Exploring the Semantic Web with Kowari

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Speaker Qualifications

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- Over 12 years of software development experience
- Has own software consulting company for design, mentoring, training and development
- Currently working in Semantic Web, AOP, Grid Computing and security consulting
- Kowari Committer

Agenda

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- The Web So Far
- Semantic Web
- Kowari
- Other SemWeb Tools
- Related Non-Semantic Web Technologies
- The Future
- References

The Web So Far

What We Like About the Web

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- Global data store
- Universal Addressability
- Common Transports
- Common Structured/Presentation Formats
- Search
- Web Services
- Anyone can publish

What Still Isn’t Right

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- Mixture of Content and Presentation
- People Can’t Agree On Anything!
- Information Overload
- Search Could Be Better
- Web Services are difficult to manage in a global and orchestrated way
- Seriously, **ANYONE** can publish!

Google Is Just the Beginning

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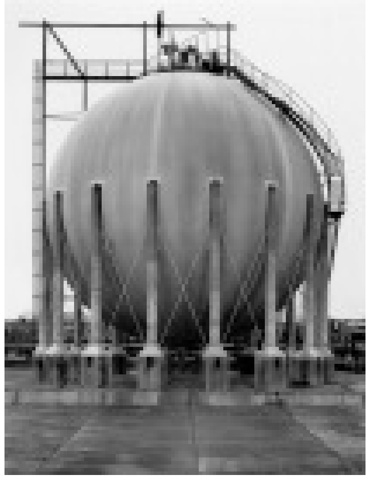
- How comfortable would you be letting your child use the Internet to find information about Louisa May Alcott's "Little Women"?
- Keyword search has its limits: "tank"



Screen-Scraping Stinks

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- What does this mean? What happens when the presentation changes?

```
<html>
  <body>
    <table>
     <tr><th>Product</th><th>Price</th></tr>
     <tr><td>Book</td><td>13.00</td>
     <tr><td>CD</td><td>16.00</td>
    </table>
  </body>
</html>
```

(cue RDF/GRDDL theme music)

Network Effects Rule!

- Metcalfe's Law Lives : "*The value of a network equals approximately the square of the numbers of users of the system.*"
- We're good on numbers, we just need to capture what is there
  - What's wrong with sites like Orkut, Friendster, tribe.net?

(cue FOAF theme music)

The Semantic Web

History

- Tim Berners-Lee (TBL) had a vision that surpassed where we are today
  - Talked about "Semantic Web" in a few slides back in 1994 at 1st WWW Conference
- *"The Semantic Web is specifically a web of machine-readable information whose meaning is well-defined by standards: it absolutely needs the interoperable infrastructure that only global standard protocols can provide" -- from the foreword to "Spinning the Semantic Web"*

Syntax vs Semantics

- XML provides a syntax for web documents
  - “Format”
  - Must agree upon semantics upfront
- We still need something to represent concepts
  - “Meaning”

Requirements for the Semantic Web

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- Ability to address arbitrary web resources, concepts, people, organizations
- Formal languages to express facts and relationships in common formats
- Ability to encode shared conceptualizations around communities and domains of interest
- Ability to map between shared conceptualizations
- Ability to discover implicit relationships

Classes/Concepts

- Example
  - A computer is a thing; a person is a thing
  - A Software Engineer is a person with one or more computers
  - A Mac is a subclass of computer with a property “creator”=”Apple”
  - A Mac User is a person with one or more Macs
  - Brian is a Software Engineer
  - Brian is a Mac User

Class Statements

- Example
  - **A computer is a thing; a person is a thing**
  - **A Software Engineer is a person with one or more computers**
  - **A Mac is a subclass of computer with a property “creator”=”Apple”**
  - **A Mac User is a person with one or more Macs**
  - Brian is a Software Engineer
  - Brian is a Mac User

Instance Statements

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- Example
  - A computer is a thing; a person is a thing
  - A Software Engineer is a person with one or more computers
  - A Mac is a subclass of computer with a property “creator”=”Apple”
  - A Mac User is a person with a property with one or more Macs
  - **Brian is a Software Engineer**
  - **Brian is a Mac User**

Inference

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- Example
  - A computer is a thing; a person is a thing
  - A Software Engineer is a person with one or more computers
  - A Mac is a subclass of computer with a property "creator"="Apple"
  - A Mac User is a person with one or more Macs
  - Brian is a Software Engineer
  - Brian is a Mac User

What can we conclude?

Mapping Classes

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- Example
  - A computer is a thing; a person is a thing
  - A Software Engineer is a person with one or more computers
  - A Mac is a subclass of computer with a property "creator"="Apple"
  - A Mac User is a person with one or more Macs
  - **A Programmer is the same thing as a Software Engineer**
  - **Steve is a Programmer**

What can we conclude?

SemWeb vs. semweb

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- Famous debate about the scope of the vision
- Top-Down: Visionaries
  - “Computer, find me anything about anything.”
- Bottom-Up: Doers
  - “Browser, find me images tagged as being about dogs.”

Where are the semantics?

- *"The problem is not that there are no semantics, the problem is that the semantics is hidden in software components." --Stefan Decker*
- Goal is to move away from stove pipes and push the meaning out of the software into the data
  - Increases the potential for integration by maintaining meaning out of context

Technologies

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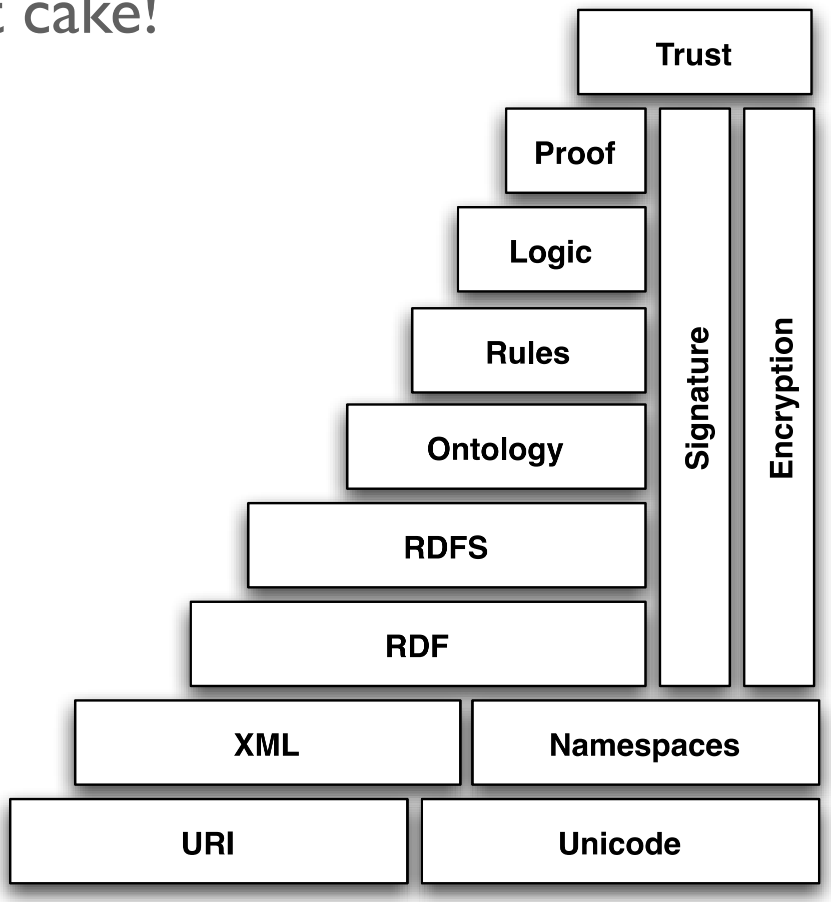
- Let them eat cake!



Trust

Proof

Logic

Rules

Ontology

RDFS

RDF

Signature

Encryption

XML

Namespaces

URI

Unicode

Technologies

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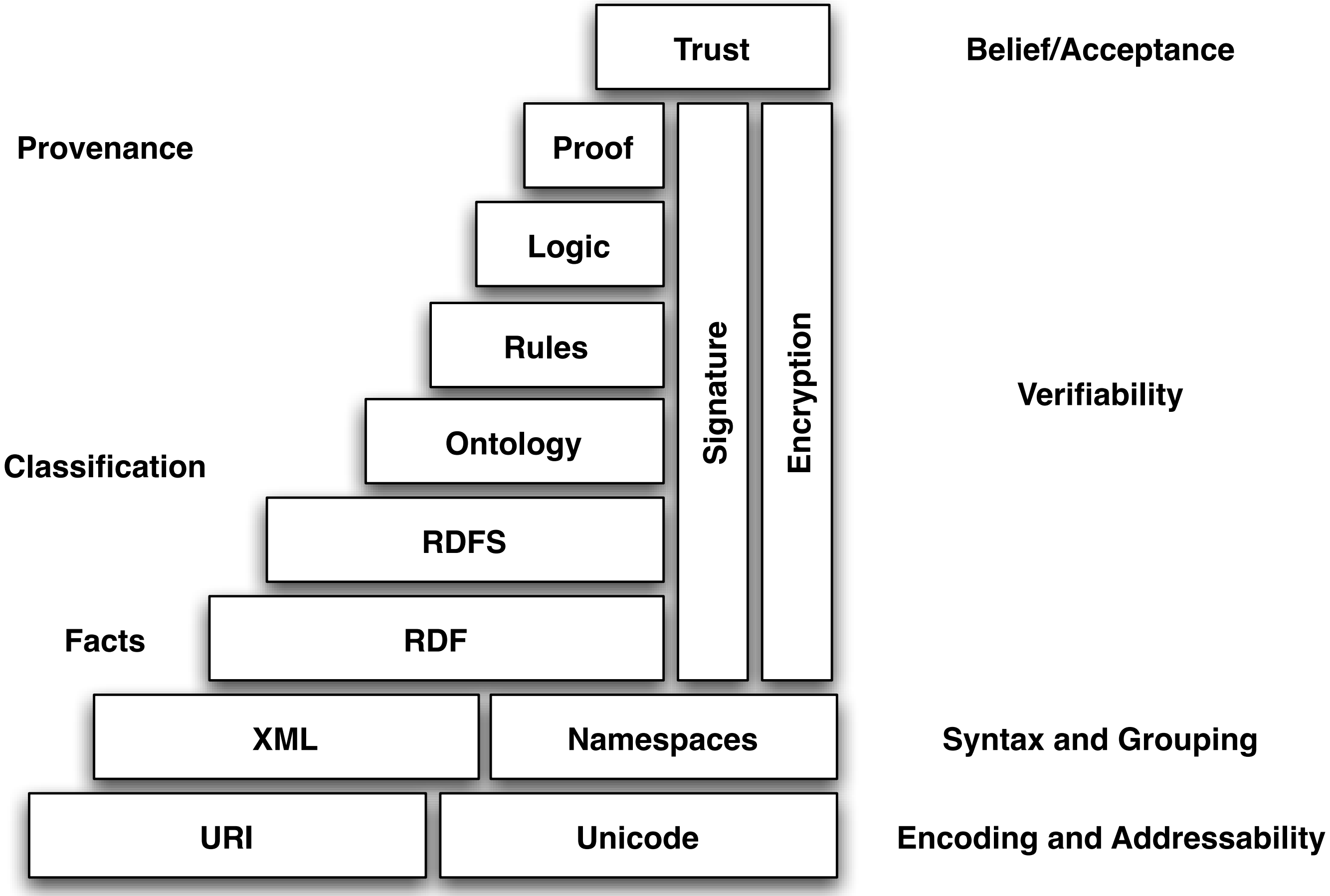

Trust
Belief/Acceptance
Provenance
Proof
Logic
Rules
Signature
Encryption
Verifiability
Ontology
Classification
RDFS
Facts
RDF
XML
Namespaces
Syntax and Grouping
URI
Unicode
Encoding and Addressability

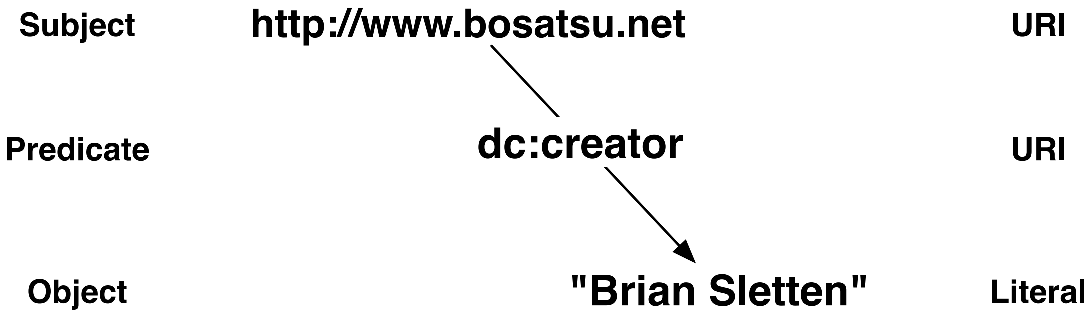
RDF

- Resource Description Framework
- W3C Recommendation
- Specification for a graph metamodel to comment on web resources (or anything)
- Uses a triple form

