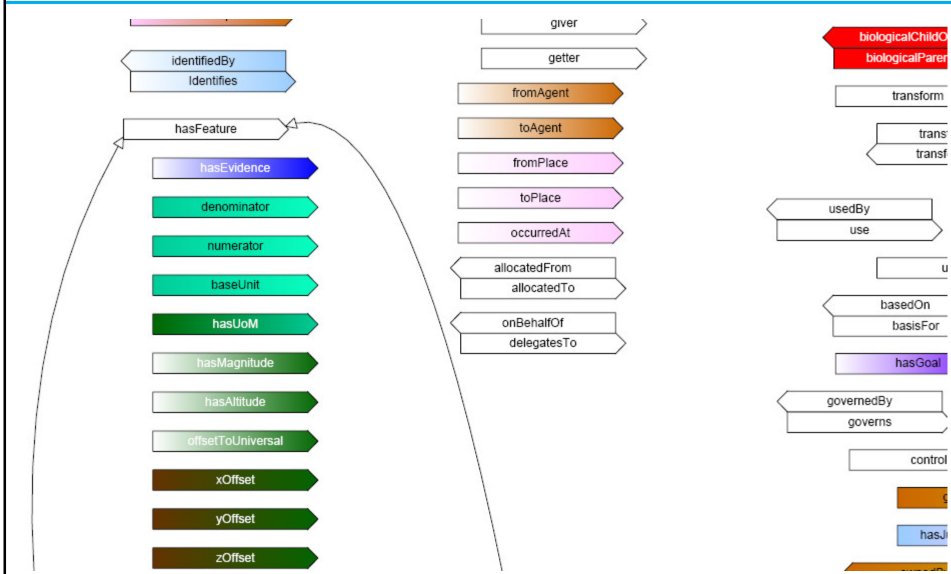


Detail of Referents from gist



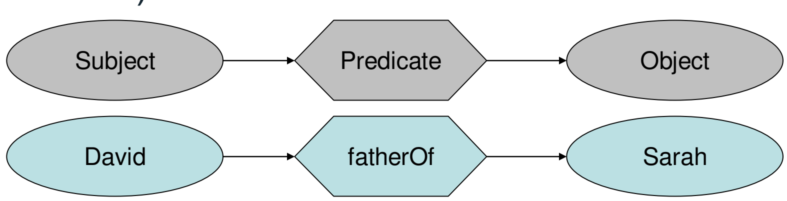
http://ontologies.semanticarts.com/gist/gist.owl

Detail of Predicates from gist



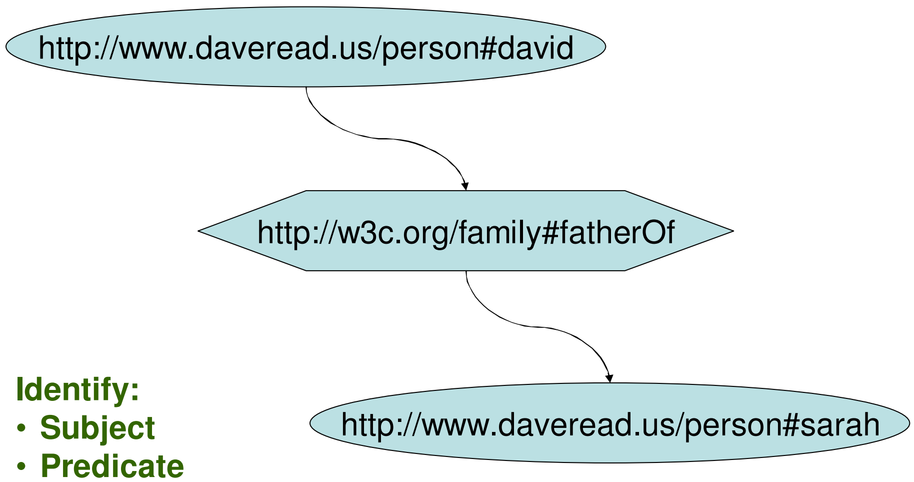
RDF Triple (Assertion)

- *Referent: the object or idea to which a word or phrase refers (thing)*
- **Subject**: A URI reference (to a referent)
- **Predicate**: The property of the triple (how the object is related to the subject) – also a URI
- **Object**: A URI reference (again, to a referent) *or* a constant



RDF Triples Use URIs

Why?



Identify:
- **Subject**
- **Predicate**
- **Object**

Note: Triples are "directed"

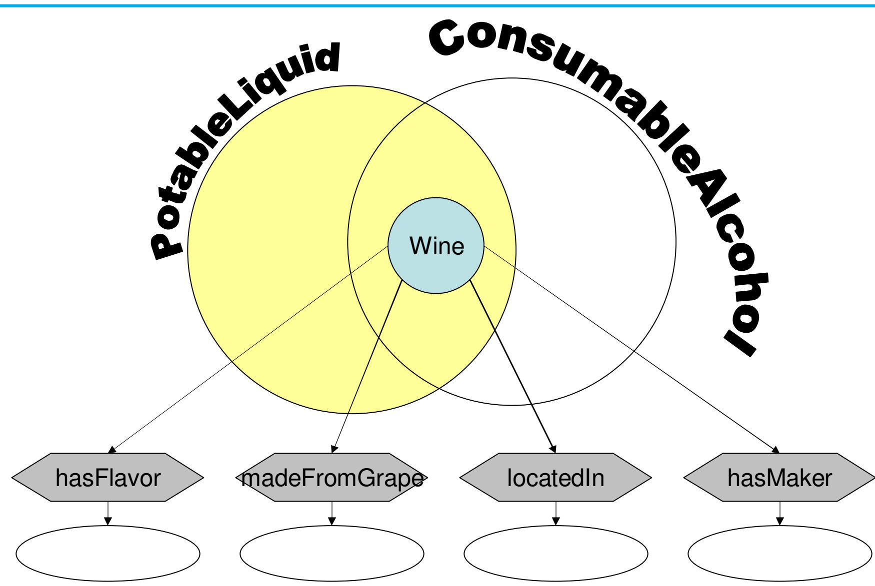
RDF as an XML Schema[4]

```
<?xml version="1.0"?>
<rdf:RDF
   xmlns:rdf=http://www.w3.org/1999/02/22-rdf-syntax-ns#
   xmlns:si="http://www.w3schools.com/rdf/">

  <rdf:Description
       rdf:about="http://www.w3schools.com">
    <si:title>W3Schools.com</si:title>
    <si:author>Jan Egil Refsnes</si:author>
  </rdf:Description>

</rdf:RDF>
```

