An Introduction to Linked Open Data

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SWIB 2014 Pre-Conference Workshop
Monday, December 1st 2014
Bonn
Schedule

Organize in teams
Introduction: Data – Graphs – Triples
Groupwork
URIs and Namespaces
Groupwork
Open Data Principles
Groupwork
Identification vs. Description
Groupwork
Triple Stores & SPARQL
Groupwork
RDF Schema
Groupwork
Summary, Questions & Discussion
Linked Open Data

- It's about data ...
- ... more precisely: about open data ...
- ... even more precisely: about linked open data!
(To be honest, we might actually be the only ones knowing such data. And there aren't too many things that one can describe in this way.)
Along came the Internet

http://www.w3.org/DesignIssues/Abstractions.html
Data, how others know it

(Of course, "others" does not mean "everybody". But at least you can describe many things this way. Maybe even everything.)
The World Wide Web

http://www.w3.org/DesignIssues/Abstractions.html
Data, how the web likes it

(No wonder, it actually looks like a web. Or, if you will, a directed labelled graph.)
The Giant Global Graph

http://www.w3.org/DesignIssues/Abstractions.html
Your turn!
Draw a graph of your social network.

(For now, stick with the people on your table)
A simple social graph

Adrian

knows

Felix

"Adrian"

"Pohl"

"Felix"

"Ostrowski"
Obviously a computer will have trouble interpreting such a diagram. The **graph data model** is an abstract one, but we can concrete it for the computer.
Graphs, (almost) how computers like them

(This notation is called Turtle and it is one of several writing styles for a data model called RDF. RDF stands for "Resource Description Framework"; this is the de-facto standard for publishing Linked Data. A big advantage of the Turtle notation: humans can actually read it!)
Basic element: the **triple**

Weaving the Web is written by Tim Berners-Lee.

(A triple is the smallest possible graph. It's components are called **subject**, **predicate** and **object**.)
Your turn!
Open the **etherpad** for your group. In this etherpad, express the graph you have drawn in RDF.
Simple social graph in RDF

```xml
<Adrian> <first name> "Adrian" .
<Adrian> <last name> "Pohl" .
<Adrian> <knows> <Felix> .
<Felix> <first name> "Felix" .
<Felix> <last name> "Ostrowski" .
<Felix> <knows> <Adrian> .
```
What does ...

... <Tim Berners-Lee>,
... <London> and
... <England>

stand for, and what does

... <has first name>,
... <is located in> and
... <has population>

mean?
We need **unambiguous reference!**

Authority files are a good start, but again we'll be the only ones understanding those. On the web, people use URIs!

(URI stands for **Uniform Resource Identifier**.)
URI

= scheme "::" hier-part [ "?" query ] [ "#" fragment ]

(????)
http://de.wikipedia.org/wiki/Uniform_Resource_Identifier
ftp://ftp.is.co.za/rfc/rfc3986.txt
file:///home/fo/doc/swib13/slides.odp
urn:isbn:978-1608454303
Graphs, how computers really like them

(A pleasant side-effect when using HTTP-URIs – which is what Linked Data is based upon, is that they can be dereferenced. When following such a link, one should get a description of the resource. More on that later.)
Graphs, (sort of) readable for humans and machines

@prefix dc: <http://purl.org/dc/terms/> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix gnd: <http://d-nb.info/gnd/> .

gnd:121649091 foaf:givenName "Tim" .
gnd:121649091 foaf:familyName "Berners-Lee" .
gnd:121649091 foaf:birthday "06/08/1955" .

(You can abbreviate URIs using prefixes. This also makes it easier to identify the vocabularies you use.)
But isn't some data we had missing!?

(There may not be a URI for everything you want to refer to, neither for entities nor for vocabularies.)

<http://d-nb.info/gnd/121649091> <is born in> <London> .
<London> <is located in> <England> .
<London> <has population> "7825200" .
<London> <has area> "130395km²" .
Don't repeat others, link!

- Reuse properties from existing vocabularies
- Link to things by simple URI reference
- Think Data-Library (as in Software-Library)
(When something you want to describe does not have a URI yet, you can use IDs that are relative to the describing document. Since two documents can't be at the same place at the same time, these IDs only have to be unique within that document. "<>" stands for the document itself. You can check here if you are creating valid turtle.)
Your turn!
Reformulate your RDF using the FOAF vocabulary. Also, use DC Terms to assert that you are the authors of the describing document. You can also add further metadata about the document if you want.
Simple social graph using FOAF

@prefix :     <#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix dc:   <http://purl.org/dc/terms/> .

:adrian foaf:givenName "Adrian" .
:adrian foaf:familyName "Pohl" .
:felix foaf:givenName "Felix" .
:felix foaf:familyName "Ostrowski" .