Subject	Predicate	Object
`http://www.bosatsu.net`	`dc:creator`	`“Brian Sletten”`

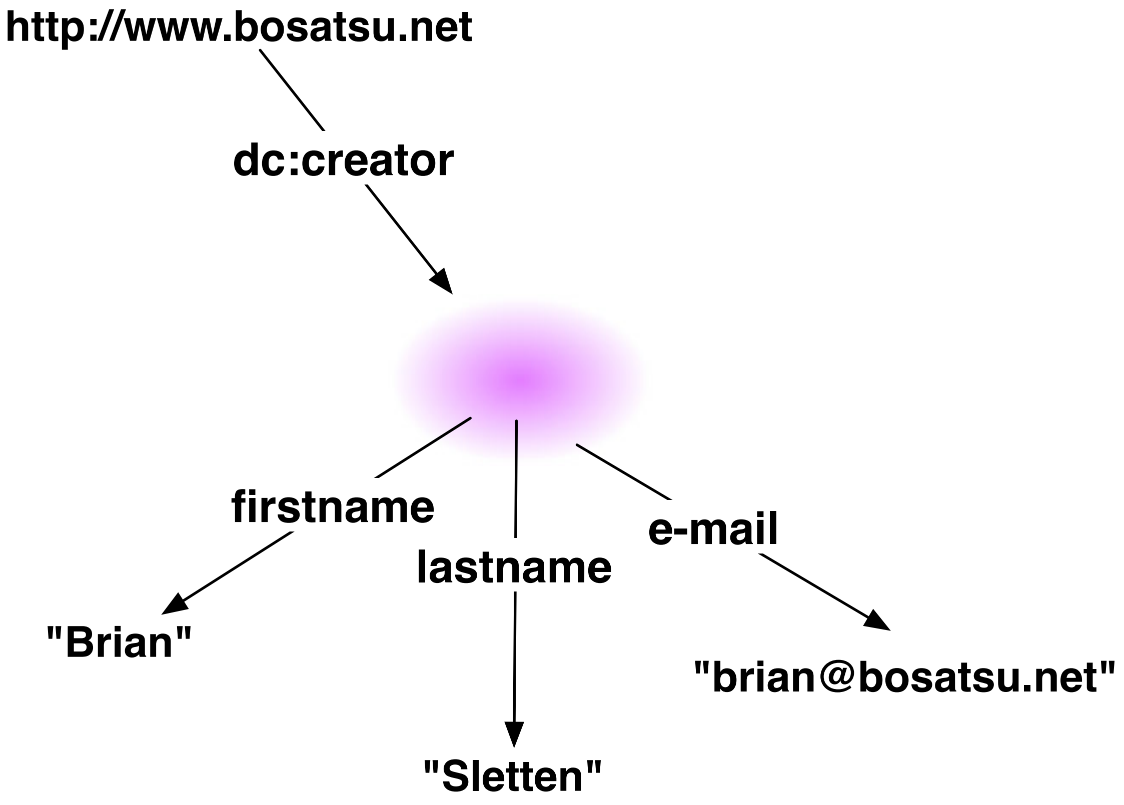
RDF

- RDF objects can be URIs or literals (strings or XSD datatypes)
- Subjects can be blank nodes or URIS
- Predicates can only be URIs
- Objects may be URIs, literals or unnamed blank nodes



Subject	**http://www.bosatsu.net**	**URI**
Predicate	**dc:creator**	**URI**
Object	**"Brian Sletten"**	**Literal**

RDF Graphs



http://www.bosatsu.net

dc:creator

firstname

lastname

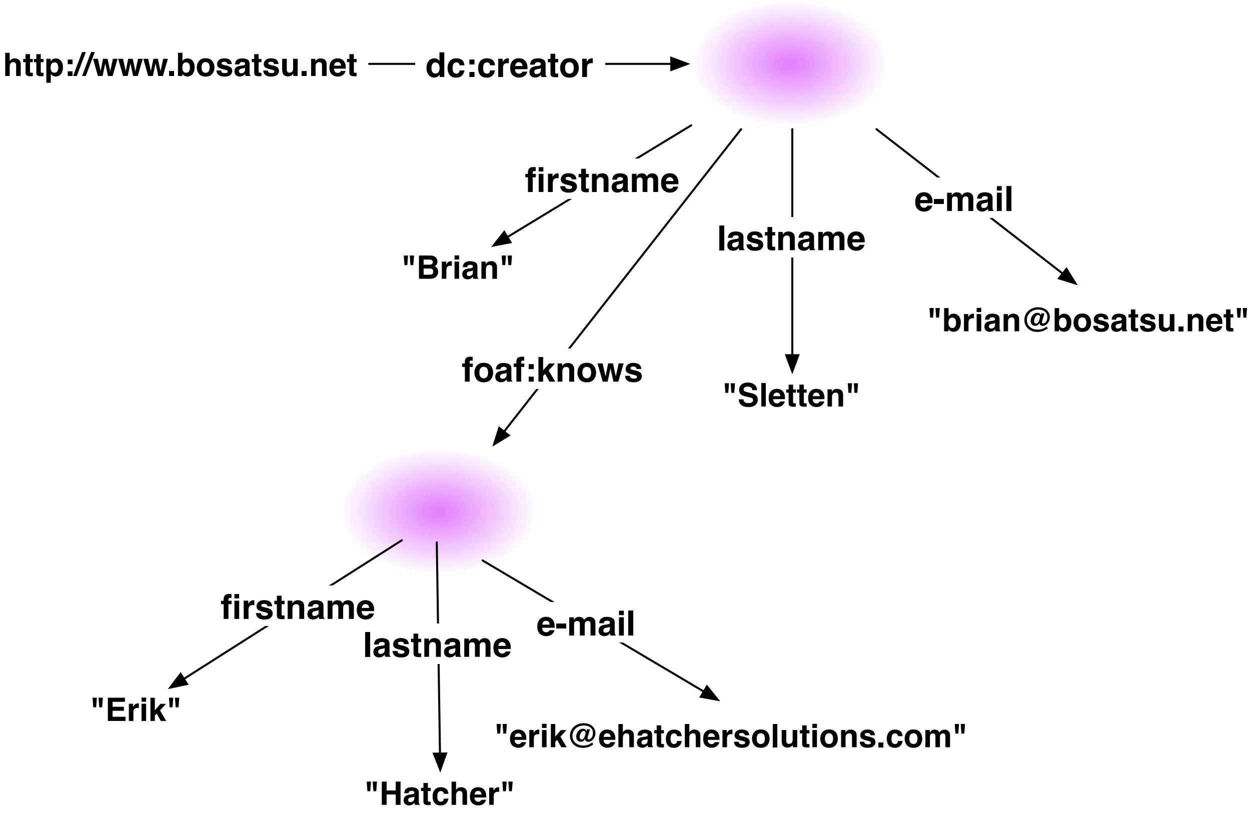
e-mail

"Brian"

"Sletten"

"brian@bosatsu.net"

RDF Graphs (cont)



http://www.bosatsu.net — dc:creator →

firstname

"Brian"

lastname

"Sletten"

e-mail

"brian@bosatsu.net"

foaf:knows

firstname

"Erik"

lastname

"Hatcher"

e-mail

"erik@ehatchersolutions.com"

RDF Formats

```
#XML
<?xml version="1.0" encoding="UTF-8"?>

<rdf:RDF xmlns:dc="http://purl.org/dc/elements/1.1/"
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
    <rdf:Description rdf:about="http://www.bosatsu.net">
    <dc:creator>Brian Sletten</dc:creator>
    </rdf:Description>
</rdf:RDF>
```

```
#NTriples
<http://www.bosatsu.net> <http://purl.org/dc/elements/1.1/creator> "Brian Sletten" .
```

```
#N3
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
<http://www.bosatsu.net>     dc:creator "Brian Sletten" .
```

http://www.mindswap.org/2002/rdfconvert/

rdf:ID vs rdf:about

- `rdf:ID` introduces a new resource
- `rdf:about` adds statements about existing resources

```
<rdf:Description rdf:about=”http://www.bosatsu.net”>
  <dc:creator>Brian Sletten</dc:creator>
</rdf>
```

RDF
Examples

Sample RDF Vocabularies

- Dublin Core
- FOAF
- DOAP
- MusicBrainz
- WordNet

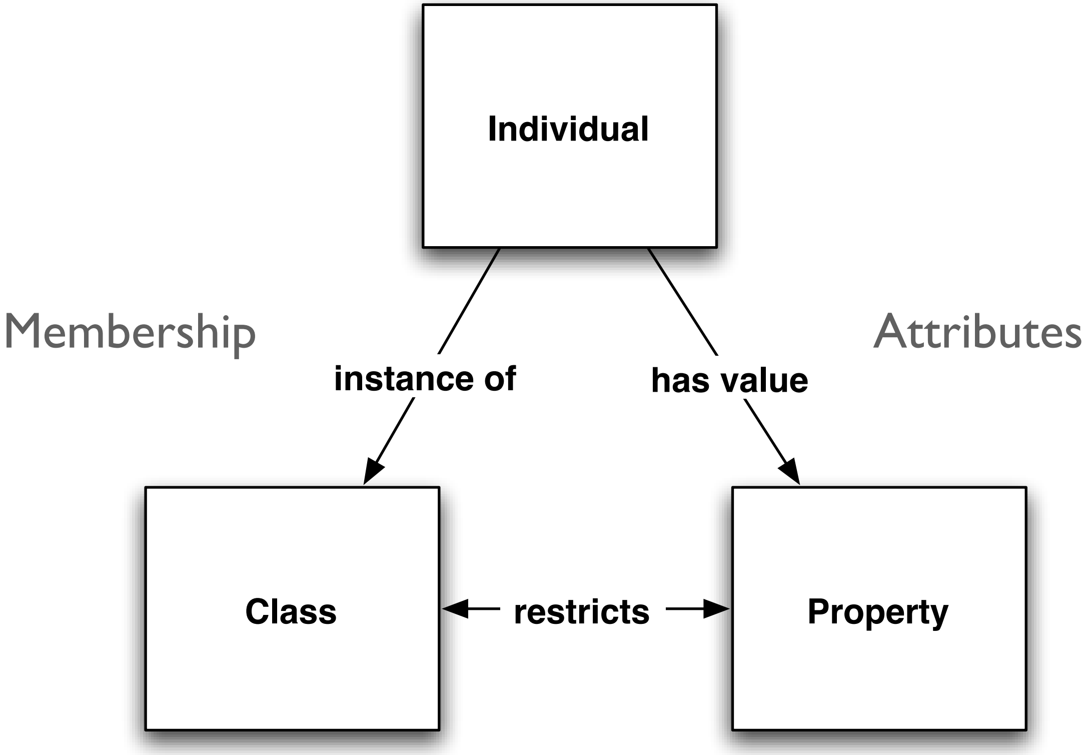
RDFS

- A specification for describing vocabularies via RDF
- W3C Recommendation
- Introduces
  - Class/Concept and Property definitions
  - Class/Concept and Property inheritance hierarchies
  - Domain and range restrictions for properties

Classes and Properties

- Class
  - A Set of instances with common properties
    - Explicit properties are stated
    - Implicit properties are inherited based on other relationships
- Property
  - A binary relationship relating an object instance to a value

Classes, Properties and Instances



Individual

Membership

instance of

has value

Attributes

Class

restricts

Property

Based on a diagram from [Lacey2005]

rdf:type

- Introduce instances of classes
- Individuals can belong to multiple classes

```
<rdf:Description rdf:ID=”http://www.bosatsu.net”>
  <rdf:type rdf:resource=”#webPage” />
</rdf>
```

Typed Literals

- **Syntactic Convenience**

```
<rdf:Description rdf:ID=”http://www.bosatsu.net”>
  <rdf:type rdf:resource=”#webPage” />
</rdf>
```

↓

```
<webPage rdf:ID=”http://www.bosatsu.net”>
...
</webPage>
```

Language Expressivity

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- The more expressive a language is, the more complicated it can be to reason about the language semantics
- Quickly get into theoretical computer science and decidability
- We want to strike a balance between being able to say interesting things and being able to get answers back before $t \to \infty$