Wine Ontology (excerpted)

```
<owl:Class rdf:ID="Wine">
 <rdfs:subClassOf rdf:resource="http://www.w3.org/TR/2003/CR-owl-guide-
    20030818/food#PotableLiquid"/>
<rdfs:subClassOf><owl:Restriction>
 <rdfs:subClassOf rdf:resource="http://www.w3.org/TR/2003/CR-owl-guide-
    20030818/food#ConsumableAlcohol"/>
<rdfs:subClassOf><owl:Restriction>
  <owl:onProperty rdf:resource="#hasMaker"/>
  <owl:allValuesFrom rdf:resource="#Winery"/>
</owl:Restriction></rdfs:subClassOf><rdfs:subClassOf><owl:Restriction>
  <owl:onProperty rdf:resource="#madeFromGrape"/>
  <owl:minCardinality
    rdf:datatype="http://www.w3.org/2001/XMLSchema#nonNegativeInteger">1</ow
    l:minCardinality>
</owl:Restriction></rdfs:subClassOf><rdfs:subClassOf><owl:Restriction>
  <owl:onProperty rdf:resource="#hasFlavor"/>
 <owl:cardinality rdf:datatype="http://www.w3.org/2001/XMLSchema#nonNegativeInteger">1</owl:cardinality>
</owl:Restriction></rdfs:subClassOf><rdfs:subClassOf><owl:Restriction>
 <owl:onProperty rdf:resource="#locatedIn"/>
 <owl:someValuesFrom rdf:resource="http://www.w3.org/TR/2003/CR-owl-guide-20030818/wine#Region"/>
</owl:Restriction></rdfs:subClassOf>
 <rdfs:label xml:lang="en">wine</rdfs:label>
 <rdfs:label xml:lang="fr">vin</rdfs:label>
</owl:Class>
```

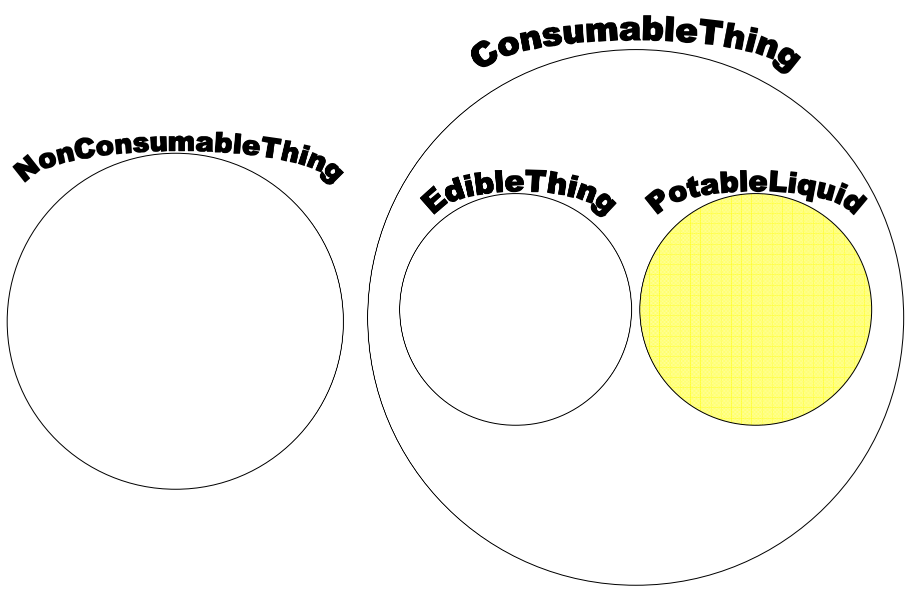

Wine Ontology (graphically)



Food Ontology (excerpt)

```
<rdf:RDF xml:base="http://www.w3.org/TR/2003/CR-owl-
   guide-20030818/food#">
 <owl:Class rdf:ID="ConsumableThing"/>
 <owl:Class rdf:ID="NonConsumableThing">
  <owl:complementOf rdf:resource="#ConsumableThing"/>
 </owl:Class>
 <owl:Class rdf:ID="EdibleThing">
  <rdfs:subClassOf rdf:resource="#ConsumableThing"/>
 </owl:Class>
 <owl:Class rdf:ID="PotableLiquid">
  <rdfs:subClassOf rdf:resource="#ConsumableThing"/>
  <owl:disjointWith rdf:resource="#EdibleThing"/>
 </owl:Class>
</rdf:RDF>
```


Food Ontology (graphically)

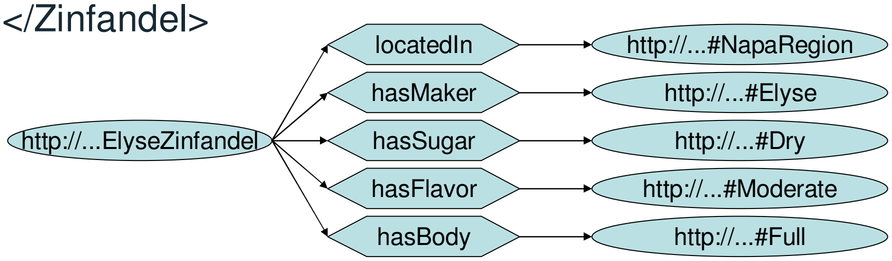


Two Instances Using the Wine Ontology

```
<Winery rdf:ID="SchlossVolrad"/>
<SweetRiesling rdf:ID="SchlossVolradTrochenbierenausleseRiesling">
  <locatedIn rdf:resource="#GermanyRegion"/>
  <hasMaker rdf:resource="#SchlossVolrad"/>
  <hasSugar rdf:resource="#Sweet"/>
  <hasFlavor rdf:resource="#Moderate"/>
  <hasBody rdf:resource="#Full"/>
</SweetRiesling>

<Winery rdf:ID="SeanThackrey"/>
<PetiteSyrah rdf:ID="SeanThackreySiriusPetiteSyrah">
  <locatedIn rdf:resource="#NapaRegion"/>
  <hasMaker rdf:resource="#SeanThackrey"/>
  <hasSugar rdf:resource="#Dry"/>
  <hasFlavor rdf:resource="#Strong"/>
  <hasBody rdf:resource="#Full"/>
</PetiteSyrah>
```


An Instance of a Wine (Triples as RDF and Graphic)

