Introduction to Preservation Metadata

REservation Metadata Implementation Strategies

Introducing to Preservation Metadata

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Outline

• What is the Semantic Web?
• Semantic Web and RDF
• Linked Data
  – Principles and goals
  – General LD applications
• Linked Data and libraries
  – Library LD applications
  – Bibliographic metadata as LD
  – Future considerations
What is the Semantic Web?

- Various methods and technologies to describe information on the World Wide Web that’s machine-understandable
- Semantics = meaning
- A “web of data” – including structured content
- A framework that allows data to be shared across boundaries
- Enable users to find, share and combine information more easily
- Anyone can say Anything about Any topic
- Treats the entire Web like a large database
Origins of “Semantic Web”

• Vision of Tim Berners-Lee, inventor of the WWW
• “Weaving the Web” described the WWW (1999)
• Scientific American article described the Semantic Web in 2001
• A web of data that can be processed directly and indirectly by machines
The traditional Web

- Internet + Documents + Links
- HTTP + HTML + URLs
The problem with the traditional Web

- Web content is loosely structured
- The “dark web” isn’t accessible
- Applications can’t do smart things
- Need structured content that can be reused and repurposed
- Content providers need to make data available in a structured format
Kafka, Franz, 1883-1924

name:
  person:
    lastName=Kafka
    firstName=Franz
    dates=1883-1914
The “regular” Web (hyperlinks)

The Library Lions

Patience and Fortitude, the world-renowned pair of marble lions that stand proudly before the majestic Beaux-Arts building at Fifth Avenue and 42nd Street in Manhattan, have captured the imagination and affection of New Yorkers and visitors from all over the world since the Library was dedicated on May 23, 1911.

Patience, south of the main steps

Called “New York's most lovable public sculpture” by architecture critic Paul Goldberger, the Lions have witnessed countless parades and been adorned with holly wreaths during the winter holidays and magnificent floral wreaths in springtime. They have been bedecked in top hats, graduation caps, Mets and Yankee caps, and more. They have been photographed alongside countless tourists, replicated as bookends, caricatured in cartoons, and illustrated in numerous children's books. One even served as the hiding place for the cowardly lion in the motion picture The Wiz.

According to Henry Hope Reed in his book, The New York Public Library, about the architecture of the Fifth Avenue building, the sculptor Edward Clark Potter obtained the commission for the lions on the recommendation of Augustus Saint-Gaudens, one of America's foremost sculptors. Potter was paid $8,000.

Edward Clark Potter

Sculptor Edward Clark Potter (1857-1923), who was commissioned to create the lions, was one of the most outstanding "animaliers" working in the United States. He ranks among the best specializing in animal subjects, artists such as A. Phimister Proctor, Edward Kemeys, Frederick Roth, and Anna Hyatt Huntington, among others.

It was in fact Potter who sculpted the horses for most of Daniel Chester French's monumental equestrian statues, including The Columbus Quadriga for the Chicago World's Columbian Exposition (1893); General Grant for Fairmount Park, Philadelphia; George Washington for the City Art Museum, and Ferdinand de Soto, both in St. Louis; and other commissions. French's Statues of Plenty for the World's Columbian Exposition include a powerful bull and horse by Edward Potter, which are now in Garfield Park, Chicago. The collaboration of French and Potter is legendary in the history of American sculpture.

Edward Potter's own work includes the General Slocum equestrian at Gettysburg, thought by Lorado Taft to be the best monument on the historic battlefield; General Joseph Hacker equestrian, Boston State House; General Charles Devens, Worcester, Massachusetts; and General Philip Kearny at Arlington National Cemetery in Virginia.

Major public works by Edward Potter in New York City include the marble statue of Zoroaster, among nine works by different artists, on the cornice of the New York Appellate Court House, Madison Square; Thidian Philosophy and Indian Religion, among the 30 heroic statues atop the cornice of The Brooklyn Museum on Eastern Parkway; and a pair of lions flanking the 36th Street entrance of The Morgan Library and Museum.

All these magnificent horses, personages, and famous American heroes are part of Potter's noteworthy and highly regarded artistic legacy, but he is best known for the Library Lions.
Saint Vincent and the Grenadines

General Information on Saint Vincent and the Grenadines

Official Name: Saint Vincent and the Grenadines
Capital: Kingstown (Current local time)
Government Type: Parliamentary democracy
Population: 115,000
Area: 130 square miles; slightly less than twice the size of Washington, D.C.
Languages: English
Literacy: Total: 96%
Year of Independence: 1979
Web site: SVGtourism.com

Articles

Newest First | Oldest First
Page: 1

Clinton Group Gets Discount For AIDS Drugs
By LAWRENCE K. ALTMAN
Former President Bill Clinton announced yesterday that his foundation had brokered an agreement with four generic drug companies to cut the cost of generic AIDS antiretroviral drugs by about a third and is now

St. Vincent and the Grenadines

Saint Vincent and the Grenadines Navigator
A list of resources about Saint Vincent and the Grenadines assembled by researchers and editors of The New York Times.

- C.I.A. World Factbook country profile
- State Department -- history and overview
- BBC country profile
- News and online media

Other Resources
BUSINESS
- Business conditions (World Bank)
- Currency conversion

ECONOMY
- Economic outlook for the most developed countries
  (Organization for Economic Cooperation and Development)
- Statistical profiles of the least developed countries (U.N.)
- World Bank country brief

BBC

NEWS
ONE-MINUTE WORLD NEWS
Page last updated at 11:12 GMT, Friday, 23 December 2011
E-mail this to a friend  Printable version

Overview  Facts  Leaders  Media

These playgrounds are worlds away from the many Vincitans who are without jobs. High unemployment has prompted many to leave the islands.