<> dc:creator <Felix> .
<> dc:creator <Adrian> .
<> dc:created "25.11.2013" .
Open Data
Open Definition

“Open means anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness).”

http://www.opendefinition.org
Open Data is a question of...

- Licensing
- Access
- Formats
Open Data is a question of...

- Licensing
- Access
- Formats
Open Data Licenses

- Attribution
- Attribution-Share-Alike
- Public-Domain
- **No** non-commercial (NC) licenses

http://www.opendefinition.org/licenses/
Open Data is a question of...

- Licensing
- Access
- Formats
Access

➔ ...to the work as a whole
➔ No more than a reasonable reproduction cost
➔ Preferably downloading via the Internet without charge
Open Data is a question of...

→ Licensing
→ Access
→ Formats
Formats

- Open file format: "a published specification for storing digital data ... which can ... be used and implemented by anyone"
- Machine-readibility counts!
- Examples: rdf, json, ods, xls, pdf, docx
Data vs. Databases
Database

“a collection of independent works, data or other materials arranged in a systematic or methodical way and individually accessible by electronic or other means.”

From: European Database Directive
'Data'

A term with different meanings:

(1) Content of a database → can be anything

(2) Recorded facts (e.g. most catalog records) → aren’t copyrightable, only as collection
Different legal status?

- Legal status of a database and its content may differ
- Example: a collection of public domain content that as a whole is protected by copyright or related rights
Opening up data in 8 steps
1. Decide what data would be most useful to others

- Your library catalogue & holdings?
- Special collection data?
- Circulation data?
- Controlled vocabulary?
- ...

2. Getting willing people together
3. Clarify potential legal problems

- Check your national legislation
- Bought data?
- From which vendors?
- What usage rights & restrictions do contracts give?
4. Export the data
5. Publish data on the web

Index of /download/dumps/DE-605

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<td></td>
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<td>[DIR] zydd/</td>
<td>18-Mar-2013 17:25</td>
<td>-</td>
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</table>
6. Apply an open license

@prefix cc: <http://creativecommons.org/ns#> .

<dataset_URI> cc:license
<http://creativecommons.org/publicdomain/zero/1.0/> .
7. Register your dataset

Open Data from the hbz Union Catalog

Here you find the raw open data of our catalog. We also provide a Linked Open Data Dump at http://thedatahub.org/dataset/lobid-resources. Here are daily updated library metadata dumps from the German hbz Union Catalog of those records which have holdings from libraries who want their data to be open. There are more than 15.5 million records.

The record format is described here. There also is a Linked Data version of the data from all libraries, see http://thedatahub.org/package/lobid-resources

Data and Resources

- **Base dump of the Open Data from the hbz union**
  - every bzip2 file in this directory with "base" in its name is a base dump...

- **The updates of the Open Data from the hbz union**
  - Daily updates

- example of rdfmab
  - this rdfmab example corresponds to http://lobid.org/resource:HT016434307
8. Let others know

March 2010: Releasing catalogue data: Cologne-based libraries to pioneer Open Data practices

Deutsche Version der Mitteilung

Joint statement of the North Rhine-Westphalian Library Service Center, the University and Public Library of Cologne, the University Library of the University of Applied Science of Cologne, the Library of the Academy of Media Arts Cologne and Library Centre of Rhineland-Palatinate.

March 2010: Cologne-based libraries and the Library Centre of Rhineland-Palatinate (LBZ) in cooperation with the North Rhine-Westphalian Library Service Center (hbz) are the first German libraries to adopt the idea of Open Access for bibliographic data. They have released their catalogue data for free public use. The University and Public Library of Cologne (hbz), the Library of the Academy of Media Arts Cologne, the University Library of Public Library of Cologne has announced to follow shortly. The release is

Libraries have been involved with the Open Access movement for a long time. Only few libraries have done so with their own data. Ralf Thiele, deputy director of the library of the University of Cologne, explained the motivation for releasing data. "The library of the University of Cologne is an active member of the Open Access movement," he said. "By releasing our catalogue data, we are contributing to the goal of making scientific information freely accessible to all."

Public data is placed in the public domain

The publication of data enables anybody to download, modify and use it. It is important to stick to the traditional duty of libraries and librarians to provide access to information without barriers. Providing this kind of access had until now been possible.

Cooperation and data exchange between libraries have been firmly established. The cooperation allows libraries to share data and to improve the quality of data. Cooperation with other library networks is expected to be enhanced by cataloging data. The German Wikipedia is an example of data sharing and collaboration.

Data for the Semantic Web

The North Rhine-Westphalian Library Service Center has recently begun to cooperate with the Library of the University of Applied Science of Cologne. The cooperation is expected to be enhanced by cataloging data. The German Wikipedia is an example of data sharing and collaboration.