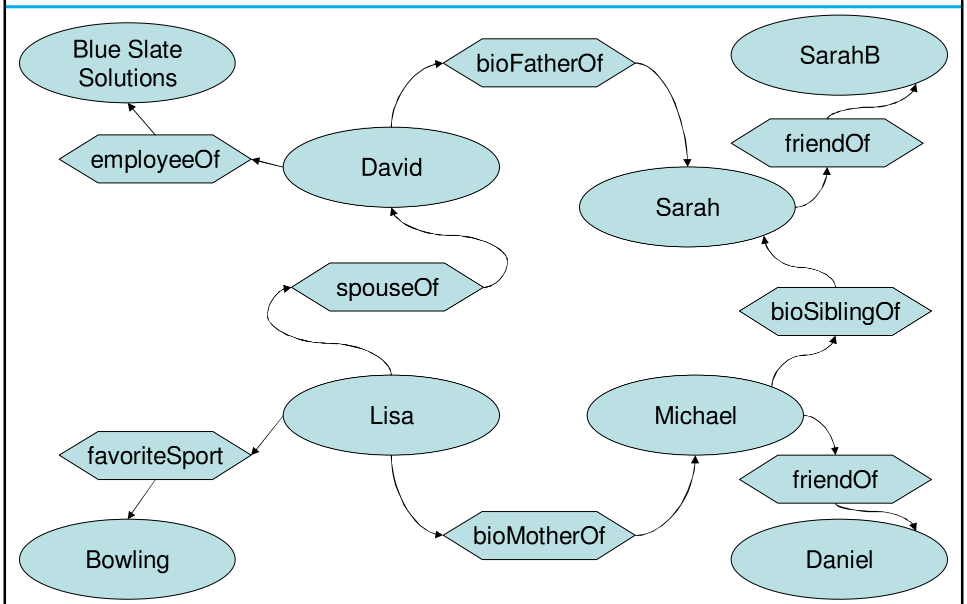
```
<Zinfandel rdf:ID="ElyseZinfandel">
  <locatedIn rdf:resource="#NapaRegion"/>
  <hasMaker rdf:resource="#Elyse"/>
  <hasSugar rdf:resource="#Dry"/>
  <hasFlavor rdf:resource="#Moderate"/>
  <hasBody rdf:resource="#Full"/>
</Zinfandel>
```



Two Types of Statements to Define a Knowledgebase

- TBox (a.k.a. T-Box)
  - Terminological component
  - Controlled vocabulary
  - Define structure and rules
  - Wine → isA → PotableLiquid
- ABox (a.k.a. A-Box)
  - Assertion component
  - Fact associated with the TBox
  - Instances, individuals *(a.k.a. The Data!)*
  - ElyseZinfandel → hasFlavor → Dry

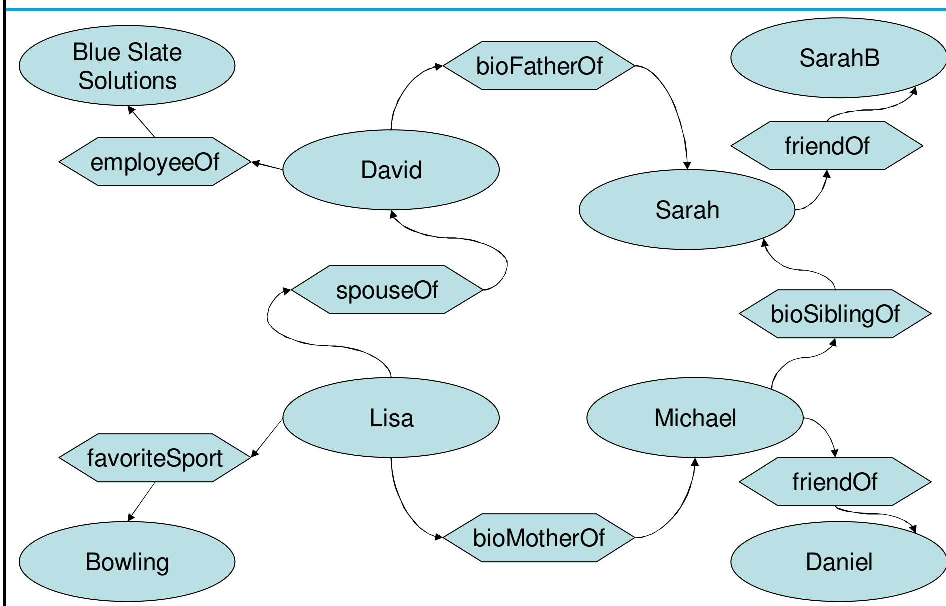
Directed Graph



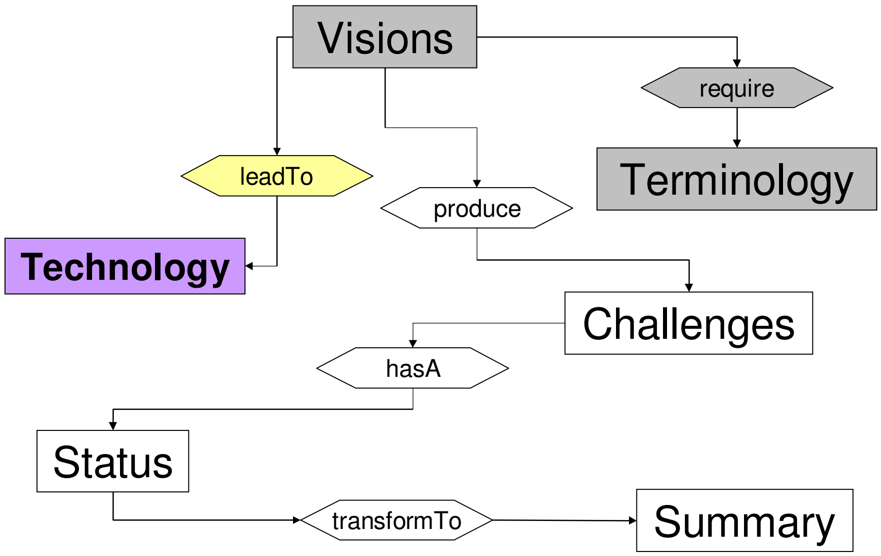
Inference (Defined via OWL and SWRL)

- Create an assertion based on a rule
  - e.g. derive new data
- Body (antecedent, precondition)
- Head (consequent, action)
- Common algorithms: tableaux, Rete
- if
  Person1 spouseOf Person2 — Body
  then
  Person2 spouseOf Person1 — Head

Brainstorm Rules and Inferences



Topics



5 Dimensions to Utilize a Technology

- Standards
  - XML, XSD, **RDF, RDFS, OWL, SPARQL**
- Infrastructure
  - **Integration libraries, Triple stores, Inferencing engines (reasoners), Semantic services**
- Content
  - **Ontologies,** Data → **Triples**
- Tools
  - **Ontology editors, Rule editors, IDEs**
- Discipline
  - **Methodologies, Standards, Best practices**

Semantic Standards (W3C Recommendations, 2004)