Like other countries in the Windwards chain, St. Vincent and the Grenadines has tried to reduce its reliance on banana exports after the
Resource Description Framework

- A W3C standard
  http://www.w3.org/RDF
- A resource is anything that has identity
  - Persons, places, documents, concepts
- Descriptions of resources
  - Attributes and features
  - Relations between things
- A framework that includes
  - A data model
  - Languages and syntax
- Emerged from Warwick Framework, 2\textsuperscript{nd} Dublin Core meeting
- Data format for Linked Data
Semantic Web concepts

- **Resource**: any thing that has identity
- **Class**: abstraction of a type of thing
- **Individual**: an instance of a class
- **Property**: an attribute of an individual
- **Ontology**: a domain specific collection of classes and properties
- **Statement/triple**:
  - **Subject**: resources
  - **Predicate**: properties
  - **Object**: resources or literals
Semantic Web concepts

- **Graph**: visual representation of statements
- **Nodes**: the subjects and objects in a graph
- **Arcs**: the predicates in a graph
- **Domains and ranges**: constraints on nodes
  - Domain: what things can be subjects
  - Range: what things (or strings) can be objects
- **Literals**: values as strings rather than things
- **Named graphs**: graphs with URIs treated as nodes
- **SPARQL**: searching language for the semantic web (like SQL)
RDF triples

Subject property Value

Book title As you like it
Statement: The Library of Congress is located in Washington DC
RDF

Statement:
The Library of Congress is located in Washington, DC.

As a triple:
ex:LC isLocatedIn “Washington, DC”
More about triples

- Subject must be a URI
- Predicate is a defined property with a URI
- Object may be:
  - Text string
  - Structured text
  - Typed text (e.g. dates, integers)
  - Controlled term
  - URI representing a thing or entity
- Data not represented as a URI doesn’t link but may be indexed, searched and displayed
The Library of Congress is located in Washington, DC

ex:LC isLocatedIn “Washington, DC”

http://id.loc.gov/vocabulary/geographicAreas/n-us-dc

http://id.loc.gov/authorities/names/n78089035.html
http://myontology:isLocatedIn
http://id.loc.gov/vocabulary/geographicAreas/n-us-dc
Relations between things

http://lccn.loc.gov/68591965

The Trial

Franz Kafka

978-0-19-923829-3

Oxford University Press
Relations between things

http://lccn.loc.gov/68591965

The Trial

978-0-19-923829-3

http://id.loc.gov/authorities/names/n81063091

http://id.loc.gov/authorities/names/n80126136

publisher

author

isbn

title

name

name

publisher
Graphs, nodes and arcs

- RDF thinks in terms of graphs, not XML or documents
- Nodes in graphs are things
- Arcs are relationships between things
- Graphs can have named things (resources identified by URIs)
- Can have text values (literals)
- Can have named relations
Graphs can have named things

http://example.com/thing
Graphs can have text values (literals)
Graphs can have numeric values (also literals)

http://example.com/thing

“text”

3.41598
Graphs can have named relations

http://example.com/thing

http://example.com/rel

http://example.com/other

3.41598

“text”
Literals

- Literals may occur in the position of object of RDF triples
- Represented by strings
- Literals may be interpreted by datatypes
  - Datatypes identified by URIs
  - XML schema datatypes often used
  - No datatype is interpreted as xs:string
- Untyped literals may have language tags
RDF rules

• The URI identifies what you’re describing
• If two people create data using the same URI they’re talking about the same thing
• That makes it easy to merge data from different sources together
• Sometimes things have multiple URIs but relationships between those URIs can be asserted
Records vs. statements

- Bibliographic traditions focus on metadata records
- Each triple is a statement
- RDF consists of a series of statements
- What does that mean for communication of metadata between institutions as is the tradition for libraries?
RDF serializations

- RDF/XML
- N3 (N Triples)
- Turtle
- Easy to translate from one to another
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:dc="http://purl.org/dc/elements/1.1/"
    xmlns:ex="http://example.org/stuff/1.0/">
    <rdf:Description rdf:about="http://www.w3.org/TR/rdf-syntax-grammar"
        dc:title="RDF/XML Syntax Specification (Revised)">
        <ex:editor>
            <rdf:Description ex:fullName="Dave Beckett">
                <ex:homePage rdf:resource="http://purl.org/net/dajobe/"/>
            </rdf:Description>
        </ex:editor>
    </rdf:Description>
</rdf:RDF>
N3 (N Triples)

Turtle

- Terse RDF triple language
- A subset of N Triples
- Plain text syntax
- Mechanism for namespace abbreviations
- No official status, but popular as human friendly alternative to RDF/XML
- Used in SPARQL queries
RDF Turtle example

@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix ex: <http://example.org/stuff/1.0/> .