Further information and links to the published datasets are available at http://www.hbz-nrw.de/kooperation/gebuehrenopen_data.

(Our new website will be launched on Monday, March 15th.)

For further questions contact:

Adrian Pohl
@acka47

The time has come! Cologne-based #libraries & the LBZ in cooperation with the #hbz open up their data:
http://tr.im/RCnV #opendata #CC0

8:16 PM - 12 Mar 10 via TweetDeck - Embed this Tweet
Now: Improve data & interfaces
Your turn!
Agree on an open Creative Commons License within your group and link your document to that license.

(The predicate <http://creativecommons.org/ns#license> is well suited for this link, but searching the Web will reveal alternatives.)
Open licencing

@prefix :     <#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .
@prefix dc:   <http://purl.org/dc/terms/> .

:adrian foaf:givenName "Adrian" .
:adrian foaf:familyName "Pohl" .
:felix foaf:givenName "Felix" .
:felix foaf:familyName "Ostrowski" .

<> dc:creator :felix .
<> dc:creator :adrian .
<> dc:created "25.11.2013" .
<> <http://creativecommons.org/ns#license>
    <http://creativecommons.org/publicdomain/zero/1.0/> .
Linked Data in Action
The Treachery of Documents

Ceci n'est pas la Tour Eiffel.
Identification and description of a resource ought to be distinguished! But in the Linked-Data-Paradigm, both are linked.
The description of a resource can be made available in various formats. Which format will be delivered can be decided by Content-Negotiation.
{  
  "@context": "person.json",
  "@id": "http://ex.org/person/1",
  "name": "Felix",
  "knows": "http://ex.org/person/2"
}

{  
  "@context": "person.json",
  "@id": "http://ex.org/person/2",
  "name": "Adrian",
  "knows": "http://ex.org/person/1"
}
Your turn!
In your description, link yourself to people from other groups that you know. This doesn't have to be reciprocal.

Also, link (approximately) to the place you live or work. Use DBpedia for this.
Scattered machine-readable descriptions are useful, but we can do better than that! RDF is a **distributed** data model that makes it easy to **combine** several descriptions. Furthermore, special **databases** exist that allow to **query** RDF data.
@prefix foaf: <xmlns.com/foaf/0.1/> .
@prefix ex1: <http://ex1.org/> .
@prefix ex2: <http://ex2.org/> .
ex1:adrian foaf:givenName "Adrian" .
ex1:adrian foaf:knows ex2:felix .

@prefix foaf: <xmlns.com/foaf/0.1/> .
@prefix there: <http://ex1.org/> .
@prefix here: <http://ex2.org/> .
here:felix foaf:givenName "Felix" .
here:felix foaf:knows there:adrian .

<http://ex1.org/adrian> <xmlns.com/foaf/0.1/givenName> "Adrian" .
<http://ex2.org/felix> <xmlns.com/foaf/0.1/givenName> "Felix" .
Felix Ostrowski

Graph thinker

Profiles

Facebook  Twitter  Slideshare  Github  Linkedin  Delicious

Activity

Is there something missing in the link? (30. November 2011)

Dead Simple: RDF and SPARQL using PHP (17. Januar 2011)

About me

INTERESTS

Semantisches Web, Informationsarchitektur, Virtuelle Bibliothek, Linked Open Data

Contacts

WORK

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Phone: +49 30 12092041

Network

Knud Möller  Adrian Pohl  Pascal Christoph

Interests

SEMANTISCHES WEB
Triple Stores

http://www.example.org/data/alice

http://de.dbpedia.org/page/Berlin

http://www.example.org/data/carol

http://de.dbpedia.org/page/Köln
SPARQL facilitates queries on the data in a triple store. The foundations for this are simply graph patterns. These look almost like triples, the difference being that they contain variables.
@prefix ex: <http://example.org/people#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .

ex:alice foaf:name "Alice" .

PREFIX ex: <http://example.org/people#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>

SELECT * WHERE {
    ex:alice foaf:name ?name .
}

name
"Alice"
@prefix ex: <http://example.org/people#> .
@prefix foaf: <http://xmlns.com/foaf/0.1/> .

ex:alice foaf:name "Alice" ;
    foaf:knows ex:bob .
ex:bob foaf:name "Bob" ;
    foaf:knows ex:carol .
ex:carol foaf:name "Carol" ;
    foaf:knows ex:alice .