Semantic Strength in Modeling Languages

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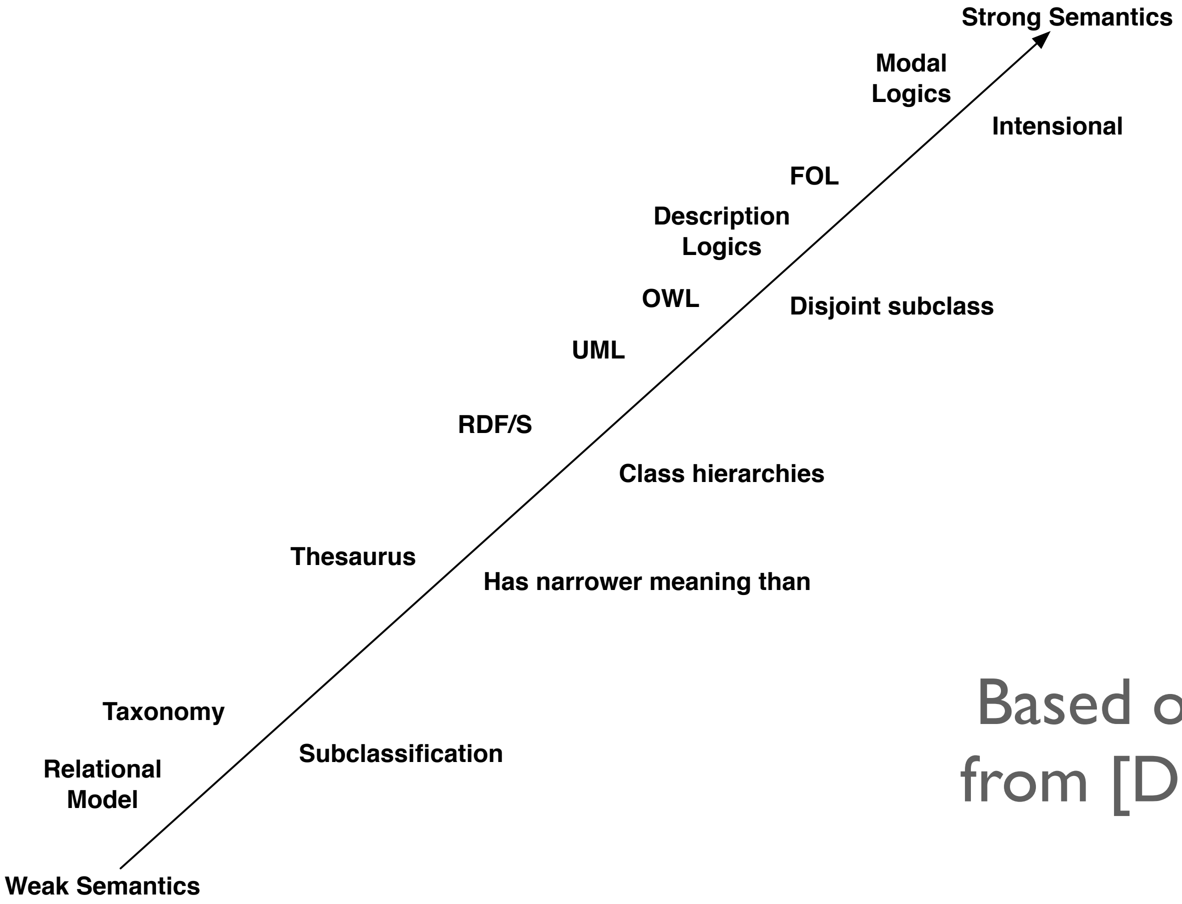

Strong Semantics

Modal Logics

Intensional

FOL

Description Logics

OWL

Disjoint subclass

UML

RDF/S

Class hierarchies

Thesaurus

Has narrower meaning than

Taxonomy

Relational Model

Subclassification

Weak Semantics

Based on a diagram from [Daconta2003]

SKOS

- Simple Knowledge Organization System (SKOS)
- W3C Working Draft (Recommendation in 2006)
- RDFS++/OWL Lite Lite
- Used to specify particular ‘concept schemes’ as RDF graphs

Where SKOS Fits

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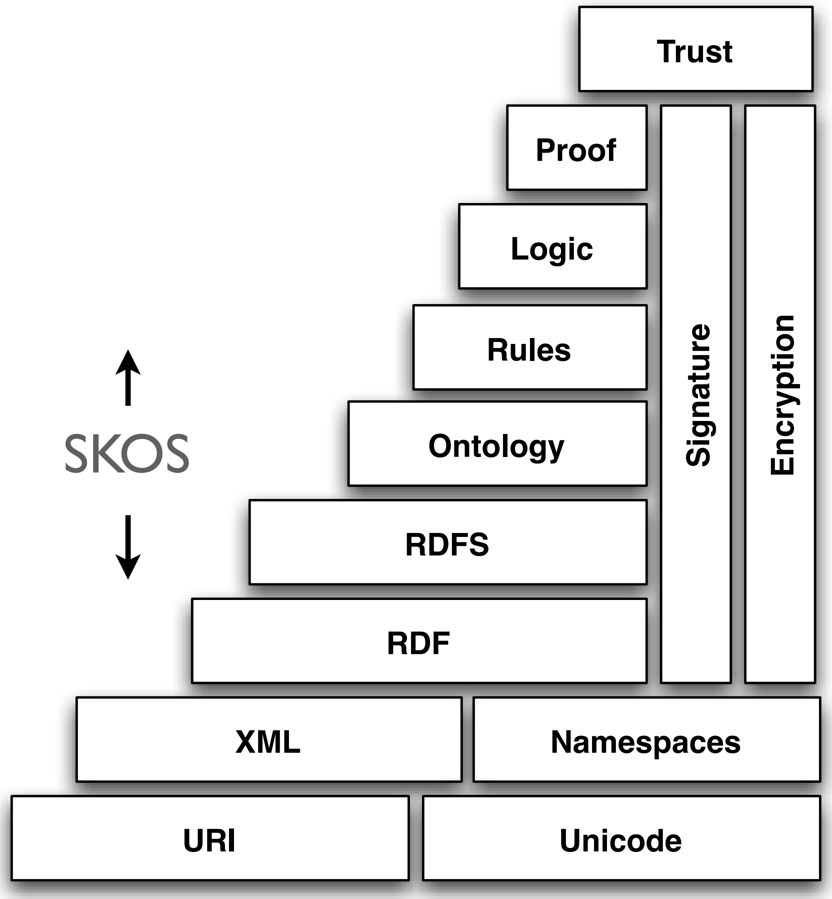
Trust
Proof
Logic
Rules
Ontology
RDFS
RDF
Signature
Encryption
XML
Namespaces
URI
Unicode
SKOS

Concept Schemes

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- Thesauri
- Taxonomies
- Subject Headers
- Controlled Vocabularies

SKOS Example

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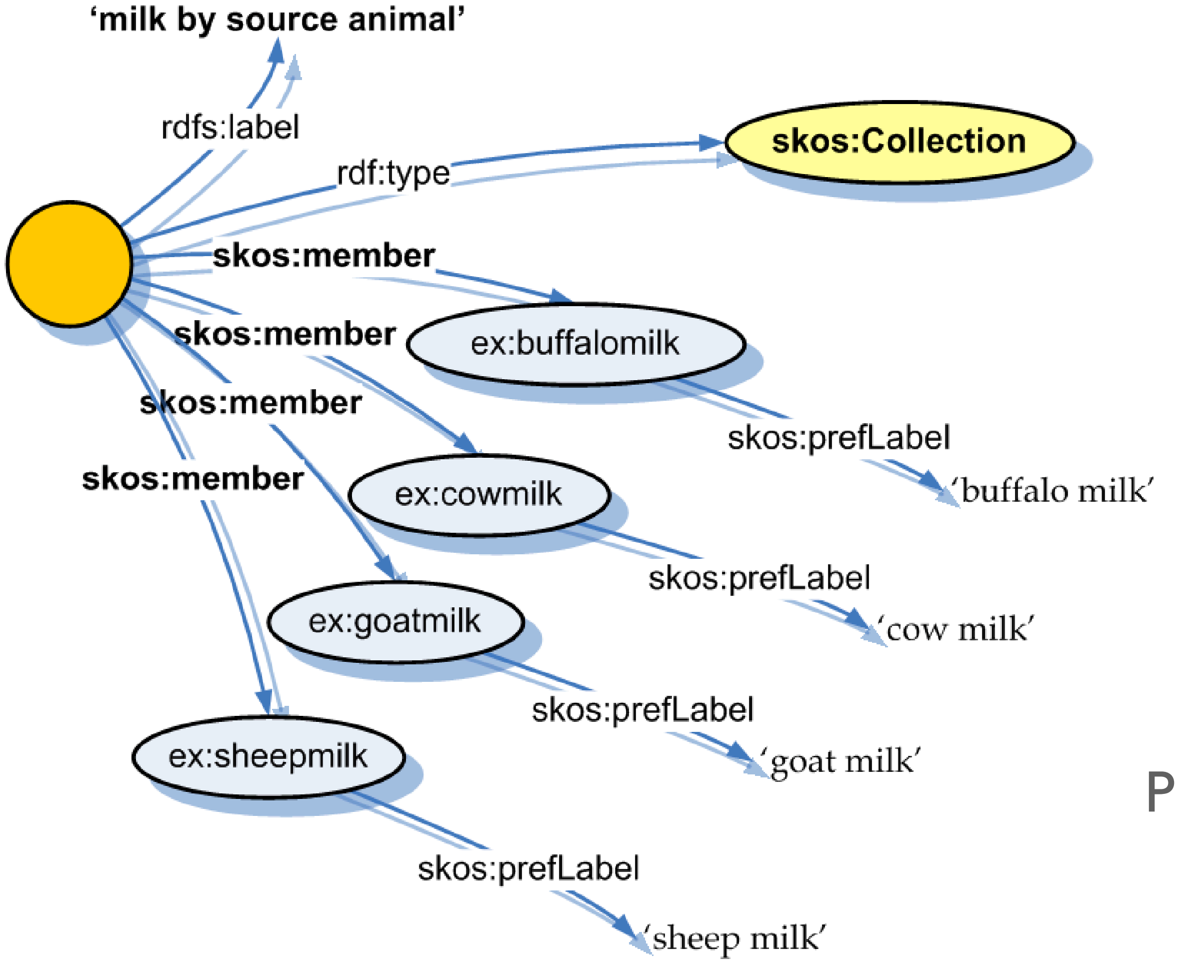
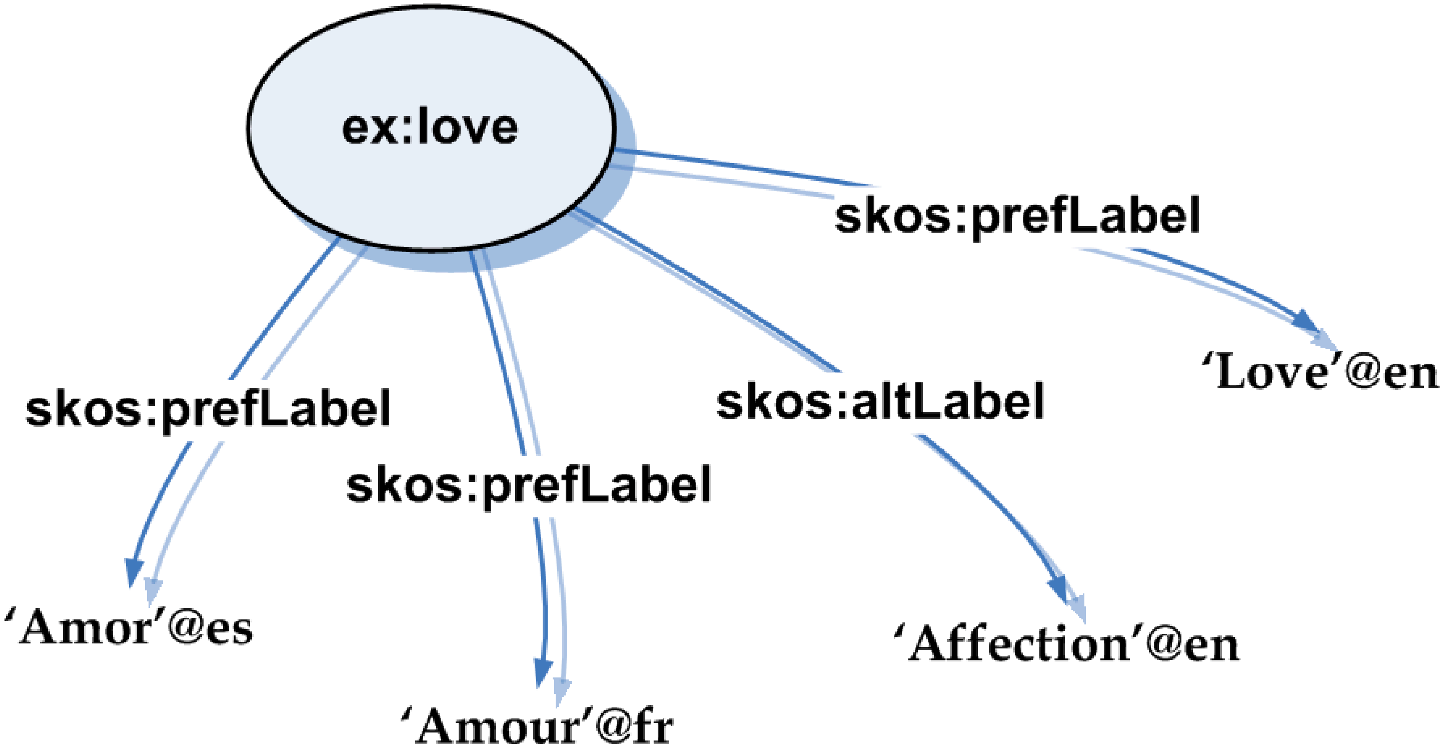

'milk by source animal'
rdfs:label
rdf:type
skos:Collection
skos:member
skos:member
skos:member
skos:member
ex:buffalomilk
ex:cowmilk
ex:goatmilk
ex:sheepmilk
skos:prefLabel
'buffalo milk'
skos:prefLabel
'cow milk'
skos:prefLabel
'goat milk'
skos:prefLabel
'sheep milk'

Picture Courtesy of
Alistair Miles

SKOS Example



ex:love

skos:prefLabel

'Love'@en

skos:prefLabel

'Amor'@es

skos:prefLabel

'Amour'@fr

skos:altLabel

'Affection'@en

Picture Courtesy of
Alistair Miles

OWL

- Web Ontology Language (OWL)
- W3C Recommendation
- Designed to support different levels of expression with different computational requirements
    - OWL Lite
    - OWL DL
    - OWL Full

OWL Metadata

- `owl:Ontology`
- `owl:versionInfo`
- `owl:priorVersion`
- `owl:backwardCompatibleWith`
- `owl:incompatibleWith`
- `owl:DeprecatedClass/owl:DeprecatedProperty`
- `owl:imports`

Predefined OWL Classes

- `owl:Thing`
  - Superclass of all classes
- `owl:Nothing`
  - Subclass of all classes

OWL Lite

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- Allows class definitions and properties from RDFS
  - `rdfs:subClassOf, owl:objectProperty, owl:datatypeProperty`
- Domain and range qualification
  - `owl:domain, owl:range`
- Basic quantifier expressions
  - `owl:allValuesFrom, owl:someValuesFrom`
- Only supports cardinality restrictions of 0 or 1

OWL Properties

- Subclasses rdf:Property
- `owl:DatatypeProperty (instance->data type)`
- `owl:ObjectProperty (instance->individual)`
- `owl:AnnotationProperty`
  - `rdfs:label, rdfs:comment, rdfs:isDefinedBy`
- `owl:OntologyProperty`

OWL DL

- Builds on OWL Lite features
- Based on Description Logics
    - A family of knowledge representation languages to formally describe the terminological knowledge of an application domain*
- Allows arbitrary cardinality restrictions

(*Thanks to Wikipedia for a concise way to describe Description Logics!)