<http://www.w3.org/TR/rdf-syntax-grammar>
  dc:title "RDF/XML Syntax Specification (Revised)" ;
  ex:editor [ 
    ex:fullname "Dave Beckett";
    ex:homePage <http://purl.org/net/dajobe/> 
  ] .
SPARQL

- Standard query language for Linked Data
- Works by matching patterns in a graph
- Queries RDF triples
- Can express queries across diverse data sources
- Uses Turtle syntax
- Uses SQL-like syntax
SPARQL query

PREFIX foaf: <http://xmlns.com/foaf/0.1/>

SELECT ?name ?email
WHERE  ?person a foaf:Person.
   ?person foaf:name ?name.
}
RDF languages

- RDF Schema (RDFS)
- RDFa
- Simple Knowledge Organization System (SKOS)
- Ontology Web Language (OWL)
- Specific ontologies
  - Bibliographic ontology (BIBO)
  - MODS/RDF and MADS/RDF
  - BIBFRAME
RDF schema (RDFS)

- Gives ability to say things about resources
- Declaration of properties (attributes) and their semantics
- Can define kinds of resources being described
- Specifies a schema specification language and mechanism to define descriptive elements
- Adopts a modular approach to metadata
- Based on the Warwick framework
RDFa

• Resource Description Framework in Attributes
• Allows for embedding RDF in HTML documents
• Adds structure to HTML pages directly
• Provides a set of markup attributes to augment the visual information on the Web with machine-readable hints
• Allows computers to extract the data

<h2 property="http://purl.org/dc/terms/title">The Trouble with Bob</h2>
<p>Date: <span property="http://purl.org/dc/terms/created">2011-09-10</span></p>
Simple Knowledge Organization System (SKOS)

- RDF application used to express knowledge organization systems such as classifications, thesauri, taxonomies, and the concepts within
- Allows distributed, decentralized management of KOS through Linked Data-inspired application
- All concepts and schemes require a URI
The SKOS data model (Classes)

- Concept Schemes (e.g., published vocabularies, thesauri, code lists, etc.)
- **Concepts** (individual entries or terms within the larger vocabulary)
- Collections (logical groupings of Concepts)
SKOS concepts

• Labeling properties: : `prefLabel`, `altLabel`, `hiddenLabel`, `notation`
• Annotation properties: `note`, `historyNote`, `scopeNote`, `changeNote`, `editorialNote`, `example`, `definition`
• Associative properties: `broader`, `narrower`, `related`, `sameAs`, `broadMatch`, `narrowMatch`, `closeMatch`, `exactMatch`, `minorMatch`, `majorMatch`
Using SKOS for controlled vocabularies

• SKOS has a defined element set which is particularly relevant for controlled vocabularies
• Relationships between entries in a concept scheme can be expressed (broader, narrower, etc.)
• Relationships between entries in different concept schemes can be expressed (exactMatch, related)
• Particularly useful for library authority data
  – id.loc.gov
  – Virtual International Authority File (VIAF)
LC Linked Data Service
Authorities and Vocabularies

Search

Hold CONTROL key for 2 or more

ALL
LC Subject Headings
LC Name Authority File
LC Classification
LC Children's Subject Headings

**Please Note: LC Classification entries are not included in general search results. You must explicitly select LC Classification in order to search the scheme. This is temporary while the impact of adding LCC to the current system is better understood.**

Search  Reset

Available Datasets
The Linked Data Service provides access to commonly found standards and vocabularies promulgated by the Library of Congress. This includes data values and the controlled vocabularies that house them. The following are currently offered as part of this service:

- LC Subject Headings
- LC Name Authority File
- LC Classification
- LC Children's Subject Headings
- LC Genre/Form Terms
- Thesaurus for Graphic Materials
- MARC Relators
- MARC Countries
- MARC Geographic Areas
- MARC Languages
- ISO639-1 Languages
- ISO639-2 Languages
- ISO639-5 Languages
- Extended Date/Time Format

Preservation Vocabularies

- Preservation Events
- Preservation Level Role
- Cryptographic Hash Functions
Dogs--Mythology

URI(s)
- http://id.loc.gov/authorities/subjects/sh90003030
- info:lc/authorities/sh90003030
- http://id.loc.gov/authorities/sh90003030#concept

Instance Of
- MADS/RDF ComplexSubject
- MADS/RDF Authority
- SKOS Concept

Components
- Dogs
- Mythology

Scheme Membership(s)
- Library of Congress Subject Headings

Collection Membership(s)
- LCSH Collection - Authorized Headings
- LCSH Collection - General Collection
- LCSH Collection - Term Permitted to be Indirectly Subdivided Geographically

Variants
- Dogs (in religion, folk-lore, etc.)

Exact Matching Concepts from Other Schemes
- http://stitch.cs.vu.nl/vocabularies/rameau/ark:/12148/cb11953444b

Earlier Established Forms
- Dogs (in religion, folk-lore, etc.)
<rdf:RDF>
  <rdf:Description rdf:about="http://id.loc.gov/authorities/subjects/sh90003030">
    <skos:prefLabel xml:lang="en">Dogs--Mythology</skos:prefLabel>
    <skos:altLabel>
      <rdf:Description>
        <skosxl:literalForm xml:lang="en">Dogs (in religion, folk-lore, etc.)</skosxl:literalForm>
      </rdf:Description>
    </skos:altLabel>
    <skos:inScheme rdf:resource="http://id.loc.gov/authorities/subjects"/>
    <skos:altLabel xml:lang="en">Dogs (in religion, folk-lore, etc.)</skos:altLabel>
    <skos:changeNote>
      <cs:ChangeSet>
        <cs:subjectOfChange rdf:resource="http://id.loc.gov/authorities/subjects/sh90003030"/>
        <cs:creatorName>Library of Congress, Network Development and MARC Standards Office</cs:creatorName>
        <cs:createdDate rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">1990-06-21T00:00:00</cs:createdDate>
        <cs:changeReason rdf:datatype="http://www.w3.org/2001/XMLSchema#string">new</cs:changeReason>
      </cs:ChangeSet>
    </skos:changeNote>
    <skos:changeNote>
      <cs:ChangeSet>
        <cs:subjectOfChange rdf:resource="http://id.loc.gov/authorities/subjects/sh90003030"/>
        <cs:creatorName>Library of Congress, Network Development and MARC Standards Office</cs:creatorName>
        <cs:createdDate rdf:datatype="http://www.w3.org/2001/XMLSchema#dateTime">1997-03-24T10:08:26</cs:createdDate>
        <cs:changeReason rdf:datatype="http://www.w3.org/2001/XMLSchema#string">revised</cs:changeReason>
      </cs:ChangeSet>
    </skos:changeNote>
  </rdf:Description>
</rdf:RDF>
SKOS in N3
Ontology Web Language (OWL)