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

SELECT ?name1 ?name2 WHERE {
  ?person1 foaf:knows ?person2 .
  ?person1 foaf:name ?name1 .
}

<table>
<thead>
<tr>
<th>name1</th>
<th>name2</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Alice&quot;</td>
<td>&quot;Bob&quot;</td>
</tr>
<tr>
<td>&quot;Bob&quot;</td>
<td>&quot;Carol&quot;</td>
</tr>
<tr>
<td>&quot;Carol&quot;</td>
<td>&quot;Alice&quot;</td>
</tr>
</tbody>
</table>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>  
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#> 

SELECT ?name ?ortname WHERE { 
  ?person1 foaf:knows ?person2 . 
  ?person2 foaf:name ?name . 
} 

<table>
<thead>
<tr>
<th>name</th>
<th>ortname</th>
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</thead>
<tbody>
<tr>
<td>&quot;Bob&quot;</td>
<td>&quot;Dresden&quot;@de</td>
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</table>
Your turn!
Use SPARQL to analyse your connections. For example you might want to determine who you know directly or indirectly or who comes from the same city as you.
Break
Let's put some **Semantic** in the **Web**

The **classes** and **properties** being used can be using **description languages for vocabularies**. The relatively simple RDF Schema (**RDFS**) is wide spread, but more complex issues can be expressed in the Web Ontology Language (**OWL**).
ex:alice foaf:knows ex:bob
# RDF Schema

foaf:knows rdf:type rdfs:Property ;
    rdfs:range foaf:Person ;
    rdfs:domain foaf:Person .

foaf:Person rdf:type rdfs:Class .

# Explicit triples

ex:bob foaf:knows ex:alice .

# Implicit triple, that follow from the schema

ex:bob rdf:type foaf:Person .
ex:alice rdf:type foaf:Person .
# RDF Schema as a "bridge" across vocabularies

``` reason
ex:colleague rdfs:subPropertyOf foaf:knows ;
  rdfs:domain        ex:Employee ;
  rdfs:range         ex:Employee .
ex:Employee         rdf:type           rdfs:Class ;
  rdfs:subClassOf    foaf:Person .
```

# Explicit triples

``` reason
ex:bob ex:colleague ex:alice .
```

# Implicit triple, that follow from the schema

``` reason
ex:bob   foaf:knows ex:alice .
ex:bob   rdf:type foaf:Person .
ex:alice rdf:type foaf:Person .
ex:bob   rdf:type foaf:Employee .
ex:alice rdf:type foaf:Employee .
```
Your turn!
Create an RDF Schema so that from these assertions
the following triples can be inferred.
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix team: <http://example.org/soccer/vocab#> .

team:player rdf:type rdfs:Property ;
   rdfs:subPropertyOf foaf:member ;
   rdfs:domain foaf:Person ;
   rdfs:range foaf:Group .

team:home rdf:type rdfs:Property ;
            rdfs:domain team:Game .

team:away rdf:type rdfs:Property ;
            rdfs:domain team:Game .

team:Game rdf:type rdfs:Class .
The expressiveness and the possibilities of inference of RDFS and OWL are not always needed.

For controlled vocabularies, the **Simple Knowledge Organization System (SKOS)** is a simpler alternative that is also based on RDF.

The **Dewey Decimal Classification** and the **Library of Congress Subject Headings** have already found their way into the **Linked-Data-world**.
ddc:1

skos:hasTopConcept

"100"

skos:notation

"Philosophie und Psychologie"@de

skos:prefLabel

"Philosophy & psychology"@en

skos:broader

ddc:16

skos:narrower

skos:broader

ddc:161
Elements of Linked (Open) Data

- **Using:** Mashups
  Mashups combine multiple datasets to create a new service, visualisation or information.

- **Using:** Search
  Linked data search engines allow search across the web of data. Conventional search may present information derived from linked data.

- **Using:** Productivity
  Linked data facilitates data integration for business intelligence or research.

- **Storing and publishing**
  Linked data can be published in simple flat files on a web server, in databases with a translation layer, or in specialised 'triples stores' built to store and share linked data. Publishing platforms understand requests for linked data & return it formatted as RDF.

- **Querying:** SPARQL
  SPARQL Protocol and RDF Query Language provides a way to run structured queries over linked data datasets. SPARQL servers expose linked open data to be queried.

- **Representing:** Vocabularies
  Vocabularies provide lists (and definitions) of common terms that can be used to describe the things and relationships in a dataset.

- **Representing:** Ontologies
  Ontologies are vocabularies that record the logical relationships between their terms and support reasoning.

- **Interchanging:** RDF
  Resource Descriptor Framework (RDF) is a model for representing data as 'triples'. RDF can be serialised into a range of different file formats, including RDF-XML and text-based Turtle or N3 syntax.

- **Identifying:** URLs
  Using HTTP Uniform Resource Locators (URLs) means that (a) data can be looked up across the internet; (b) decisions about 'namespaces' for data are managed through the Domain Name System (DNS).

- **Transporting:** HTTP (The World Wide Web)
  Data is hosted on servers that can talk Hypertext Transfer Protocol (HTTP) to each other and to browsers in order to exchange data across the Internet.

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