- RDF
  - Resource Description Framework
  - All information represented as triples:
    Subject → Predicate → Object
  - Assertions (also inferences)
- RDFS
  - Resource Description Framework Schema
  - Necessary to support ontologies
  - Principally adds classes, properties, types
- OWL
  - Web Ontology Language
    - (figures that a standard about semantics would have a confused acronym)
  - Relationships between classes, properties, equality, cardinality
  - Required for computer processing of content (inferencing, reasoning)
  - Very limited – single assertion inferencing

Additional (more volatile) "Standards"

- SPARQL
  - SPARQL Protocol and RDF Query Language
  - W3C Recommendation, 2008
  - Query language for RDF triples

```
Select ?name
where {<http://blueslate.net/#BlueSlate>
        <http://blueslate.net/#employs> ?person .
        ?person <http://blueslate.net/#hasName> ?name }
```

- SWRL
  - Semantic Web Rule Language
  - W3C Member Submission, 2004
  - Supports rule authoring, overcoming single-instance inferencing limitations in OWL
  - Combines OWL and RuleML

```
hasParent(?x1,?x2) ^ hasBrother(?x2,?x3) = hasUncle(?x1,?x3)
```

Software Technologies

- **Jena** – a framework for working with semantic web concepts
- **Pellet** – a semantic reasoner using the tableau algorithm
- Sesame – RDF triple store
- Virtuoso – RDB supporting SQL and SPARQL
- R2RQ – language to define RDB-to-RDF mappings
- Oracle – RDF triple store (A-Box)

RDF Serialization Syntaxes

- **RDF/XML** – “general purpose language for representing information on the Web”

```
<rdf:Description rdf:about="http://monead.com/semantic/education#claimant">
  <rdfs:subPropertyOf rdf:resource="http://monead.com/semantic/education#Person"/>
  <rdf:type rdf:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
</rdf:Description>
```

- **N3** (Notation 3) – readable alternative to RDF/XML

```
dsr:AutoPolicy
    a       owl:Class ;
    rdfs:subClassOf dsr:Policy ;
    owl:equivalentClass
        [ a       owl:Restriction ;
          owl:minCardinality 1 ;
          owl:onProperty dsr:manufacturer
        ] .
```

- **N-Triples** – subset of N3

```
<http://monead.com/semantic/education#policyHolder> <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
    <http://www.w3.org/2002/07/owl#ObjectProperty> .
```

- **Turtle** (Terse RDF Triple Language) - subset of N3

```
dsr:AutoPolicy
    a       owl:Class ;
    rdfs:subClassOf dsr:Policy ;
    owl:equivalentClass
        [ a       owl:Restriction ;
          owl:minCardinality 1 ;
          owl:onProperty dsr:manufacturer
        ] .
```

Class

```
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix owl:  <http://www.w3.org/2002/07/owl#> .
@prefix xsd:  <http://www.w3.org/2001/XMLSchema#> .
@prefix rdf:   <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix dsr:  <http://monead.com/semantic/education#> .

dsr:Person   a      owl:Class .

dsr:Policy    a      owl:Class .

dsr:Insured   a      owl:Class ;
     rdfs:subClassOf dsr:Person .
```


Property

```
dsr:construction  a    owl:ObjectProperty .

dsr:name   a    owl:DatatypeProperty .

dsr:claimant
     rdfs:subPropertyOf dsr:name .
```

For you OO folks, anything seem strange?

Individual

```
dsr:CivicPolicy
      a       dsr:Policy ;
      dsr:deductable "500" ;
      dsr:manufacturer "Honda" ;
      dsr:premium "342" .

dsr:McCoyLH
      a       dsr:Person ;
      dsr:legalName "Leonard H. McCoy" ;
      dsr:name "Bones" , "Leonard McCoy" ;
      dsr:policyHeld dsr:CivicPolicy , dsr:ColonialPolicy
    .
```


Restriction Class and Special Property

```
dsr:PolicyHolder
      a       owl:Class ;
      owl:equivalentClass
              [ a       owl:Restriction ;
                owl:onProperty dsr:policyHeld ;
                owl:someValuesFrom dsr:Policy
              ] .

dsr:policyHolder
      a       owl:ObjectProperty ;
      owl:inverseOf dsr:policyHeld .
```

Inferences

```
<http://monead.com/semantic/education#PolicyHolder>
      <http://www.w3.org/2000/01/rdf-schema#subClassOf>
              <http://monead.com/semantic/education#PolicyHolder> ,
     <http://www.w3.org/2002/07/owl#Thing> ;
<http://www.w3.org/2002/07/owl#equivalentClass>
              [ a       <http://www.w3.org/2002/07/owl#Restriction> ;
                <http://www.w3.org/2002/07/owl#onProperty>
                        <http://monead.com/semantic/education#policyHeld> ;
                <http://www.w3.org/2002/07/owl#someValuesFrom>
                        <http://monead.com/semantic/education#Policy>
              ] .

<http://monead.com/semantic/education#CivicPolicy>
      a       <http://www.w3.org/2002/07/owl#Thing> ;
      <http://monead.com/semantic/education#policyHolder>
              <http://monead.com/semantic/education#McCoyLH> ;
      =       <http://monead.com/semantic/education#CivicPolicy> .
```


Tree View of the Inferred Information

Basic SPARQL Query

- select ?s ?p ?o where { ?s ?p ?o }

Results

s	p	o
http://monead.com/semantic/education#policyHolder	http://www.w3.org/...	http://www.w3.org/...
http://monead.com/semantic/education#policyHolder	http://www.w3.org/...	http://monead.co...
http://monead.com/semantic/education#policyHolder	http://www.w3.org/...	http://monead.co...
http://monead.com/semantic/education#policyHolder	http://www.w3.org/...	http://monead.co...
http://monead.com/semantic/education#policyHolder	http://www.w3.org/...	http://www.w3.org/...
http://monead.com/semantic/education#claimant	http://www.w3.org/...	http://www.w3.org/...
http://monead.com/semantic/education#claimant	http://www.w3.org/...	http://monead.co...
http://monead.com/semantic/education#claimant	http://www.w3.org/...	http://www.w3.org/...
http://monead.com/semantic/education#claimant	http://www.w3.org/...	http://monead.co...
http://monead.com/semantic/education#claimant	http://www.w3.org/...	http://monead.co...
http://monead.com/semantic/education#claimant	http://www.w3.org/...	http://www.w3.org/...
http://monead.com/semantic/education#PolicyHolder	http://www.w3.org/...	http://www.w3.org/...
http://monead.com/semantic/education#PolicyHolder	http://www.w3.org/...	http://monead.co...