OWL DL (cont)

- Class definition based on property values
    - `owl:hasValue`
- Class expressions via boolean combinators
    - `owl:unionOf, owl:intersectionOf, owl:complementOf`
- Class enumeration and disjunction
    - `owl:oneOf, owl:disjointWith`

OWL Full

- Builds on OWL DL
- Classes can be treated as instances
- Inverse functional properties
- Undecidable but useful given the "Open World" assumption about the Web

OWL Property Restrictions

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- `owl:FunctionalProperty`
  - Only one value per individual (reasoner hint)
- `owl:InverseFunctionalProperty`
  - Relates two properties
- `owl:equivalentProperty`
  - Equates two properties

OWL Property Restrictions (cont)

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- `owl:TransitiveProperty`
  - Allows inference by following the transitivity
- `owl:SymmetricProperty`
  - An object property that simplifies expression

Kowari

What’s a Kowari?

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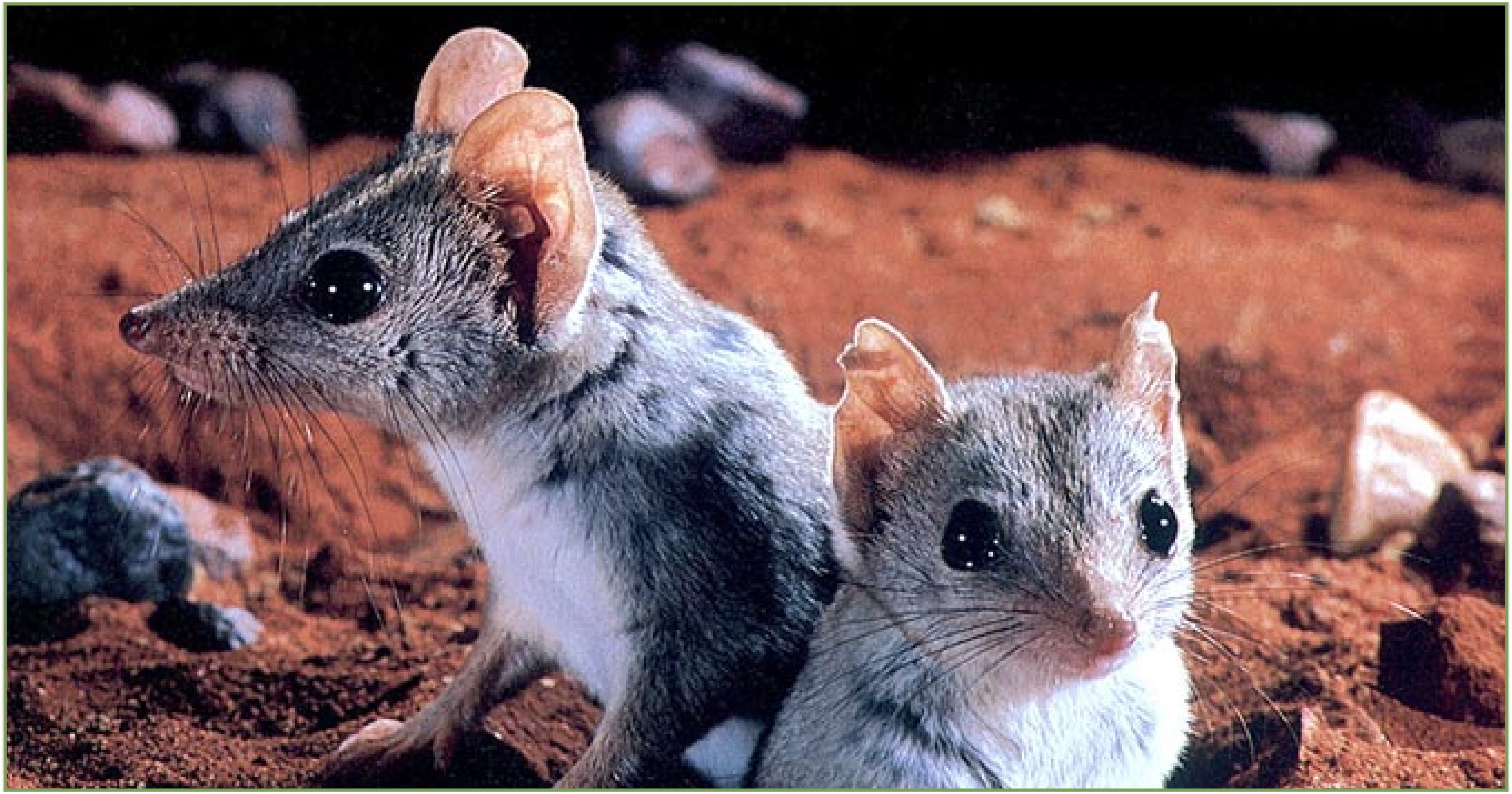

History

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- Scalable open source RDF triplestore database
- Originally created by Tucana Technologies as the core of their Tucana Knowledge Server (TKS) triplestore database
- Northrop Grumman bought the TKS assets in 2005 and will continue to support the commercial and open source development

Kowari Features

- 100% Java with native RDF support
- SQL-like Query language (moving toward SPARQL support)
- Can be embedded or standalone
- Multiple transports
- Plug-in Resolver architecture
- Integration with Lucene for full-text search
- Simple inference capabilities

Why Not an RDBMS?

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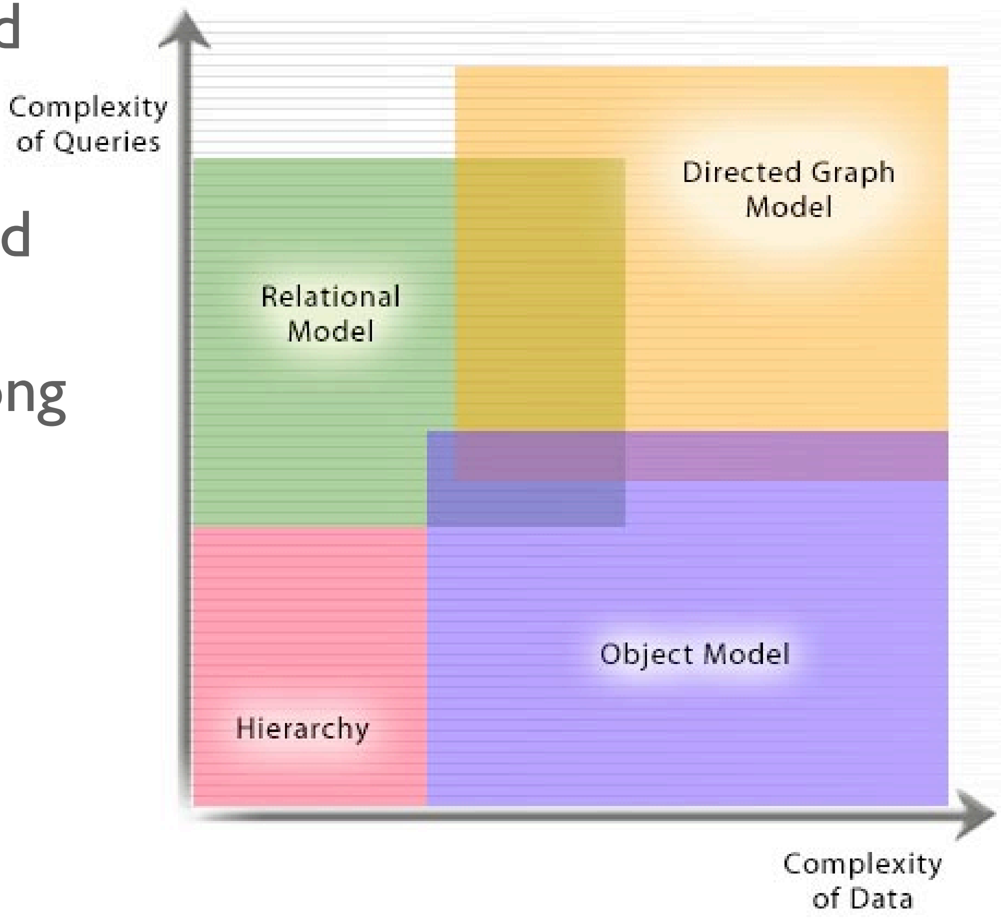
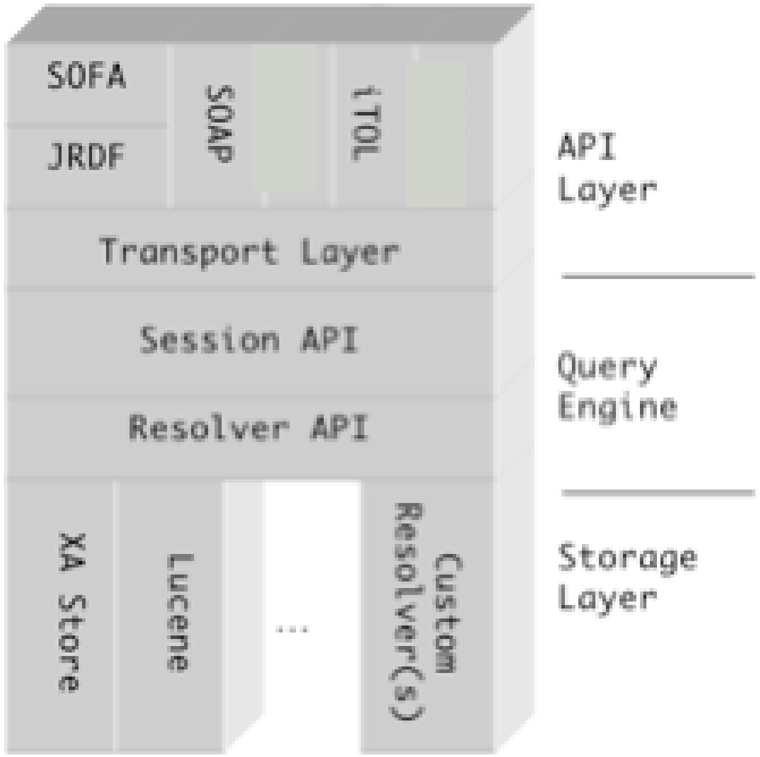
- Semantic Web stack is based on RDF triples
- Generalized RDBMSes could certainly store RDF, but the tables would end up very long
- Kowari is optimized for storing triples
- Complex, dynamic data and complex queries don't fit RDBMes as well


Complexity of Queries
Directed Graph Model
Relational Model
Object Model
Hierarchy
Complexity of Data

Kowari Architecture


SOFA
JRDF
SOAP
iTQL
API Layer
Transport Layer
Session API
Resolver API
Query Engine
XA Store
Lucene
...
Custom Resolver(s)
Storage Layer

(Thanks to Dave Wood for the previous two images)