- Uses RDF model to allow for combining constructs to match properties, classes and individuals
- Larger vocabulary and stronger syntax than RDF
- Enhances the ability to represent information and match with other things already modeled
- Gives a way to express concepts from one context in terms of concepts from another
- *Restrictions* allow defining individuals of a class in terms of an existing properties and classes
OWL ontologies

• SKOS is an OWL ontology for expressing a broad range of concept schemes and thesauri

• New ontologies appear every day

• Some in the library community:
  – Resource Description and Access (RDA)
  – MADS/RDF and MODS/RDF
  – PREMIS OWL (draft recently released)
  – Bibliographic ontology (BIBO)
Semantic Web application architecture

- **RDF Parser** reads text in a serialization format and interprets it as triples
- **RDF Serializer** takes triples and expresses it in a serialization format
- **RDF Triple Store** is a database for storing and retrieving data in the form of triples and can merge information from multiple sources
- **RDF Query Engine** has capability to retrieve information from RDF store according to structured queries
- **Application** performs work with the data it processes, e.g. analysis, user interaction using a programming language
- **Application Programming Interface (API)** provides means to use data in an application
Take a break…

• Come back in 10 min.
Linked Data

- A feature of the Semantic Web where links are made between resources
- Goes beyond hypertext links (i.e. between web pages) but between any kind of object or concept
- From Wikipedia: "a term used to describe a method of exposing, sharing, and connecting data via dereferenceable URIs on the Web"
- Ties together disparate pieces of information that aren’t available from a single source
- Users can use links to find similar resources and aggregate results
- Linked “Open” Data: instead of embedding data (in text, in tables, etc), simply share the data (openly)
Linked Data: basic principles

• Use URIS for names of things
• Use HTTP URIs so people can look them up “dereferencable URIs”
• Make the data available
• Provide useful information when people find URI
• Include links to other things so people can discover more
Growth of LOD cloud
2007
Some Linked Open Data applications

- DBpedia
- FOAF (Friend of a friend)
- BBC
- New York Times
- Internet Movie Database
- MusicBrainz
- Geonames
- Government data
- id.loc.gov
DBPedia

- Extracts structured information from Wikipedia as Linked Data and combines into huge, cross-domain knowledge base
- Allows users to query relationships and properties associated with Wikipedia resources
- Describes more than 3.64 million things as of Sept. 2011, about half in a consistent ontology
- Multilingual (97 languages)
- Links to 2.7 million images, 6.3 million web pages, 6.2 million to other RDF data sets
DBpedia resources