Number of Results: 160

Another SPARQL Query

prefix dsr: <http://monead.com/semantic/education#>

select ?s ?o where { ?s dsr:policyHolder ?o}

Results

s	o
http://monead.com/semantic/education#Colonia...	http://monead.com/semantic/education#McCoyLH
http://monead.com/semantic/education#CivicPo...	http://monead.com/semantic/education#McCoyLH

Many More Features Within RDF, RDFS, OWL

- Dynamic Classes (Categorization)
  - someValuesFrom
  - Intersection
  - Union
  - Complement
  - Boolean
  - Enumerations
- Special Properties
  - Inverse
  - Transitive
  - Symmetric
  - Functional
  - Inverse Functional
- And much more…

What About Java?

- In the semantic realm we've seen syntax to create classes, properties, individuals and rules. How do we use this information in our applications?
- For Java, we need to connect between the triple-based and OO worlds
- Just like with O/R, there are frameworks to handle triple mapping and give us APIs to leverage
  - We will look at **Jena**
- We also need to be able to support the inferencing aspect of the semantic web
  - We will use **Pellet**

Key Jena (and a Pellet) Classes

com.hp.hpl.jena.ontology.Individual
com.hp.hpl.jena.ontology.OntModel
com.hp.hpl.jena.query.Query
com.hp.hpl.jena.query.QueryExecution
com.hp.hpl.jena.query.QueryFactory
com.hp.hpl.jena.query.QuerySolution
com.hp.hpl.jena.query.ResultSet
com.hp.hpl.jena.rdf.model.Model
com.hp.hpl.jena.rdf.model.ModelFactory
com.hp.hpl.jena.rdf.model.Property
com.hp.hpl.jena.rdf.model.RDFNode
com.hp.hpl.jena.rdf.model.Statement
com.hp.hpl.jena.rdf.model.StmtIterator
com.hp.hpl.jena.reasoner.Reasoner

org.mindswap.pellet.jena.PelletReasonerFactory

Loading a Serialized Model

Reasoner reasoner =
PelletReasonerFactory.*theInstance*().create();

Model infModel =
ModelFactory.*createInfModel*(reasoner,
ModelFactory.*createDefaultModel*());

OntModel model =
ModelFactory.*createOntologyModel*(OntModelSpec
.*OWL_DL_MEM*, infModel);

inputStream = new
ByteArrayInputStream(assertions.getText()
.getBytes("UTF-8"));

model.read(inputStream, null, “TURTLE”);

Obtain the Classes from a Model

```
OntClass ontClass;
ExtendedIterator<OntClass> classesIterator;

classesIterator = ontModel.listClasses();
while (classesIterator.hasNext()) {
  ontClass = classesIterator.next();
  if (ontClass.isAnon()) {
    oneClassNode = new
    DefaultMutableTreeNode("Anonymous Class ("
      + ontClass.getId().getLabelString() + ")");
  } else {
    oneClassNode = new DefaultMutableTreeNode(ontClass
    .getLocalName() + " (" + ontClass.getURI() + ")");
  }
  // Do something with the oneClassNode instance
}
```


Obtain the Individuals in a Class

```
Individual individual;
ExtendedIterator<Individual> individualsIterator;

// Assume setup from previous slide

individualsIterator = ontModel.listIndividuals(ontClass);
while (individualsIterator.hasNext()) {
  individual = individualsIterator.next();
  if (individual.isAnon()) {
    // can use individual.getId().getLabelString() for anon label
  } else {
    // can use individual.getLocalName() and individual.getURI()
  }
}
```

Get Predicates and Objects for Subjects

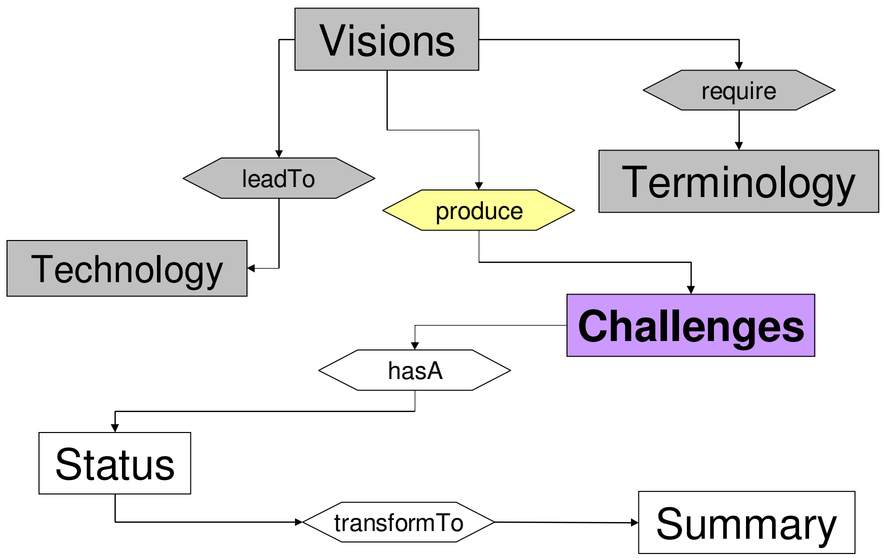
```
Statement statement; Property property; RDFNode rdfNode; StmtIterator stmtIterator;

// Assume setup from previous slide

stmtIterator = individual.listProperties();
while (stmtIterator.hasNext()) {
  statement = stmtIterator.next();
  property = statement.getPredicate();
  rdfNode = statement.getObject();
  if (property.isAnon()) {
    // can use property.getId().getLabelString() to get anon label
  } else {
    // can use property.getLocalName() and property.getURI() for predicate (property)
  }
  // Now get the object (could be literal or object)
  if (rdfNode.isLiteral()) {
    // Is a literal: get String representation with statement.getString()
  } else {
    // Is an object, can use statement.getResource().getLocalName()
    // and statement.getResource().getURI()
  }
}
```


Demo

- RDB Conversion to RDF
- Differences in Inferencing Levels
- Exploring an RDF Graph
- Querying the Cloud: DBPedia

Sample code: **http://monead.com/semantic/**

Topics



Semantics: Change in Multiple Dimensions

Data Interpretation Topic	Current Technology	Description Logics Ontology
Structural Bias	Format input to conform to model	Accept input and attempt to make sense of it
Completeness	Model is assumed complete *"Negation as failure"*	Model is assumed partial *"Open-world reasoning"*
Class	Template for all instances	Set for relating instances
Disjointness	All rows (tuples) assumed to refer to different referents	Unless declared, any two instances may be referring to the same referent
Fact Model	Used as defined	Altered through inference
Data Volatility	Facts come and go	Facts can only be added *(well, let me explain…)*