Kowari Storage

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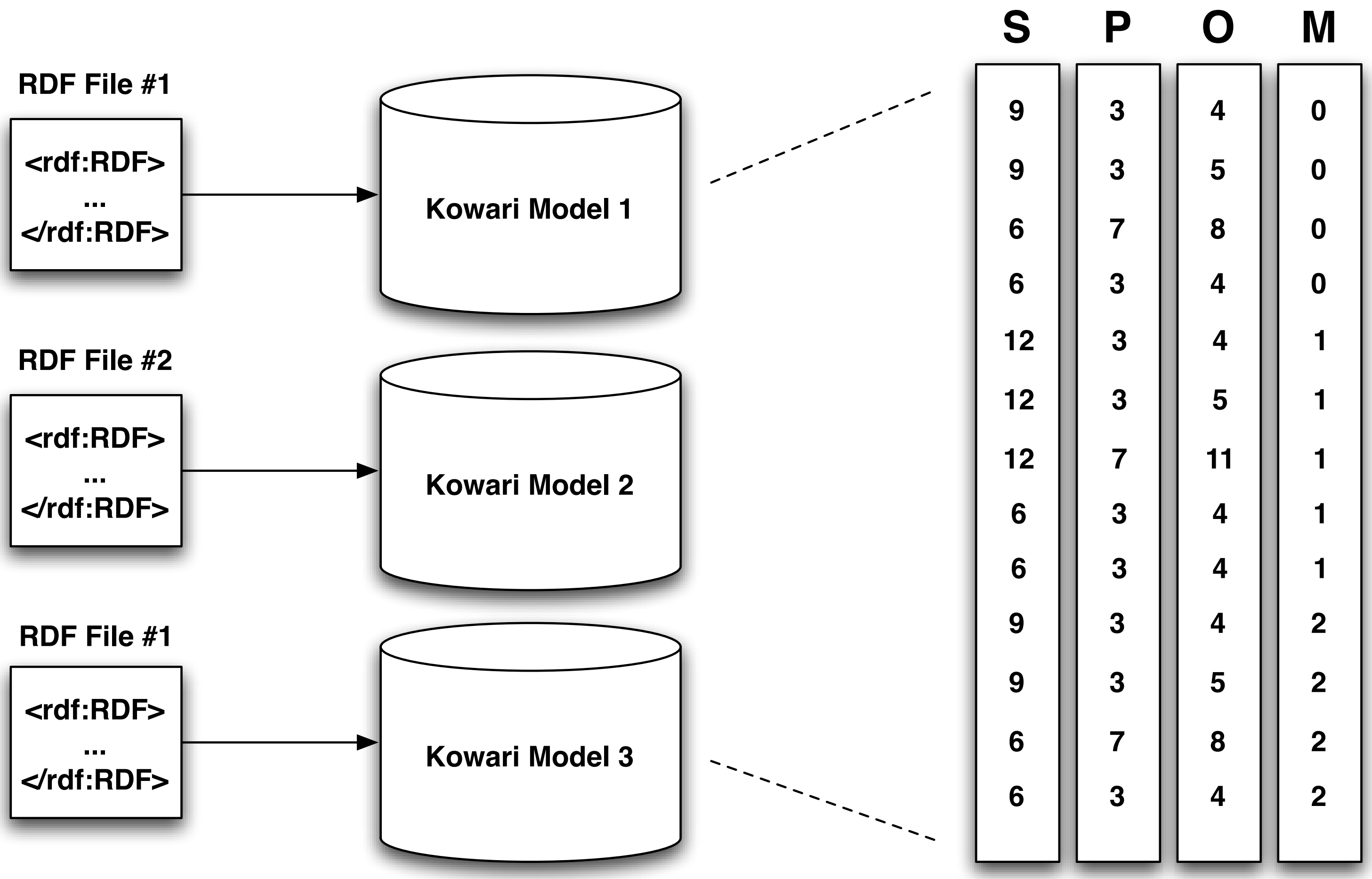

RDF File #1
<rdf:RDF>
...
</rdf:RDF>
Kowari Model 1
RDF File #2
<rdf:RDF>
...
</rdf:RDF>
Kowari Model 2
RDF File #1
<rdf:RDF>
...
</rdf:RDF>
Kowari Model 3

S	P	O	M
9	3	4	0
9	3	5	0
6	7	8	0
6	3	4	0
12	3	4	1
12	3	5	1
12	7	11	1
6	3	4	1
6	3	4	1
9	3	4	2
9	3	5	2
6	7	8	2
6	3	4	2

Starting Kowari

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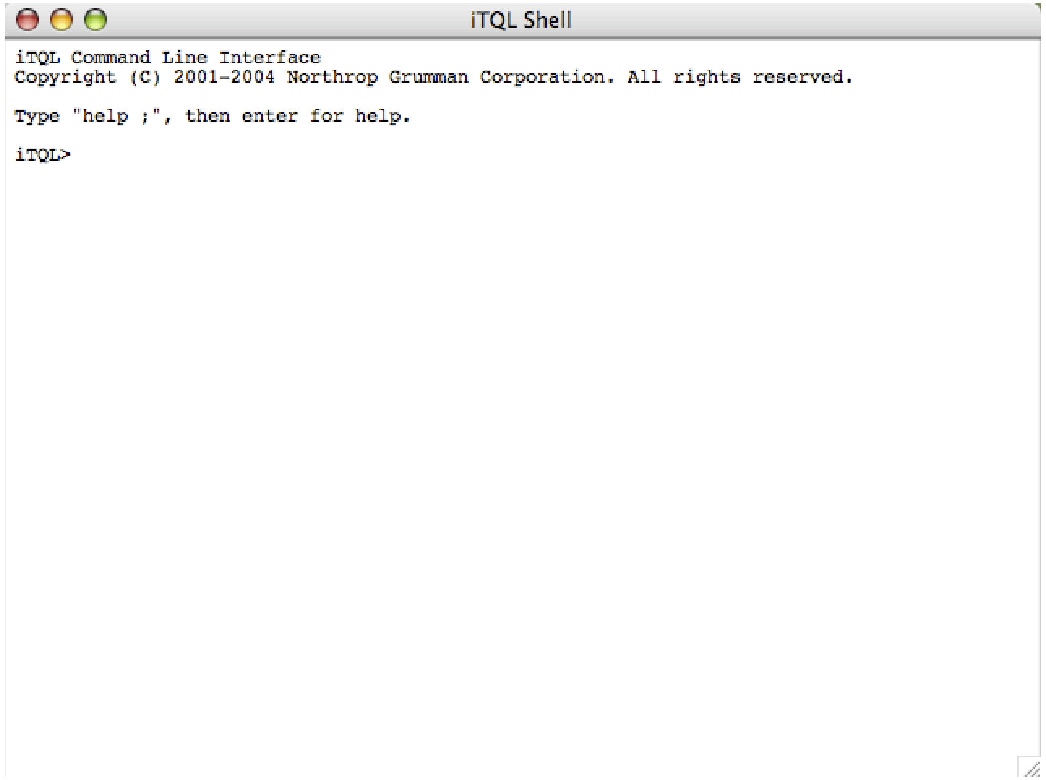
```
Harpua:/usr/local/workspaces/kowari-pmn/kowari-1.1 brian$ java -jar dist/kowari-1.1.0.jar
Kowari Metadata Store Version 1.1.0 (Build v1.1.0.214)
 INFO [main] (EmbeddedKowariServer.java:736) - RMI Registry started automatically on port
1099
0 [main] INFO org.kowari.server.EmbeddedKowariServer  - RMI Registry started
automatically on port 1099
 INFO [main] (EmbeddedKowariServer.java:785) - java.security.policy set to jar:file:/usr/
local/workspaces/kowari-pmn/kowari-1.1/dist/kowari-1.1.0.jar!/conf/kowari-rmi.policy
35 [main] INFO org.kowari.server.EmbeddedKowariServer  - java.security.policy set to
jar:file:/usr/local/workspaces/kowari-pmn/kowari-1.1/dist/kowari-1.1.0.jar!/conf/kowari-
rmi.policy
2005-10-25 23:21:56,613 INFO  Database - Host name aliases for this server are:
[localhost, Harpua.local, 127.0.0.1, 10.0.0.5]
2005-10-25 23:22:12,406 INFO  EmbeddedKowariServer - Successfully started Kowari server
at rmi://10.0.0.5/server1 in directory /usr/local/workspaces/kowari-pmn/kowari-1.1/
server1
2005-10-25 23:22:12,408 INFO  EmbeddedKowariServer -

Typing Ctrl-C in this console or killing this process id will shutdown this server
```

Starting iTQL Shell

```
Harpua:/usr/local/workspaces/kowari-pmn/kowari-1.1 brian$ java -jar dist/itql-1.1.0.jar
```

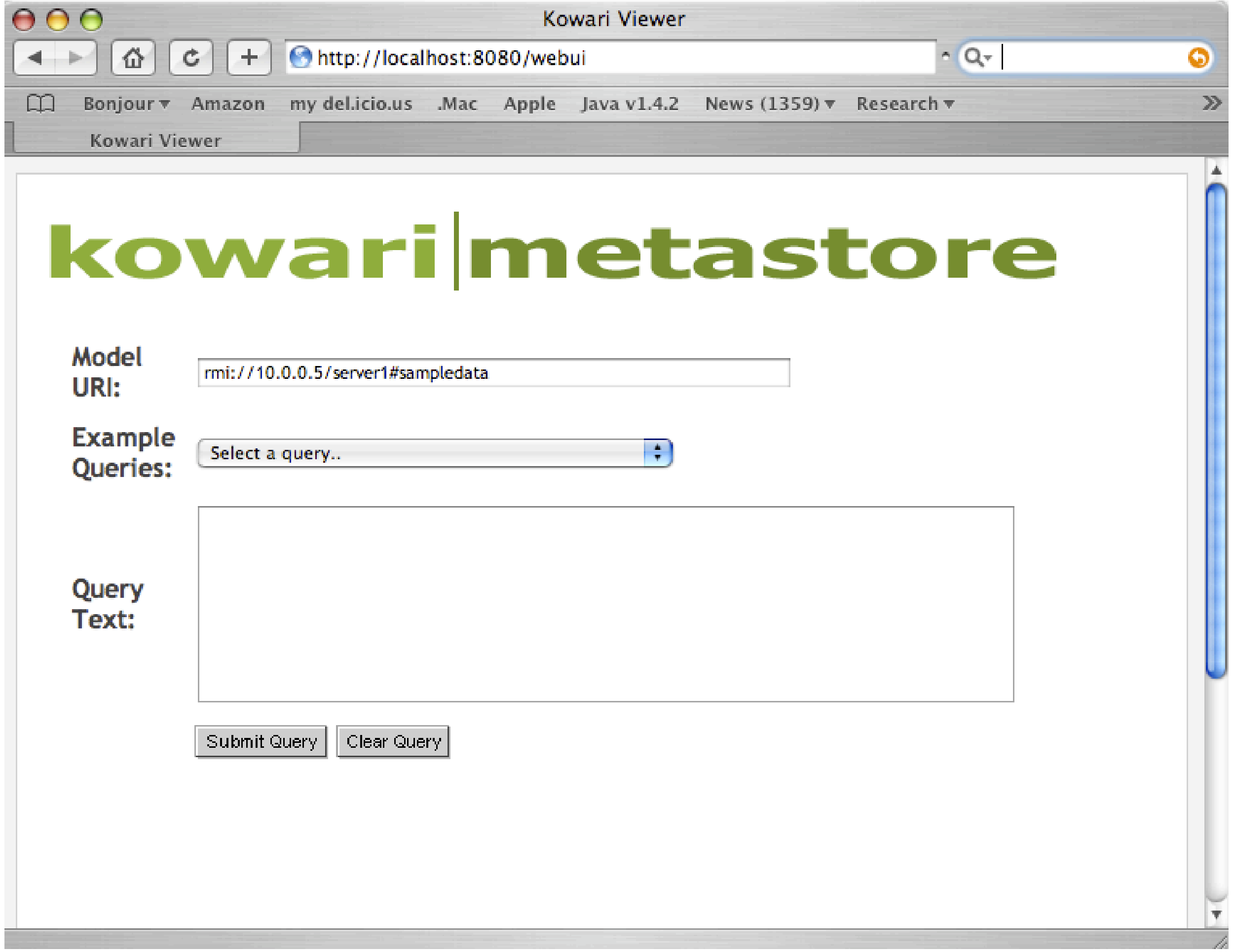


```
iTQL Command Line Interface
Copyright (C) 2001-2004 Northrop Grumman Corporation. All rights reserved.

Type "help ;", then enter for help.

iTQL>
```

Kowari Webui



Kowari Viewer

http://localhost:8080/webui

kowari|metastore

Model URI: rmi://10.0.0.5/server1#sampledata

Example Queries: Select a query..

Query Text:

Bonjour
Amazon
my del.icio.us
.Mac
Apple
Java v1.4.2
News (1359)
Research
Kowari Viewer
Submit Query
Clear Query

Creating Models

Host name

Model name

```
create <rmi://localhost/server1#nofluffjuststuff>;
```

Transport

Server Instance

```
(2 queries, 0.698 seconds)
Query Executed:
create <rmi://localhost/server1#nofluffjuststuff>;
Result Message:
Successfully created model rmi://10.0.0.5/server1#nofluffjuststuff
```

Inserting Statements

Query Executed:

insert <http://www.bosatsu.net> <http://purl.org/dc/elements/1.1/creator> 'Brian Sletten' into <rmi://localhost/server1#nofluffjuststuff>;

Result Message:

Successfully inserted statements into rmi://localhost/server1#nofluffjuststuff

Query Executed:

insert <http://www.bosatsu.net> <http://purl.org/dc/elements/1.1/description> 'Bosatsu Consulting,Inc. Homepage' into <rmi://localhost/server1#nofluffjuststuff>;

Result Message:

Successfully inserted statements into rmi://localhost/server1#nofluffjuststuff

Query Executed:

insert <http://www.bosatsu.net> <ns:managedBy> <http://www.hunttech.net> into <rmi://localhost/server1#nofluffjuststuff>;

Result Message:

Successfully inserted statements into rmi://localhost/server1#nofluffjuststuff

Querying Model

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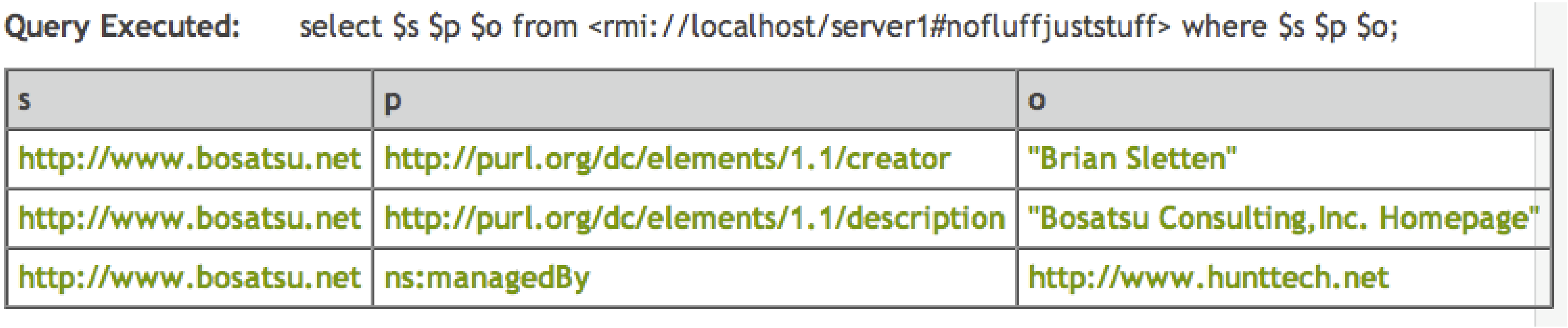