- Wikipedia articles are mostly free text but also contains different types of structured information
- Uses InfoBox templates, categorization information, images, geo-coordinates, links to external sources
- SPARQL for querying
- RDF for representing extracted information and presenting it
- InfoBox data set extracts properties from articles
- InfoBox templates mapped to Dbpedia ontology
Example of data in DBpedia

```json
{{Infobox Town AT | name = Innsbruck | image_coa = InnsbruckWappen.png | image_map = Karte-tirol-I.png | state = [[Tyrol]] | regbzk = [[Statutory city]] | population = 117,342 | population_as_of = 2006 | pop_dens = 1,119 | area = 104.91 | elevation = 574 | lat_deg = 47 | lat_min = 16 | lat_hem = N | lon_deg = 11 | lon_min = 23 | lon_hem = E | postal_code = 6010-6080 | area_code = 0512 | licence = I | mayor = Hilde Zach | website = [http://innsbruck.at] | }}

| Country | Austria |
| State | Tyrol |
| Administrative region | Statutory city |
| Area | 104.91 km² |
| Population density | 1,119 /km² |
| Elevation | 574 m |
| Coordinates | 47°16' N 11°23' E |
| Postal code | 6010-6080 |
| Area code | 0512 |
| Licence plate code | I |
| Mayor | Hilde Zach |
| Website | www.innsbruck.at |
Examples of linking Dbpedia with other datasets

- Geonames
- MusicBrainz
- New York Times
- World Factbook
- Project Gutenberg
- US Census
- Freebase
- Drugbank
### Example from Dbpedia ontology

**Celebrity** *(Show in class hierarchy)*

- **Label (en):** celebrity
- **Label (fr):** célébrité
- **Super classes:** Person

#### Properties on Celebrity:

<table>
<thead>
<tr>
<th>Name</th>
<th>Label</th>
<th>Domain</th>
<th>Range</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>almaMater (edit)</td>
<td>alma mater</td>
<td>Person</td>
<td>EducationalInstitution</td>
<td>schools that they attended</td>
</tr>
<tr>
<td>astrologicalSign (edit)</td>
<td>astrological sign</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
<tr>
<td>award (edit)</td>
<td>award</td>
<td>Person</td>
<td>Award</td>
<td></td>
</tr>
<tr>
<td>birthDate (edit)</td>
<td>birth date</td>
<td>Person</td>
<td>xsd:date</td>
<td>where the person was born</td>
</tr>
<tr>
<td>birthName (edit)</td>
<td>birth name</td>
<td>Person</td>
<td>xsd:string</td>
<td></td>
</tr>
<tr>
<td>birthPlace (edit)</td>
<td>birth place</td>
<td>Person</td>
<td>Place</td>
<td>The place where the person has been buried.</td>
</tr>
<tr>
<td>birthYear (edit)</td>
<td>birth year</td>
<td>Person</td>
<td>xsd:gYear</td>
<td></td>
</tr>
<tr>
<td>bloodType (edit)</td>
<td>blood type</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
<tr>
<td>board (edit)</td>
<td>board</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
<tr>
<td>bodyDiscovered (edit)</td>
<td>body discovered</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
<tr>
<td>buriedPlace (edit)</td>
<td>buried place</td>
<td>Person</td>
<td>Place</td>
<td></td>
</tr>
<tr>
<td>bustSize (edit)</td>
<td>bust size</td>
<td>Person</td>
<td>Length</td>
<td></td>
</tr>
<tr>
<td>child (edit)</td>
<td>child</td>
<td>Person</td>
<td>Person</td>
<td></td>
</tr>
<tr>
<td>citizenship (edit)</td>
<td>citizenship</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
<tr>
<td>complexion (edit)</td>
<td>complexion</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
<tr>
<td>deathCause (edit)</td>
<td>death cause</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
<tr>
<td>deathDate (edit)</td>
<td>death date</td>
<td>Person</td>
<td>xsd:date</td>
<td>the place where they died</td>
</tr>
<tr>
<td>deathPlace (edit)</td>
<td>death place</td>
<td>Person</td>
<td>Place</td>
<td></td>
</tr>
<tr>
<td>deathYear (edit)</td>
<td>death year</td>
<td>Person</td>
<td>xsd:gYear</td>
<td></td>
</tr>
<tr>
<td>description (edit)</td>
<td>description</td>
<td>Person</td>
<td>xsd:string</td>
<td>Short description of a person</td>
</tr>
<tr>
<td>dubber (edit)</td>
<td>dubber</td>
<td>Person</td>
<td>Person</td>
<td>the person who dubs another person e.g. an actor or a fictional character in movies</td>
</tr>
<tr>
<td>education (edit)</td>
<td>education</td>
<td>Person</td>
<td>owl:Thing</td>
<td></td>
</tr>
</tbody>
</table>
### Example from Dbpedia ontology

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>electionDate</td>
<td>election date</td>
<td>Person</td>
<td><strong>xsd:date</strong></td>
</tr>
<tr>
<td>employer</td>
<td>employer</td>
<td>Person</td>
<td>Organisation</td>
</tr>
<tr>
<td>ethnicity</td>
<td>ethnicity</td>
<td>Person</td>
<td>EthnicGroup</td>
</tr>
<tr>
<td>eyeColor</td>
<td>eye color</td>
<td>Person</td>
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### Bend It Like Beckham

**Resource URL:** http://data.linkedmdb.org/resource/film/39062

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#### United Kingdom of Great Britain and Northern Ireland

Ca. 71 m

Ahendiman Nkabon An Riecht Aontaith A Riegh ...

**United Kingdom**
- independent political entity
- population: 62348447
- N 54° 45' 30" W 2° 41' 43"
- 54.75844 / -2.69531
- GeoNameId: 2635167

**Zoom**  move  edit  history  tag  delete  alternate names
**Perma link**  geotree  semantic web  rdf
**Part of**  contains
### Keira Knightley (Actor)

**Resource URI:** http://data.linkedmdb.org/resource/ea/31286

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**Date of birth:** Mar 25, 1985 (age 37 years)

**Place of birth:** Teddington, United Kingdom

**Height:** 1.7 m (5 ft 7 in)

**Religion:** Atheism

**Also known as:** Keira Christina Knightley, Keira Knightley

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**People**