Relational Databases Versus Knowledgebases[18]

Feature	Relational Database	Knowledgebase
Structure	Schema	Ontology statements
Data	Rows	Instance statements
Administration Lang.	DDL	Ontology statements
Query Lang.	SQL	SPARQL
Relationships	Foreign keys	Multidimensional
Logic	Triggers or external	Formal logic statements
Uniqueness	Key for table	URI *(sort of)*

Shift in Design and Programming Paradigms

- Class indicates membership
  - not structure or behavior
- May create instances without creating a class
- Instances may belong to multiple classes
  - without any inheritance relationship between those classes
- Property (predicate) is a first-class concept
  - sub-properties and super-properties
- Properties are not associated with a particular class
- ***Provably*** versus ***satisfiably*** true or false
- ***Necessary*** and/or ***sufficient*** for inferencing

Sounds Good…

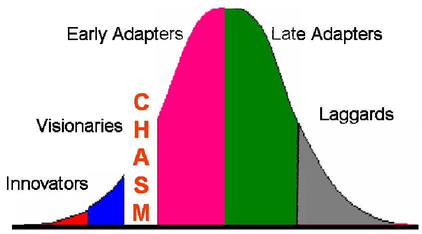
… Why the Long Journey to Adoption?

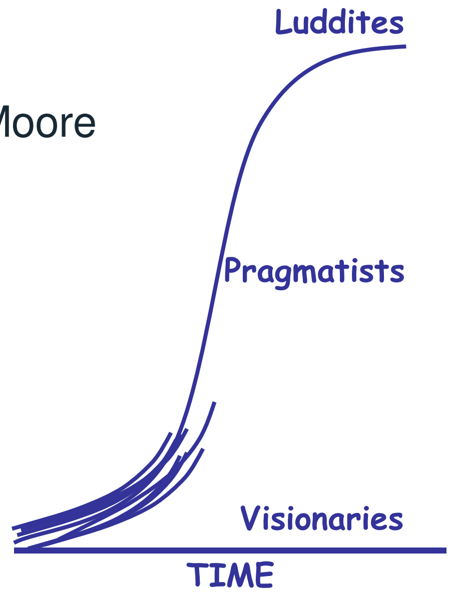
Types of Innovation

- **Sustaining / Incremental Innovation**: generally small innovations in products and processes aimed at existing customers
- **Disruptive / Discontinuous Innovation**: significant innovations generally aimed at unknown or non-existent customers

Normal Distribution and the Adoption S-Curve

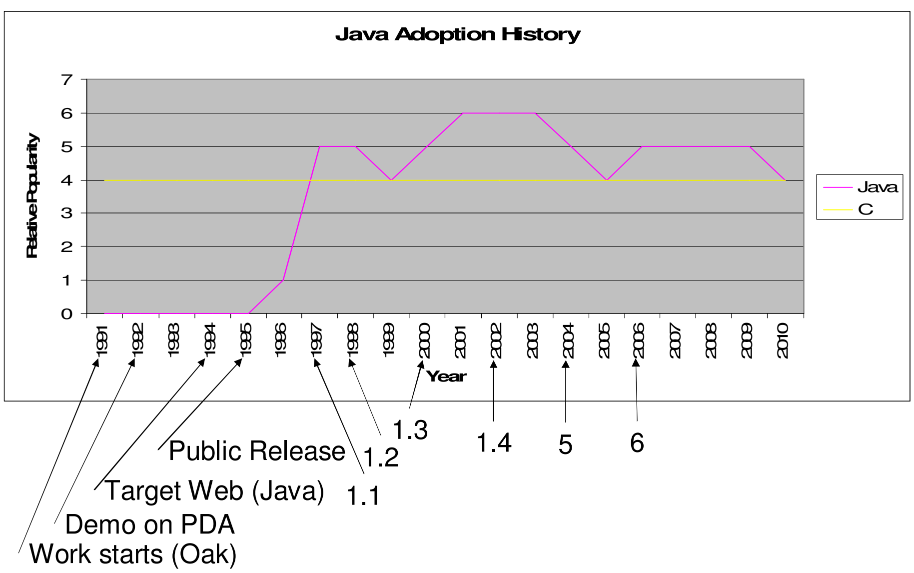
Geoffrey Moore





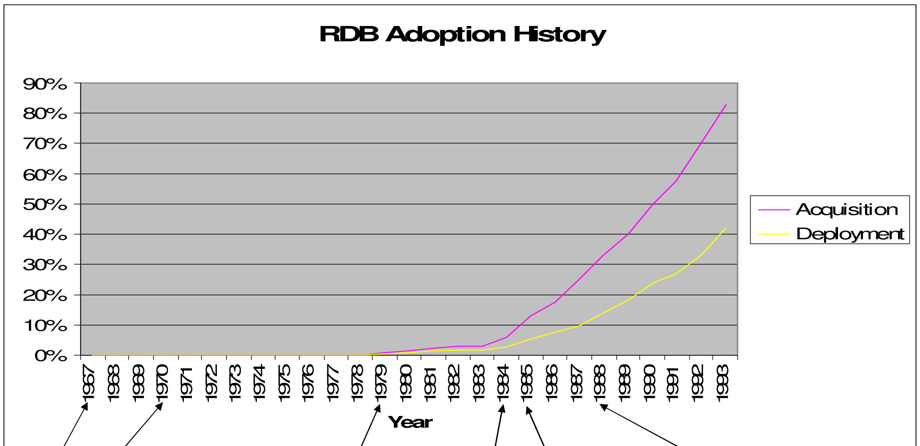
BLUE SLATE solutions

Sustaining Innovation: Java [11, 12]



BLUE SLATE solutions

Disruptive Innovation: Relational Databases[13, 14, 15, 16]



Sybase DB2 MS SQL Server

Oracle v2 (marketing gimmick, no v1)

Codd publishes, “Relational Model of Data for Large Shared Data Banks"

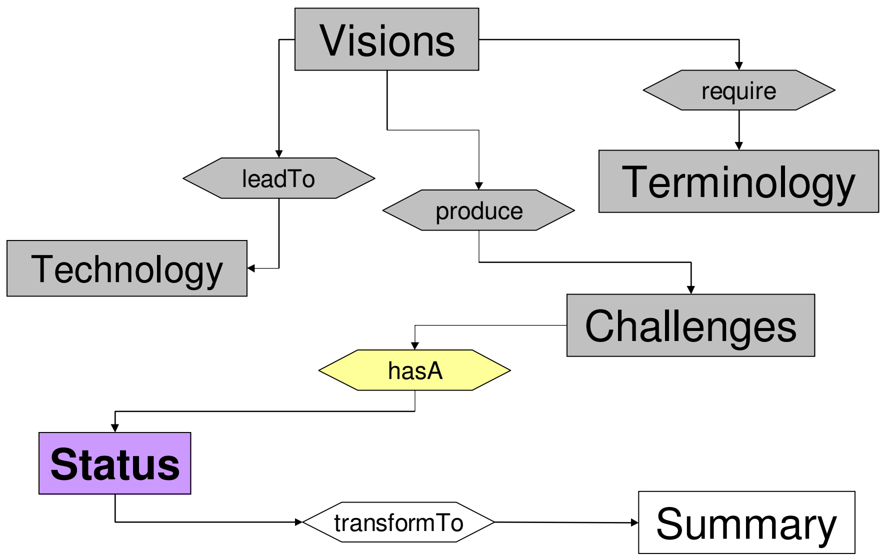
Edgar Codd begins relational algebra -> relational data research

What is the Semantic Web’s Timeline?