Query Executed: select $s $p $o from <rmi://localhost/server1#nofluffjuststuff> where $s $p $o;

s	p	o
http://www.bosatsu.net	http://purl.org/dc/elements/1.1/creator	"Brian Sletten"
http://www.bosatsu.net	http://purl.org/dc/elements/1.1/description	"Bosatsu Consulting,Inc. Homepage"
http://www.bosatsu.net	ns:managedBy	http://www.hunttech.net

```
iTQL> select $s $p $o from <rmi://localhost/server1#nofluffjuststuff>
where $s $p $o;
[ http://www.bosatsu.net, http://purl.org/dc/elements/1.1/creator,
"Brian Sletten" ]
[ http://www.bosatsu.net, http://purl.org/dc/elements/1.1/
description, "Bosatsu Consulting,Inc. Homepage" ]
[ http://www.bosatsu.net, ns:managedBy, http://www.hunttech.net ]
3 rows returned.
```

Loading From a File/URL

```
Query Executed:
load <file:/Users/brian/Documents/Personal/brian.rdf> into <rmi://localhost/
server1#nofluffjuststuff>;
Result Message:
Successfully loaded 73 statements from file:/Users/brian/Documents/Personal/
brian.rdf into rmi://localhost/server1#nofluffjuststuff


Query Executed:
create <rmi://localhost/server1#slashdot>;
Result Message:
Successfully created model rmi://10.0.0.5/server1#slashdot
Query Executed:
load <http://slashdot.org/index.rss> into <rmi://localhost/server1#slashdot>;
Result Message:
Successfully loaded 156 statements from http://slashdot.org/index.rss into
rmi://localhost/server1#slashdot
```

More Complicated Queries

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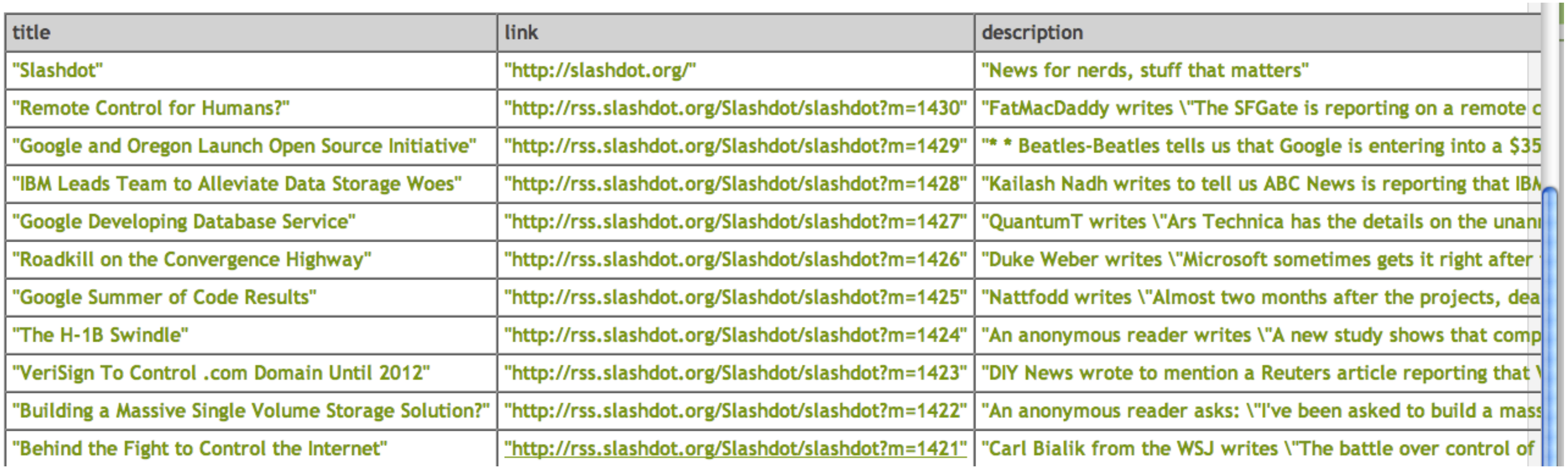
```
select <variable list> from <model> where <constraint expression>;
```

```
select $title $link $description from <rmi://10.0.0.5/server1#slashdot> where
$article <http://purl.org/rss/1.0/title> $title and $article <http://purl.org/
rss/1.0/link> $link and $article <http://purl.org/rss/1.0/description>
$description;
```



title	link	description
"Slashdot"	"http://slashdot.org/"	"News for nerds, stuff that matters"
"Remote Control for Humans?"	"http://rss.slashdot.org/Slashdot/slashdot?m=1430"	"FatMacDaddy writes \"The SFGate is reporting on a remote c
"Google and Oregon Launch Open Source Initiative"	"http://rss.slashdot.org/Slashdot/slashdot?m=1429"	"* * Beatles-Beatles tells us that Google is entering into a $35
"IBM Leads Team to Alleviate Data Storage Woes"	"http://rss.slashdot.org/Slashdot/slashdot?m=1428"	"Kailash Nadh writes to tell us ABC News is reporting that IB
"Google Developing Database Service"	"http://rss.slashdot.org/Slashdot/slashdot?m=1427"	"QuantumT writes \"Ars Technica has the details on the unan
"Roadkill on the Convergence Highway"	"http://rss.slashdot.org/Slashdot/slashdot?m=1426"	"Duke Weber writes \"Microsoft sometimes gets it right after
"Google Summer of Code Results"	"http://rss.slashdot.org/Slashdot/slashdot?m=1425"	"Nattfodd writes \"Almost two months after the projects, dea
"The H-1B Swindle"	"http://rss.slashdot.org/Slashdot/slashdot?m=1424"	"An anonymous reader writes \"A new study shows that comp
"VeriSign To Control .com Domain Until 2012"	"http://rss.slashdot.org/Slashdot/slashdot?m=1423"	"DIY News wrote to mention a Reuters article reporting that
"Building a Massive Single Volume Storage Solution?"	"http://rss.slashdot.org/Slashdot/slashdot?m=1422"	"An anonymous reader asks: \"I've been asked to build a mass
"Behind the Fight to Control the Internet"	"http://rss.slashdot.org/Slashdot/slashdot?m=1421"	"Carl Bialik from the WSJ writes \"The battle over control of

Resolver Example - MP3

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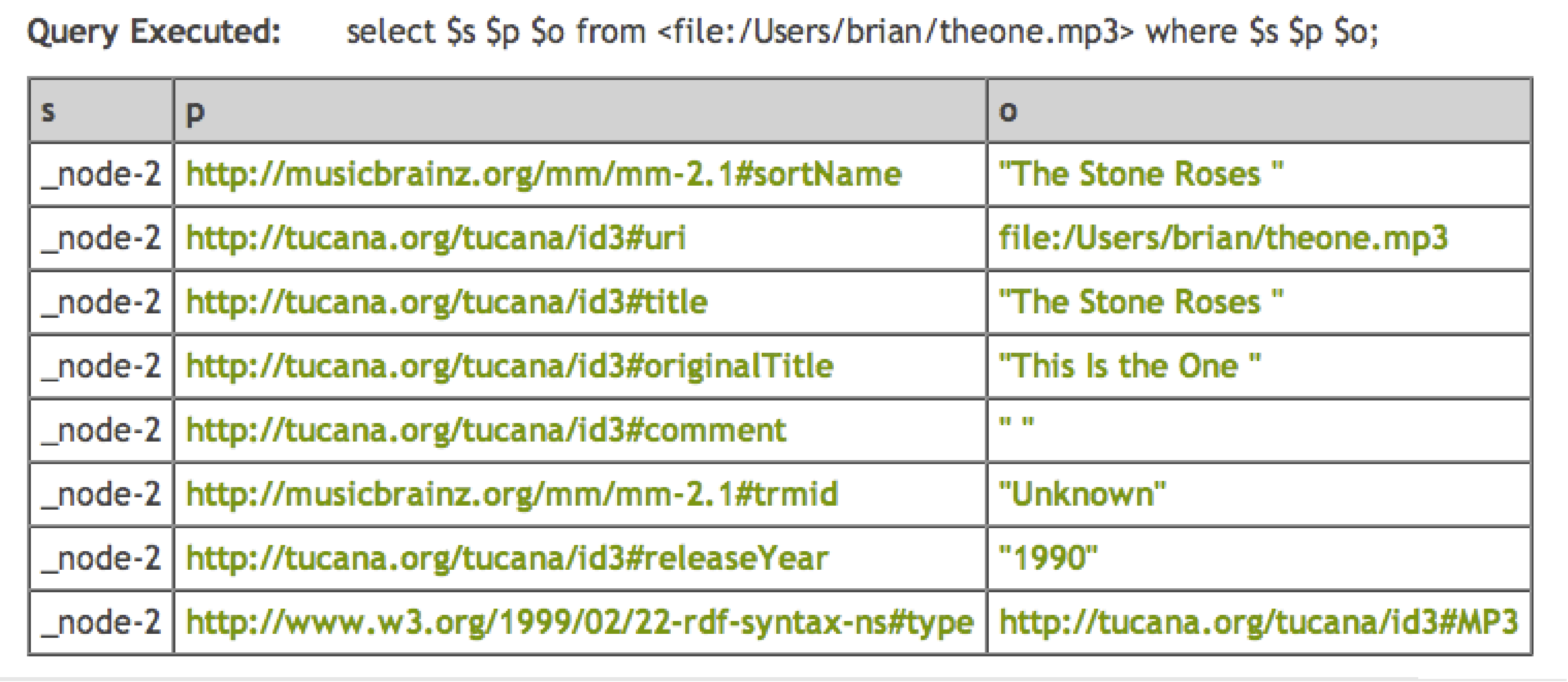

Query Executed: select $s $p $o from <file:/Users/brian/theone.mp3> where $s $p $o;

s	p	o
_node-2	http://musicbrainz.org/mm/mm-2.1#sortName	"The Stone Roses "
_node-2	http://tucana.org/tucana/id3#uri	file:/Users/brian/theone.mp3
_node-2	http://tucana.org/tucana/id3#title	"The Stone Roses "
_node-2	http://tucana.org/tucana/id3#originalTitle	"This Is the One "
_node-2	http://tucana.org/tucana/id3#comment	" "
_node-2	http://musicbrainz.org/mm/mm-2.1#trmid	"Unknown"
_node-2	http://tucana.org/tucana/id3#releaseYear	"1990"
_node-2	http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://tucana.org/tucana/id3#MP3

Tucana Knowledge Server

- Commercially-supported product based on Kowari
- Tucana Management Console
- Support for Distributed Queries
- `relate` keyword
- Model-level Security

SemWeb Tools

Jena/Joseki

- Jena
  - Java-based API for reading and writing RDF
  - OWL API
  - In-Memory and persistent storage
- Joseki
  - RDF publishing server

Simile

- Joint project between W3C and MIT
- Application of SemWeb technologies to DSpace digital repository for
    - digital assets
    - schemata
    - vocabularies
    - ontologies

Tupelo

- Project at NCSA supported by NEES and OGCE
- RDF-OWL-based metadata and data archiving system
- Version and access control at the object-level
- Grid Service interfaces for metadata and data services