**Place of birth:** Teddington, United Kingdom

**Keira Knightley Quotes**

“...I know for a fact the work is going to dry up, and people will get bored of me. That’s not bitterness, just the truth.”

**Country of nationality:** England

**Gender:** Female

**Profession:** Actor, Model

---

[View Keira Knightley: Professions »](#)
New York Times

- NY Times controlled vocabularies
  - Index terms
  - People
  - Places
  - Align NYT terms with other LOD vocabularies
  - Over 10,000 tags published
- About 15,000 links to other sources, e.g.
  - Dbpedia
  - Freebase
  - Geonames
  - Many linked manually
- Released semantic APIs
  - developer.nytimes.com
# Dylan, Bob

**http://data.nytimes.com/60333230376963593933**

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| cc:attributionURL             | http://data.nytimes.com/60333230376963593933 |
| cc:license                    | http://creativecommons.org/licenses/by/3.0/us/ |
| dc:creator                    | The New York Times Company |
| dcterms:created               | 2009-03-03 |
| dcterms:modified              | 2010-06-22 |

CHRONOLOGY OF COVERAGE

A 1962 concert honoring Bob Dylan is coming out in video and a refreshed CD edition. MORE

Editorial defends Bob Dylan, who has been charged in France for violating law that restricts free speech; finds irony in fact that country has presented Dylan with the Legion of Honor while simultaneously prosecuting him for speaking out against racism MORE

Op-Ed article by writer Bill Wyman argues that Bob Dylan should win the Nobel Prize in Literature. MORE

Jon Pareles reviews performances by Bob Dylan, Wilco, My Morning Jacket and Ryan Bingham at Pier A Park in Hoboken, Nj, as part of Americanarama Festival of Music. MORE

Sony Music releases a very limited album of early Bob Dylan
Library Linked Data

- W3C Library Linked Data Incubator Group report Oct 2011
  - Reviewed benefits to library, museum, archives community for putting data out as LOD
  - Provided recommendations
  - Elaborated use cases and mining them for functional requirements and design patterns
  - Identified existing library LOD resources
  - Detailed relevant technologies
  - [http://www.w3.org/2005/Incubator/lld/](http://www.w3.org/2005/Incubator/lld/)
Library data and Linked Data

- Rich stores of bibliographic and authority metadata
- Highly standardized metadata formats
  - MARC
  - MODS
- Robust controlled vocabularies
  - Subject heading lists
  - Code lists
  - Formal thesauri
- Emerging data models in RDF
Bibliographic vocabularies

- Bibliographic Ontology (BIBO)
  - Zotero, Omeka, Eprints, etc.
- FRBR
- ISBD
- Resource Description and Access (RDA)
- MODS/RDF and MADS/RDF
- BIBFRAME
Exposing library data as LOD

• Library authority data
  – Link with URIs so people discover more things
  – Authority data is intended to do this
  – Open up controlled vocabularies for the wider web

• Linked library (museum and archive) data
  – British Library
  – German National Library
  – Europeana
  – Swedish National Library
  – Library of Congress authority data
  – Virtual International Authority File (VIAF)
  – Dewey Decimal Classification (DDC)
  – Archives Hub
Metadata element sets as Linked Data

- **Dublin Core** (http://dublincore.org)
  - Early implementer of RDF; Warwick Framework
  - Based on Dublin Core Abstract Model
  - 15 cross-domain metadata elements; later additional elements and element refinements added
  - Syntax encoding schemes
  - Vocabulary encoding schemes
  - Metadata registry

- **Resource Description and Access**
  - Elements, roles and vocabularies in metadata registry
  - IFLA, FRBR and ISBD elements also registered
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</tr>
<tr>
<td>Dimensions</td>
<td>property</td>
<td>.../Elements/dimensions</td>
<td>New-Proposed</td>
<td>2009-06-15 16:49</td>
<td>DianeH</td>
</tr>
<tr>
<td>Base material</td>
<td>property</td>
<td>.../Elements/baseMaterial</td>
<td>New-Proposed</td>
<td>2009-08-20 21:23</td>
<td>DianeH</td>
</tr>
<tr>
<td>Applied material</td>
<td>property</td>
<td>.../Elements/appliedMaterial</td>
<td>New-Proposed</td>
<td>2009-08-20 21:36</td>
<td>DianeH</td>
</tr>
<tr>
<td>Form of work</td>
<td>property</td>
<td>.../Elements/formOfWork</td>
<td>New-Proposed</td>
<td>2009-09-21 20:55</td>
<td>DianeH</td>
</tr>
<tr>
<td>Date of work</td>
<td>property</td>
<td>.../Elements/dateOfWork</td>
<td>New-Proposed</td>
<td>2009-09-21 20:53</td>
<td>DianeH</td>
</tr>
<tr>
<td>Place of origin of the work</td>
<td>property</td>
<td>.../placeOfOriginOfTheWork</td>
<td>New-Proposed</td>
<td>2009-09-21 20:54</td>
<td>DianeH</td>
</tr>
<tr>
<td>Date of expression</td>
<td>property</td>
<td>.../Elements/dateOfExpression</td>
<td>New-Proposed</td>
<td>2009-08-21 18:30</td>
<td>DianeH</td>
</tr>
<tr>
<td>Language of expression</td>
<td>property</td>
<td>.../Elements/languageOfExpression</td>
<td>New-Proposed</td>
<td>2009-08-21 18:31</td>
<td>DianeH</td>
</tr>
<tr>
<td>Other distinguishing characteristic of the expression</td>
<td>property</td>
<td>.../gCharacteristicOfTheExpression</td>
<td>New-Proposed</td>
<td>2009-08-10 13:04</td>
<td>DianeH</td>
</tr>
</tbody>
</table>

466 results
MARC and Bibliographic Framework Transition Initiative

• Rethinking bibliographic control because of technological and environmental changes
• Determine aspects of MARC to be retained
• Based on Semantic Web and Linked Data technologies
• Foster reuse of existing rich metadata
• Integrate library data and other cultural heritage data on the Web
• Eric Miller/Zepheira under contract to develop model and begin experimentation
BIBFRAME

- Moving MARC 21 to a Web-based, Linked Data approach
- Uses a data model that defines the relationship between Works, Instances, Authorities