- 1994:Tim Berners-Lee posits the value of semantics on the web at the (first) International WWW Conference
- 1995:OCLC/NCSA Metadata Workshop, Dublin, OH
- 1999:Dan Brickley submits “Nodes and Arcs 1989-1999” as a proposal to the W3C in November, which leverages RDF
- 2001:Tim Berners-Lee publishes an article entitled, “The Semantic Web” in the May issue of “Scientific American”
- 2004:RDF, RDFS and OWL become W3C Recommendations
- 2005:FACT++ released with support for OWL DL
- 2006:Metatomix release eclipse-based toolkit for RDF/OWL editing
- 2006:Oracle adds a native triple-store to their Oracle 10g product (release 2)
- 2007:TopQuadrant releases development tool for RDF/OWL, integrates with multiple engines

Sources: product web sites and W3C.org as of May 9, 2010

Topics



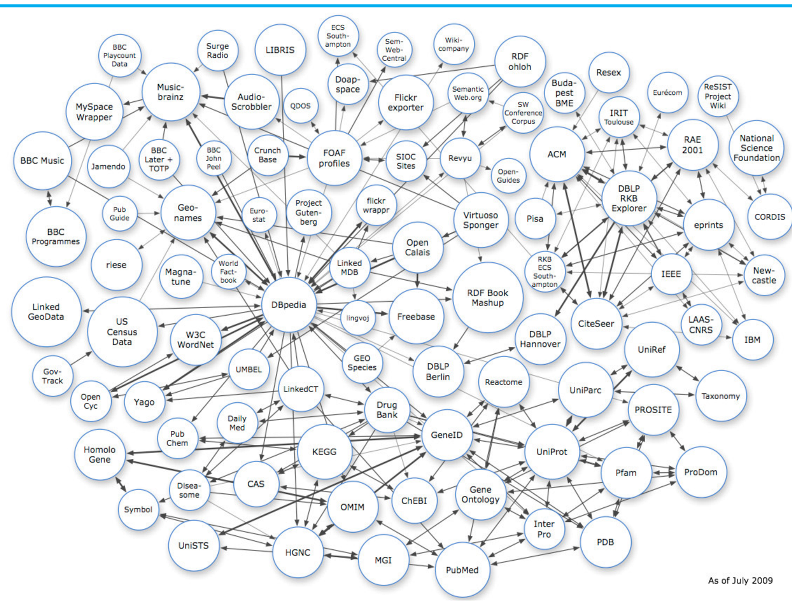
Standards

- RDF/RDFS: Stable (implemented in multiple products)
- OWL: version 2 a W3C recommendation
  - second system effect
- SPARQL: Lacks support for querying RDFS and OWL-based extensions to RDF
- SWRL: Not yet a W3C recommendation
- *Focus needed on rule expression standards*

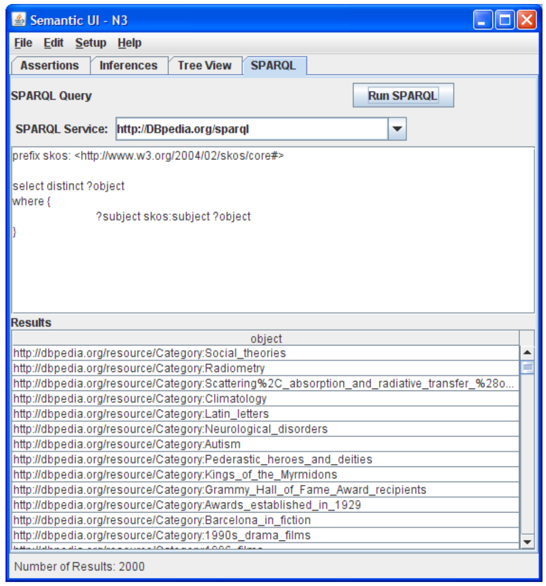
Technology

- Development Tools
  - Lack usability beyond hardcore semantic-savvy developers
  - Buggy, inconsistent interpretation of standards
- Runtime environments
  - Limited feature sets
  - Performance issues (time/space tradeoffs)
- Products and libraries include: Oracle, Metatomix, FACT++, Protégé, Siderean, TopBraid, SWiFT Subleme, Calais, Jena