SWOOP

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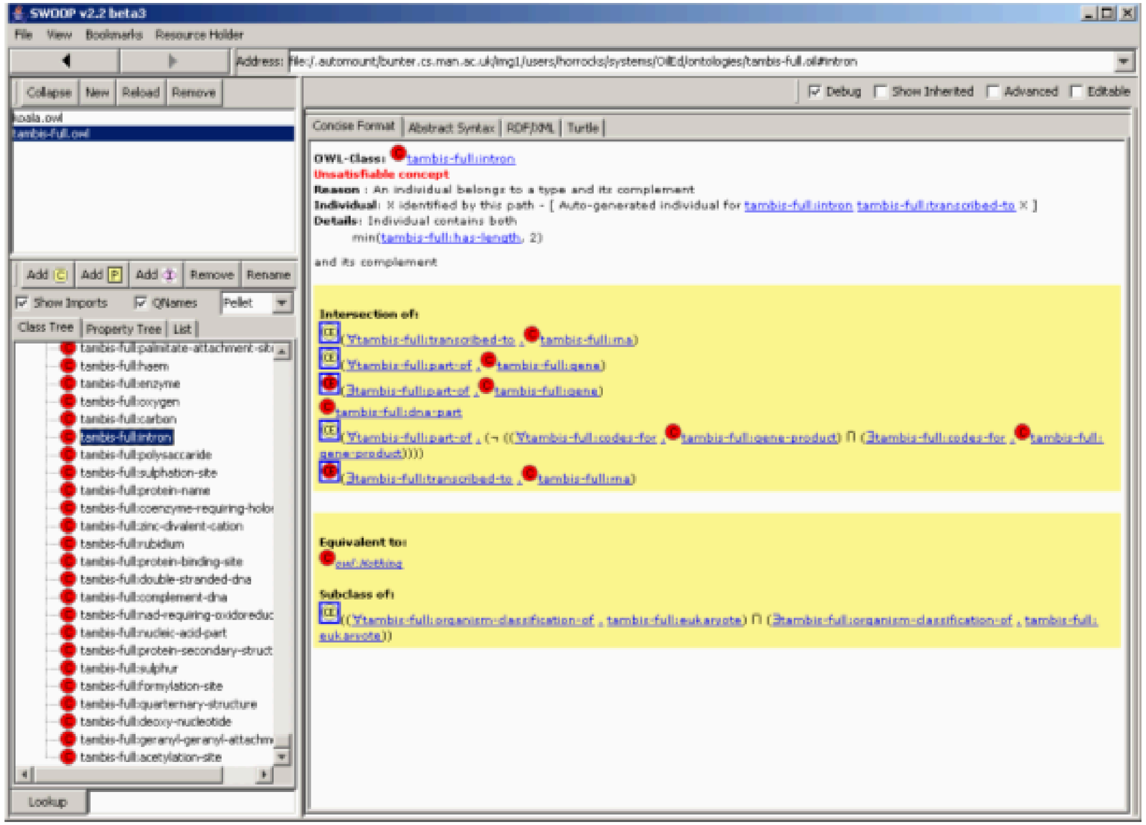
- Ontology Editor from UMD MindSwap group
- GUI with ontology debugging support
- “Dave, your class definition subsumes nothing”


SWOOP v2.2 beta3
File View Bookmarks Resource Holder
Address: file:/.automount/bunter.cs.man.ac.uk/img1/users/horrocks/systems/OilEd/ontologies/tambis-full.oil#intron
Collapse New Reload Remove
koala.owl
tambis-full.owl
Add C Add P Add I Remove Rename
☑ Show Imports ☑ QNames Pellet
Class Tree Property Tree List
tambis-full:palmitate-attachment-site
tambis-full:haem
tambis-full:enzyme
tambis-full:oxygen
tambis-full:carbon
tambis-full:intron
tambis-full:polysaccaride
tambis-full:sulphation-site
tambis-full:protein-name
tambis-full:coenzyme-requiring-holo
tambis-full:zinc-divalent-cation
tambis-full:rubidium
tambis-full:protein-binding-site
tambis-full:double-stranded-dna
tambis-full:complement-dna
tambis-full:nad-requiring-oxidoreduc
tambis-full:nucleic-acid-part
tambis-full:protein-secondary-struct
tambis-full:sulphur
tambis-full:formylation-site
tambis-full:quarternary-structure
tambis-full:deoxy-nucleotide
tambis-full:geranyl-geranyl-attachm
tambis-full:acetylation-site
Lookup
☑ Debug ☐ Show Inherited ☐ Advanced ☐ Editable
Concise Format Abstract Syntax RDF/XML Turtle

OWL-Class: tambis-full:intron
Unsatisfiable concept
Reason : An individual belongs to a type and its complement
Individual: X identified by this path - [Auto-generated individual for tambis-full:intron tambis-full:transcribed-to X]
Details: Individual contains both
min(tambis-full:has-length, 2)

and its complement

Intersection of:
(∀tambis-full:transcribed-to , tambis-full:rna)
(∀tambis-full:part-of , tambis-full:gene)
(∃tambis-full:part-of , tambis-full:gene)
tambis-full:dna-part
(∀tambis-full:part-of , (¬ ((∀tambis-full:codes-for , tambis-full:gene-product) ⊓ (∃tambis-full:codes-for , tambis-full:gene-product))))
(∃tambis-full:transcribed-to , tambis-full:rna)

Equivalent to:
owl:Nothing

Subclass of:
((∀tambis-full:organism-classification-of , tambis-full:eukaryote) ⊓ (∃tambis-full:organism-classification-of , tambis-full:eukaryote))

Related Non-SemWeb Technologies

New Applications (cont)

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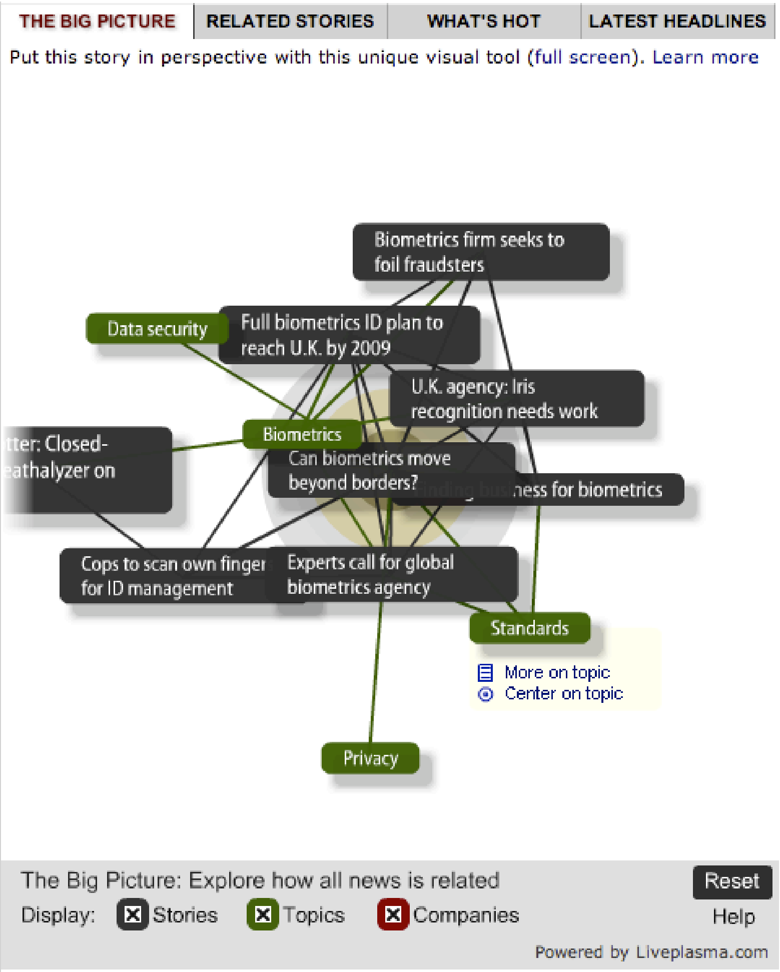
- CNet has new ontology-driven “Big Picture” navigator
- Identifies related stories based on keywords and central concepts


THE BIG PICTURE
RELATED STORIES
WHAT'S HOT
LATEST HEADLINES

Put this story in perspective with this unique visual tool (full screen). Learn more

Biometrics firm seeks to foil fraudsters
Data security
Full biometrics ID plan to reach U.K. by 2009
U.K. agency: Iris recognition needs work
tter: Closed-
athalyzer on
Biometrics
Can biometrics move beyond borders?
ness for biometrics
Cops to scan own finger for ID management
Experts call for global biometrics agency
Standards
More on topic
Center on topic
Privacy

The Big Picture: Explore how all news is related

Display: ☒ Stories ☒ Topics ☒ Companies

Reset
Help

Powered by Liveplasma.com

Related Non-SemWeb Technologies (cont)

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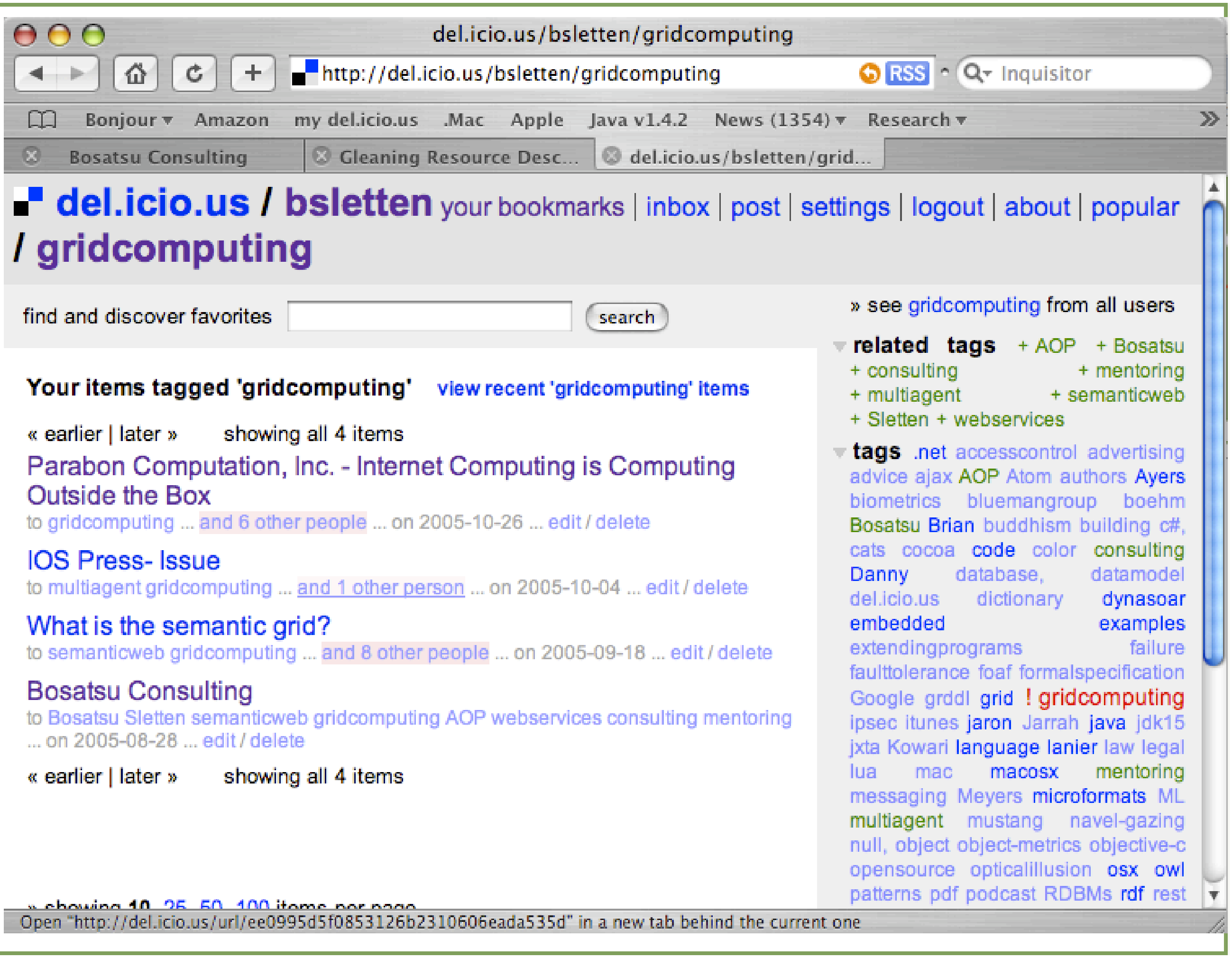
- del.icio.us
- Social bookmarks driven by decentralized user-tagging


del.icio.us/bsletten/gridcomputing
http://del.icio.us/bsletten/gridcomputing
RSS
Inquisitor
Bonjour ▾
Amazon
my del.icio.us
.Mac
Apple
Java v1.4.2
News (1354) ▾
Research ▾
Bosatsu Consulting
Gleaning Resource Desc...
del.icio.us/bsletten/grid...

del.icio.us / bsletten your bookmarks | inbox | post | settings | logout | about | popular

/ gridcomputing

find and discover favorites ☐ search

Your items tagged 'gridcomputing' view recent 'gridcomputing' items

« earlier | later » showing all 4 items

Parabon Computation, Inc. - Internet Computing is Computing Outside the Box

to gridcomputing ... and 6 other people ... on 2005-10-26 ... edit / delete

IOS Press- Issue

to multiagent gridcomputing ... and 1 other person ... on 2005-10-04 ... edit / delete

What is the semantic grid?

to semanticweb gridcomputing ... and 8 other people ... on 2005-09-18 ... edit / delete

Bosatsu Consulting

to Bosatsu Sletten semanticweb gridcomputing AOP webservices consulting mentoring ... on 2005-08-28 ... edit / delete

« earlier | later » showing all 4 items

» showing **10**, 25, 50, 100 items per page

» see gridcomputing from all users

related tags + AOP + Bosatsu + consulting + mentoring + multiagent + semanticweb + Sletten + webservices