- Identifies as Web resources all entities (resources), attributes, and relationships between entities (properties)
- Establishes a vocabulary that is expressed as RDF


111 p. : ill. ; 28 cm.

Includes bibliographical references and index.

Library automation management: Handbooks, manuals, etc.

Library planning: Handbooks, manuals, etc.

Kelsey, Ann L.

Fiels, Keith Michael.
LC Linked Data service (Authorities and vocabularies)

- Controlled vocabulary access and management (for LC and for the community)
- Allows both human-oriented and programmatic access to LC maintained authorities and vocabularies
- First offering was Library of Congress Subject Headings in April 2009 with additional vocabularies added
- Offers bulk data downloads in several RDF serializations
Goals of LC’s service

• Expose LC developed vocabularies to wider communities
• Make controlled lists openly available
• Provide comprehensive information about controlled terms
• Experiment with semantic web technologies and linked data
• Facilitate development and maintenance process for vocabularies
Available vocabularies

- Library of Congress Subject Headings and Genre/Form headings
- Library of Congress Name Authority File
- MARC language, country and geographic area codes
- ISO 639 language codes
- Preservation metadata controlled vocabularies
- Thesaurus for graphic materials
- Library of Congress Classification (experimental)
MADS/RDF in ID

- An RDF vocabulary better suited to LIS needs
  - MADS XML $\rightarrow$ MADSRDF
- Better support for complex headings
- Support for library-specific authority types
- Support for types of labels
- Support for deprecated headings
- Mapped to SKOS for interoperability
Dylan, Bob, 1941-
- <madsrdf:PersonalName rdf:about="http://id.loc.gov/authorities/names/n50030190">
  <rdf:type rdf:resource="http://www.loc.gov/mads/rdf/v1#Authority"/>
  <madsrdf:authoritativeLabel xml:lang="en">Dylan, Bob, 1941-</madsrdf:authoritativeLabel>
  <madsrdf:elementList rdf:parseType="Collection">
    - <madsrdf:ElementName>
      <madsrdf:elementValue xml:lang="en">Dylan, Bob</madsrdf:elementValue>
    </madsrdf:ElementName>
    - <madsrdf:ElementName>
      <madsrdf:elementValue xml:lang="en">1941</madsrdf:elementValue>
    </madsrdf:ElementName>
  </madsrdf:elementList>
  <madsrdf:classification>ML420.D98</madsrdf:classification>
  <madsrdf:classification>PS3554.Y56</madsrdf:classification>
  <madsrdf:isMemberOfMADSCollection rdf:resource="http://id.loc.gov/authorities/names/collection_NAMESAuthorizedHeadings"/>
  <madsrdf:isMemberOfMADSCollection rdf:resource="http://id.loc.gov/authorities/names/collection_LCNAF"/>
  <madsrdf:hasExactExternalAuthority rdf:resource="http://viaf.org/viaf/sourceID/LC%7Cn+50030190#skos:Concept"/>
  <madsrdf:isMemberOfMADSSScheme rdf:resource="http://id.loc.gov/authorities/names"/>
</madsrdf:PersonalName>

- <madsrdf:identifiesRWO>
  - <madsrdf:RWO>
    <rdf:type rdf:resource="http://xmlns.com/foaf/0.1/Person"/>
    <madsrdf:birthdate>19410524</madsrdf:birthdate>
  </madsrdf:RWO>
</madsrdf:identifiesRWO>

- <madsrdf:hasVariant>
  - <madsrdf:PersonalName>
    <rdf:type rdf:resource="http://www.loc.gov/mads/rdf/v1#Variant"/>
    <madsrdf:variantLabel xml:lang="en">Zimmerman, Robert, 1941 May 24</madsrdf:variantLabel>
    <madsrdf:elementList rdf:parseType="Collection">
      - <madsrdf:ElementName>
        <madsrdf:elementValue xml:lang="en">Zimmerman, Robert</madsrdf:elementValue>
      </madsrdf:ElementName>
      - <madsrdf:ElementName>
        <madsrdf:elementValue xml:lang="en">1941 May 24</madsrdf:elementValue>
      </madsrdf:ElementName>
    </madsrdf:elementList>
  </madsrdf:PersonalName>
</madsrdf:hasVariant>
MADS/RDF

• Challenges with SKOS
  – SKOS intentionally simple (augmented with DC properties)
  – No support for precoordinated headings
  – SKOS is lossy

*skos:prefLabel*
Europe – Description and Travel – Early Works to 1800

*skos:altLabel*
Europe – Description and travel – 17th century
Europe – Description and travel – 17th-18th centuries
Europe – Description and travel – 18th century
Europe – Description and travel – To 1600
MADS/RDF

SKOS, challenges

`skos:preLabel`
Geographic
Topic
Genre/Form
Europe – Description and Travel – Early Works to 1800

`skos:altLabel`
Temporal
Europe – Description and travel – 17th century
Europe – Description and travel – 17th-18th centuries
Europe – Description and travel – 18th century
Europe – Description and travel – To 1600

Each part of the pre-coordinated heading *could* be its own Authority record
<rdf:RDF>
  <rdf:Description rdf:about="http://id.loc.gov/authorities/subjects/sh92005862">
    <rdf:type rdf:resource="http://www.w3.org/2004/02/skos/core#Concept"/>
    <skos:prefLabel xml:lang="en">Europe--Description and travel--Early works to 1800</skos:prefLabel>
  </rdf:Description>
  <skos:altLabel>
    <rdf:Description>
      <rdf:type rdf:resource="http://www.w3.org/2008/05/skos-xl#Label"/>
      <skosxl:literalForm xml:lang="en">Europe--Description and travel--To 1600</skosxl:literalForm>
    </rdf:Description>
  </skos:altLabel>
  <skos:altLabel>
    <rdf:Description>
      <rdf:type rdf:resource="http://www.w3.org/2008/05/skos-xl#Label"/>
      <skosxl:literalForm xml:lang="en">Europe--Description and travel--17th century</skosxl:literalForm>
    </rdf:Description>
  </skos:altLabel>
  <skos:altLabel>
    <rdf:Description>
      <rdf:type rdf:resource="http://www.w3.org/2008/05/skos-xl#Label"/>
      <skosxl:literalForm xml:lang="en">Europe--Description and travel--17th-18th centuries</skosxl:literalForm>
    </rdf:Description>
  </skos:altLabel>
  <skos:altLabel>
    <rdf:Description>