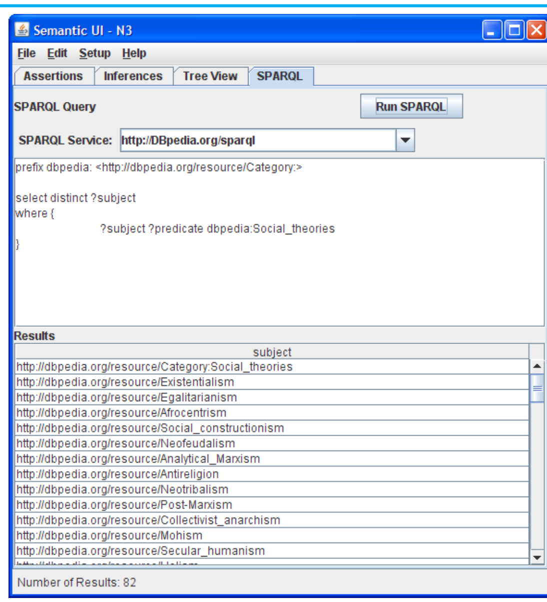
Linked Data Cloud



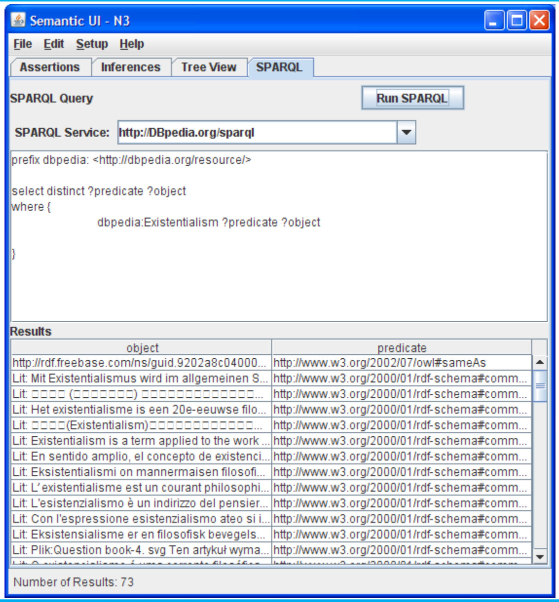
Querying the Cloud – DBpedia Objects



Querying the Cloud – Social Theories



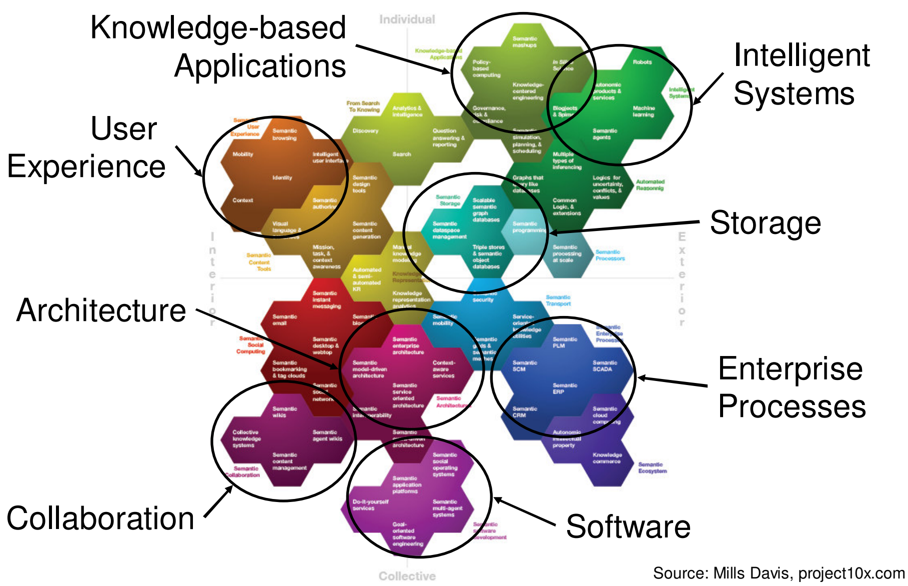
Querying the Cloud – Predicates and Objects for Existentialism



Some Thought Leaders

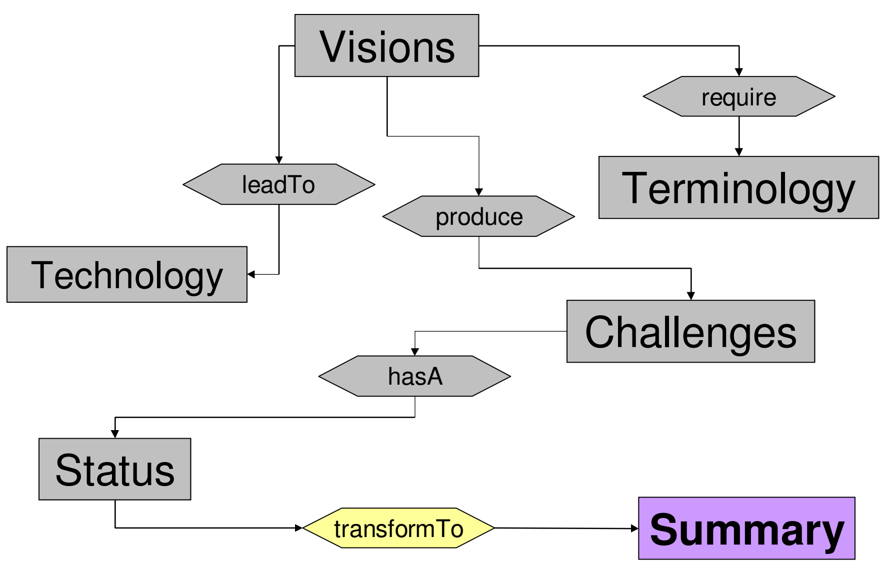
- Sir Tim Berners-Lee at TED
  - 2009
    - http://www.ted.com/talks/tim_berners_lee_on_the_next_web.html
  - 2010
    - http://www.ted.com/talks/tim_berners_lee_the_year_open_data_went_worldwide.html
- Dave McComb, *Semantic Arts Inc.*
- Dr. James Hendler, Professor, *RPI*
- Dean Allemang, Chief Technology Consultant, *TopQuadrant*

Semantic Tech Product and Service Opportunities



Source: Mills Davis, project10x.com

Topics



POCs, Partial SDLC, Limited Deployments

- Lower-level (structural) standards are sound
- Tools exist to test concepts and develop ontologies
- Structured semantic ontology definitions supported
- Specific use cases can leverage existing semantic technology
- FOAF, RDFa and microformats can be leveraged on websites now
  - "Bridging the Human and Data Webs"[19]
- Integration protocols are absent
  - currently use known standards (web services, SOA)
  - theories abound (location-agnostic services)
- Rule authoring standards in flux
- Query language in its infancy
- Upper ontologies required to achieve shared meaning

A Few Relevant Resources

- Books
  - **Semantic Web Programming** (2009)
    Hebler, John et al
    ISBN-13: 978-0470418017
    Solid introduction to semantic concepts and their use within Java applications (via Jena and Pellet).
  - **Semantic Web for the Working Ontologist** (2008)
    Allemang, Dean and Handler, Jim
    ISBN-13: 978-0123735560
    Excellent coverage of semantic modeling (RDF, RDFS, OWL) as well as inferencing. Serves as a great reference guide as well.
  - **Programming the Semantic Web** (2009)
    Segaran, Toby et al
    ISBN-13: 978-0596153816
    Uses Python to drill into the low-level implementaton details around semantically-based application operation.
- Web
  - W3C Semantic Web Activity Homepage: http://www.w3.org/2001/sw/
  - Jena: http://jena.sourceforge.net/
  - Pellet: http://clarkparsia.com/pellet/
  - Dave's Semantic Homepage: http://monead.com/semantic/
  - Cheat Sheet: http://ebiquity.umbc.edu/_file_directory_/resources/97.pdf

Thank You

Q&A

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Semantic Workbench
Goal: To Create
An Open Source Semantic
Technology Exploration Tool
Please participate:
semanticwb.sourceforge.net

Sources

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