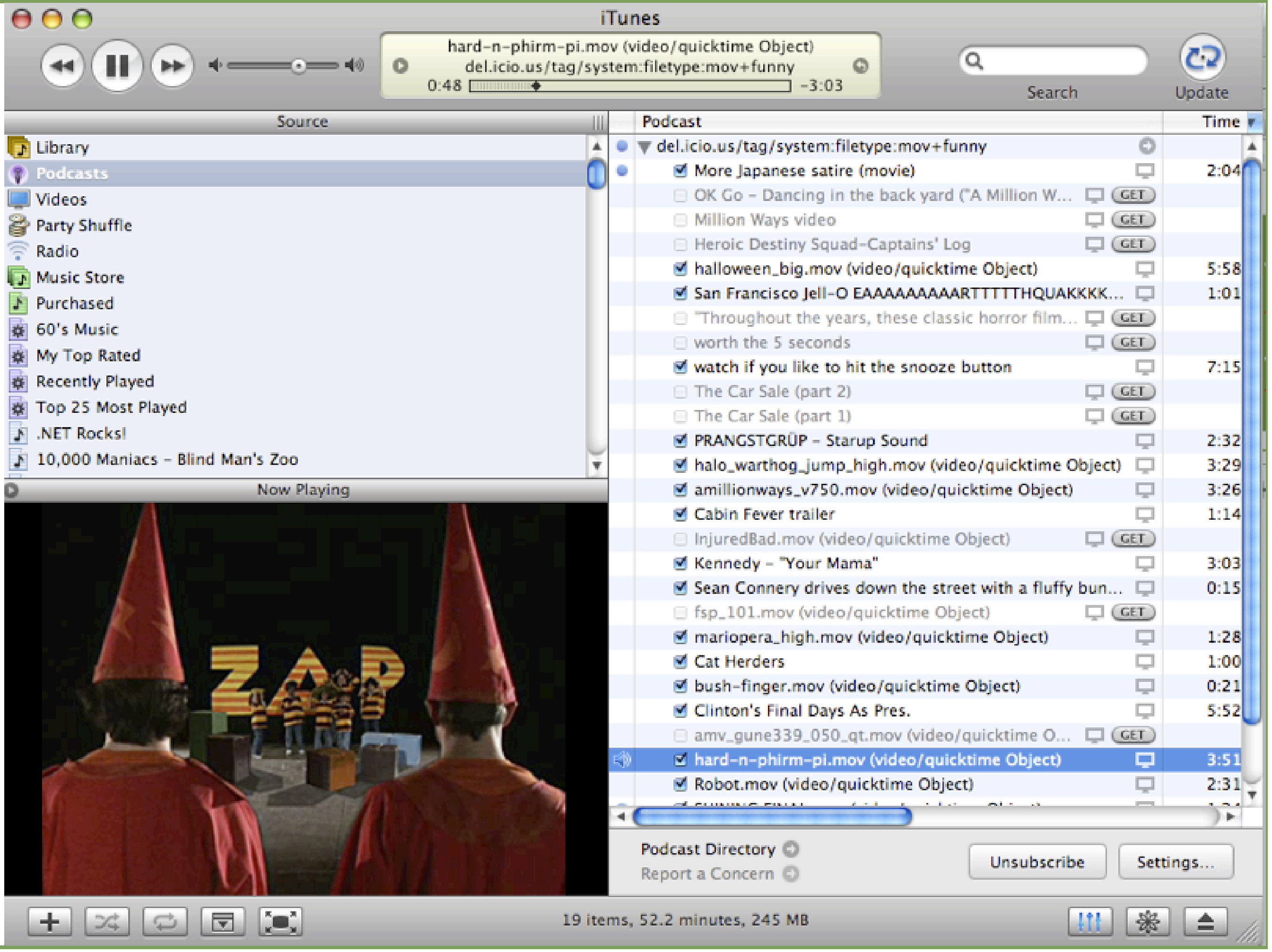
tags .net accesscontrol advertising advice ajax AOP Atom authors Ayers biometrics bluemangroup boehm Bosatsu Brian buddhism building c#, cats cocoa code color consulting Danny database, datamodel del.icio.us dictionary dynasoar embedded examples extendingprograms failure faulttolerance foaf formalspecification Google grddl grid ! gridcomputing ipsec itunes jaron Jarrah java jdk15 jxta Kowari language lanier law legal lua mac macosx mentoring messaging Meyers microformats ML multiagent mustang navel-gazing null, object object-metrics objective-c opensource opticalillusion osx owl patterns pdf podcast RDBMs rdf rest

Open "http://del.icio.us/url/ee0995d5f0853126b2310606eada535d" in a new tab behind the current one

Related Non-SemWeb Technologies (cont)

菩薩

- del.icio.us + RSS + PodCasts + iTunes = decentralized content feeds based on user-driven metadata tagging


iTunes
Search
Update
Source
Library
Podcasts
Videos
Party Shuffle
Radio
Music Store
Purchased
60's Music
My Top Rated
Recently Played
Top 25 Most Played
.NET Rocks!
10,000 Maniacs - Blind Man's Zoo
Now Playing
Podcast Directory
Report a Concern
Unsubscribe
Settings...

hard-n-phirm-pi.mov (video/quicktime Object)
del.icio.us/tag/system:filetype:mov+funny
0:48 -3:03

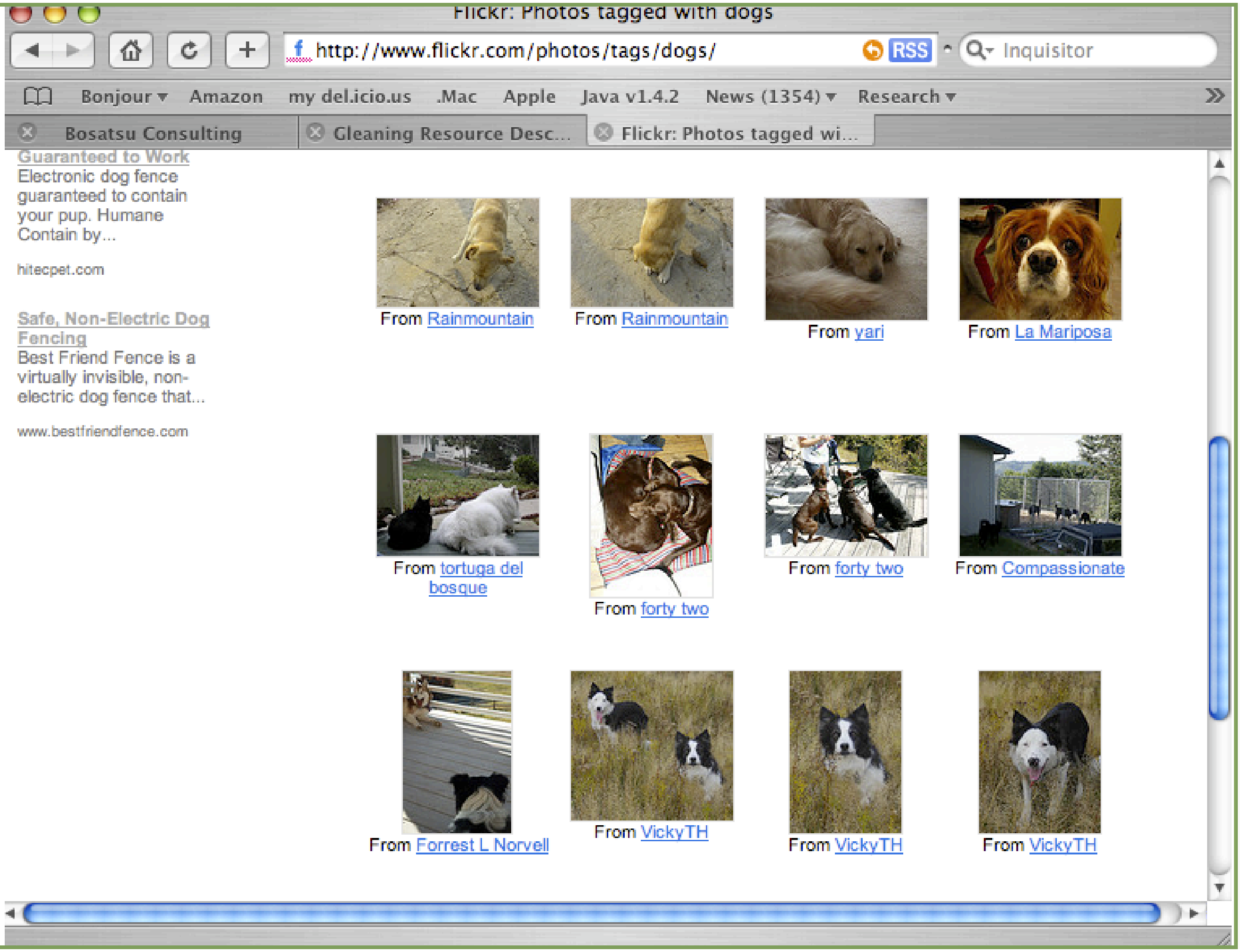
	Podcast	Time
	del.icio.us/tag/system:filetype:mov+funny	
☑	More Japanese satire (movie)	2:04
☐	OK Go - Dancing in the back yard ("A Million W... GET	
☐	Million Ways video GET	
☐	Heroic Destiny Squad-Captains' Log GET	
☑	halloween_big.mov (video/quicktime Object)	5:58
☑	San Francisco Jell-O EAAAAAAAAARTTTTTHQUAKKKK...	1:01
☐	"Throughout the years, these classic horror film... GET	
☐	worth the 5 seconds GET	
☑	watch if you like to hit the snooze button	7:15
☐	The Car Sale (part 2) GET	
☐	The Car Sale (part 1) GET	
☑	PRANGSTGRÜP - Starup Sound	2:32
☑	halo_warthog_jump_high.mov (video/quicktime Object)	3:29
☑	amillionways_v750.mov (video/quicktime Object)	3:26
☑	Cabin Fever trailer	1:14
☐	InjuredBad.mov (video/quicktime Object) GET	
☑	Kennedy - "Your Mama"	3:03
☑	Sean Connery drives down the street with a fluffy bun...	0:15
☐	fsp_101.mov (video/quicktime Object) GET	
☑	mariopera_high.mov (video/quicktime Object)	1:28
☑	Cat Herders	1:00
☑	bush-finger.mov (video/quicktime Object)	0:21
☑	Clinton's Final Days As Pres.	5:52
☐	amv_gune339_050_qt.mov (video/quicktime O... GET	
☑	hard-n-phirm-pi.mov (video/quicktime Object)	3:51
☑	Robot.mov (video/quicktime Object)	2:31

19 items, 52.2 minutes, 245 MB

Related Non-SemWeb Technologies (cont)

菩薩

- Flickr : decentralized user-driven metadata tagging of photos


Flickr: Photos tagged with dogs
http://www.flickr.com/photos/tags/dogs/
RSS
Inquisitor
Bonjour
Amazon
my del.icio.us
.Mac
Apple
Java v1.4.2
News (1354)
Research
Bosatsu Consulting
Gleaning Resource Desc...
Flickr: Photos tagged wi...

Guaranteed to Work
Electronic dog fence guaranteed to contain your pup. Humane Contain by...

hitecpet.com

Safe, Non-Electric Dog Fencing
Best Friend Fence is a virtually invisible, non-electric dog fence that...

www.bestfriendfence.com

From Rainmountain
From Rainmountain
From yari
From La Mariposa
From tortuga del bosque
From forty two
From forty two
From Compassionate
From Forrest L Norvell
From VickyTH
From VickyTH
From VickyTH

The Future

What's Ahead?

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- Interest is rising in SemWeb technologies!
- RDF and OWL are starting to show up in more places
- Altova just announced a SemWeb editing product
- Oracle is announcing SemWeb capabilities
- Yahoo and Google are hiring SemWeb personalities
- Web Services are calling out for semantics!

SemWeb Directions

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- One complaint is that no one wants to enter metadata
  - Oh yeah? MusicBrainz, Flickr, del.icio.us, etc.
  - Still we want to minimize the burden on humans to improve the web experience for computers
- Ontology editors will improve for better user experience

SemWeb Directions (cont)

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- Entity extraction will get better for automagic tagging
- Embedded RDF/OWL via languages like GRDDL
- Continued adoption of Doer technologies like FOAF/DOAP
- Web Service annotation with semantic markup for easier and richer orchestration

References

Specifications

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Tool	Location
URI	http://www.w3.org/Addressing/
XML	http://www.w3.org/XML/
RDF	http://www.w3.org/RDF/
RDFS	http://www.w3.org/TR/rdf-schema/
SKOS	http://www.w3.org/2004/02/skos/core
OWL	http://www.w3.org/TR/owl-features/

Books

[Alesso2005], Alesso, Smith, "Developing Semantic Web Services", A.K. Peters Ltd., 2005.

[Antoniou2004], Antoniou, van Harmelen, "A Semantic Web Primer", MIT Press, 2004.

[Daconta2003], Daconta, Obrst, and Smith, "The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management", Wiley, 2003.

[Fensel2003], Fensel, Hendler, Lieberman and Wahlster, "Spinning the Semantic Web: Bringing the World Wide Web to Its Full Potential", MIT Press, 2003.

[Lacey2005] "OWL: Representing Information Using the Web Ontology Language, Trafford, 2005.

[Passin2004], Passin, "Explorer's Guide to the Semantic Web", Manning, 2004.

[Powers2003], Powers, "Practical RDF", O'Reilly, 2003.

Links

Topic	Location
Kowari	http://www.kowari.org
TKS	http://tucana.es.northropgrumman.com/
FOAF	http://www.foaf-project.org/
DOAP	http://usefulinc.com/doap
Dublin Core	http://dublincore.org/
MusicBrainz	http://musicbrainz.org/
Examples	http://www.bosatsu.net/talks/SemWebExamples.zip

Links

菩薩

Topic	Location
Jena	http://jena.sourceforge.net/
Joseki	http://www.joseki.org/
Simile	http://simile.mit.edu
Tupelo	http://dlt.ncsa.uiuc.edu/wiki/index.php/Main_Page
SWOOP	http://www.mindswap.org/2004/SWOOP/

Contact

- Please send questions/feedback to brian@bosatsu.net
- Slides: http://www.bosatsu.net/talks/SemWeb-UVA.pdf