      <rdf:type rdf:resource="http://www.w3.org/2008/05/skos-xl#Label"/>
      <skosxl:literalForm xml:lang="en">Europe--Description and travel--18th century</skosxl:literalForm>
    </rdf:Description>
  </skos:altLabel>
  <skos:inScheme rdf:resource="http://id.loc.gov/authorities/subjects/">
    <skos:altLabel xml:lang="en">Europe--Description and travel--To 1600</skos:altLabel>
    <skos:altLabel xml:lang="en">Europe--Description and travel--17th century</skos:altLabel>
    <skos:altLabel xml:lang="en">Europe--Description and travel--17th-18th centuries</skos:altLabel>
  </skos:inScheme>
</rdf:RDF>
<rdf:RDF>
  <madsrdf:ComplexSubject rdf:about="http://id.loc.gov/authorities/subjects/sh92005862">
    <rdf:type rdf:resource="http://www.loc.gov/mads/rdf/v1#Authority"/>
    <madsrdf:authoritativeLabel xml:lang="en">
      Europe--Description and travel--Early works to 1800
    </madsrdf:authoritativeLabel>
  </madsrdf:ComplexSubject>
  <madsrdf:componentList rdf:parseType="Collection">
    <madsrdf:Geographic rdf:about="http://id.loc.gov/authorities/subjects/sh85045631">
      <rdf:type rdf:resource="http://www.loc.gov/mads/rdf/v1#Authority"/>
      <madsrdf:authoritativeLabel xml:lang="en">Description and travel</madsrdf:authoritativeLabel>
    </madsrdf:Geographic>
    <madsrdf:elementList rdf:parseType="Collection">
      <madsrdf:element rdf:parseType="Collection">
        <madsrdf:elementValue xml:lang="en">Description and travel</madsrdf:elementValue>
      </madsrdf:element>
    </madsrdf:elementList>
  </madsrdf:componentList>
  <madsrdf:Topic>
    <rdf:type rdf:resource="http://www.loc.gov/mads/rdf/v1#Authority"/>
    <madsrdf:authoritativeLabel xml:lang="en">Description and travel</madsrdf:authoritativeLabel>
    <madsrdf:elementList rdf:parseType="Collection">
      <madsrdf:element rdf:parseType="Collection">
        <madsrdf:elementValue xml:lang="en">Description and travel</madsrdf:elementValue>
      </madsrdf:element>
    </madsrdf:elementList>
  </madsrdf:Topic>
  <madsrdf:GenreForm>
    <rdf:type rdf:resource="http://www.loc.gov/mads/rdf/v1#Authority"/>
    <madsrdf:authoritativeLabel xml:lang="en">Early works to 1800</madsrdf:authoritativeLabel>
    <madsrdf:elementList rdf:parseType="Collection">
      <madsrdf:element rdf:parseType="Collection">
        <madsrdf:elementValue xml:lang="en">Early works to 1800</madsrdf:elementValue>
      </madsrdf:element>
    </madsrdf:elementList>
  </madsrdf:GenreForm>
</madsrdf:componentList>
MODS/RDF

- **Metadata Object Description Schema**
  - XML schema for bibliographic data
  - Derivative of MARC

- **Ontology released as draft and now undergoing revision**
  - Defines classes and properties for MODS elements
  - Links to vocabularies in id.loc.gov
  - Uses MADS/RDF where applicable
  - Allows for exposing rich library metadata from library catalogs
Tools

- Element sets and vocabularies available as Linked Data
- Metadata registries
- Tools for using and connecting data
  - Semantic Web APIs
  - Open Graph protocol
  - Schema.org
Open Graph protocol

- Facebook adopted OGP to allow it to integrate with other web resources
- Adding basic metadata to web pages to turn them into “graph objects”
- Establishes a linked web of data
- Includes defined properties to describe things
- Embed description using simplified RDFa
- Required properties: og:title; og:type; og:image; og:url
- Each “like” button generates at least 4 triples
- Highly successful Semantic Web model
Embedding OGP in a web page

<meta property="og:type" content="book"/>
<meta property="og:url" content="http://www.workingontologist.com/"/>
<meta property="og:image" content="http://covers.elsevier.com/165_FW/9780123735560.jpg"/>
<meta property="og:site_name" content="Working Ontologist"/>
Schema.org

- Collection of schemas for webmasters to mark up web pages
- Structured data to enhance search results in search engines
- Cooperative project with Bing, Yahoo, Google
- Provides direct access to structured data
- A shared markup vocabulary, sharing a collection of schemas
- GoodRelations project integrates e-commerce schemas and provides a rich, widely-used terminology for e-commerce data sharing
Schema.org and web pages

- Uses microdata format to embed metadata in HTML content
- OCLC is embedding metadata in RDFa into catalog records in WorldCat
- Metadata ("microdata") is retrievable as Linked Data, e.g. to produce citations
- New way of publishing data
- SchemaBibEx: established to develop a library extension for improved representation of bibliographic information
Schema.org markup

- **Itemscope**: identifies what it’s about
- **Itemtype**: uses schema’s type vocabulary
- **Itemprop**: label properties
- Can embed additional properties about values

```html
<div itemscope itemtype="http://schema.org/Movie">
  <h1 itemprop="name">Avatar</h1>
  <div itemprop="director" itemscope itemtype="http://schema.org/Person">
    Director: <span itemprop="name">James Cameron</span> (born <span itemprop="birthDate">August 16, 1954</span>)
  </div>
  <span itemprop="genre">Science fiction</span>
  <a href="..//movies/avatar-theatrical-trailer.html" itemprop="trailer">Trailer</a>
</div>
```
Closing thoughts

• Libraries have a wealth of data that could be used more widely
• Connections between library data and other Linked Data sources will facilitate reuse of well formulated, trusted, rich data
• New ways of publishing data are emerging
• Bibliographic metadata formats are evolving to open up the data in library systems
• There are many more players now publishing their data as LOD
• The growth of Linked Data will improve everyone’s access to information
Questions?

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