INF3580 – Semantic Technologies – Spring 2010

Lecture 13: Publishing RDF Data on the Web

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Today's Plan

Outline

RDF on the Web

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  - “Linked Open Data” (LOD)

Outline

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- From the RDF standpoint, all are OK
- In practice, software wants to locate information
  - Protocols like http, ftp, etc. are an advantage

The Problem

- Need to differentiate between:
  - A web page or RDF file about Berlin
  - The city of Berlin
- e.g. the city was "created" around 1200...
- A URI for Berlin should not be an existing HTTP resource (why?)
- Need another way to retrieve information about a resource

$\neq$

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    - The slash-namespace solution (aka HTTP 303 redirects)

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  - The URI cannot denote a *downloadable* resource
- Two W3C-recommended solutions:
  - The hash-namespace solution
  - The slash-namespace solution (aka HTTP 303 redirects)
- To fully understand them, we need to have a look at HTTP!

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  - Send:

    ```
    GET /martingi/ HTTP/1.1
    User-Agent:  Mozilla/5.0 (X11; U; Linux i686; ...
    Accept:  text/html,application/xhtml+xml,...
    Accept-Language:  no, en
    Host:  heim.ifi.uio.no
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- Other “methods”: `HEAD`, `POST`, `PUT`,. . .

HTTP (cont.)

- A typical response to the GET request:

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HTTP/1.1 200 OK
Date:  Wed, 05 May 2010 14:15:24 GMT
Server:  Apache/2.2.14 (Unix) ...
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  - `303 See Other`

Fragment identifiers

- A *fragment identifier* is the part after # in a URI

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- Various uses with JavaScript (AJAX), PDF viewers, etc.

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- This is known as a "hash namespace"

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- Server at `www.oracle.com` responds:

```
HTTP/1.1 200 OK
Content-Type:  text/html
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  - Requests RDF, e.g. `Accept:  application/rdf+xml, text/turtle`
  - Server uses e.g. 303 redirection to an RDF file
- HTML web client:
  - Requests text, e.g. `Accept:  text/html, text/plain`

Content Type Negotiation for RDF

- Given the URI of a non-information resource. . .
  - A semantic web applications wants RDF data, as discussed
  - A regular WWW browser wants HTML, human readable
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- HTML web client:
  - Requests text, e.g. `Accept: text/html, text/plain`
  - Server uses e.g. 303 redirection to an HTML file
- Also possible with hash namespaces, see `http://www.w3.org/TR/swbp-vocab-pub/`

Example: dbpedia.org

- Requesting the URI `http://dbpedia.org/resource/Oslo`

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  - Server returns:

```
HTTP/1.1 303 See Other
Location: http://dbpedia.org/page/Oslo
```

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    ```

  - Client requests `http://dbpedia.org/page/Oslo`

Example: dbpedia.org

- Requesting the URI `http://dbpedia.org/resource/Oslo`
- From an HTML web browser:
  - Sends `Accept: text/html` in request
  - Server returns:

    ```
    HTTP/1.1 303 See Other
    Location: http://dbpedia.org/page/Oslo
    ```

  - Client requests `http://dbpedia.org/page/Oslo`
  - Server sends HTML document:

    ```
    HTTP/1.1 200 OK
    Content-Type: text/html
    ```

Example: dbpedia.org (cont.)

- Requesting the URI `http://dbpedia.org/resource/Oslo`

Example: dbpedia.org (cont.)

- Requesting the URI `http://dbpedia.org/resource/Oslo`
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```
HTTP/1.1 303 See Other
Location:  http://dbpedia.org/data/Oslo.xml
```

Example: dbpedia.org (cont.)

- Requesting the URI `http://dbpedia.org/resource/Oslo`
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    - Sends `Accept: application/rdf+xml` in request
    - Server returns:

      ```
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      Location: http://dbpedia.org/data/Oslo.xml
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Example: dbpedia.org (cont.)

- Requesting the URI `http://dbpedia.org/resource/Oslo`
- From a semantic web browser:
  - Sends `Accept: application/rdf+xml` in request
  - Server returns:

    ```
    HTTP/1.1 303 See Other
    Location: http://dbpedia.org/data/Oslo.xml
    ```

  - Client requests `http://dbpedia.org/data/Oslo.xml`
  - Server sends RDF/XML document:

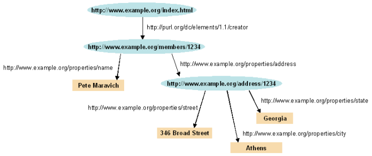
    ```
    HTTP/1.1 200 OK
    Content-Type: application/rdf+xml
    ```

Outline

The Problem

- The HTML web contains lots of human-readable information
- How can clients discover the location of corresponding machine-readable information?

$$\xrightarrow{?}$$


http://www.example.org/index.html
http://purl.org/dc/elements/1.1/creator
http://www.example.org/members/1234
http://www.example.org/properties/name
http://www.example.org/properties/address
Pete Maravich
http://www.example.org/address/1234
http://www.example.org/properties/street
http://www.example.org/properties/state
Georgia
346 Broad Street
http://www.example.org/properties/city
Athens

Embedding RDF/XML in (X)HTML

- First idea: Embed RDF/XML in HTML or XHTML:

```
<html>
  <head>
    <title>My Homepage</title>
    <rdf:RDF>
      <rdf:Description rdf:about="#me">
        <foaf:name>Martin Giese</foaf:name>
        ...
```

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        ...
```

- Not recommended:
- Does not fit HTML or XHTML DTDs
- No satisfactory solution, due to flexible RDF vocabulary
- B.t.w. there *is* a `metadata` element in SVG for this!

HTML LINK elements

- `LINK` occur inside HTML `HEAD` elements

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- relate a document to other documents

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  - (and some more)

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  - `rel` – the kind of relation
  - `type` – the media type of the related document
  - `href` – the URL of the other document
  - `title` – the title of the other document
  - (and some more)
- E.g. a style sheet:

```
<html>
  <head>
    <title>My Homepage</title>
    <link rel="stylesheet" type="text/css" href="style.css">
```

LINKing to RDF

- To link to an RDF representation:

```
<LINK rel="meta"
      type="application/rdf+xml"
      title="RDF/XML version"
      href="http://dbpedia.org/data/Oslo.xml">
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- Also: `rel="alternate"`
  - Note: difference between meta-data and alternative representation
- Various web browser plugins exist to detect these LINKs

HTTP `Link:` response headers

- Non-standardized proposal, originally by Berners-Lee, 1992

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- Same information as in LINK HTML element, but as HTTP header:

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Link: <foaf.rdf>; rel="meta"; type="application/rdf+xml"
```

HTTP `Link:` response headers

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- Generated by a few servers, recognized by a few clients
- Same information as in LINK HTML element, but as HTTP header:

  ```
  Link:  <foaf.rdf>; rel="meta"; type="application/rdf+xml"
  ```
- Advantage: can be sent also with non-HTML data

Outline

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The aim of RDFa is to allow a single RDF graph to be carried in various types of document mark-up.

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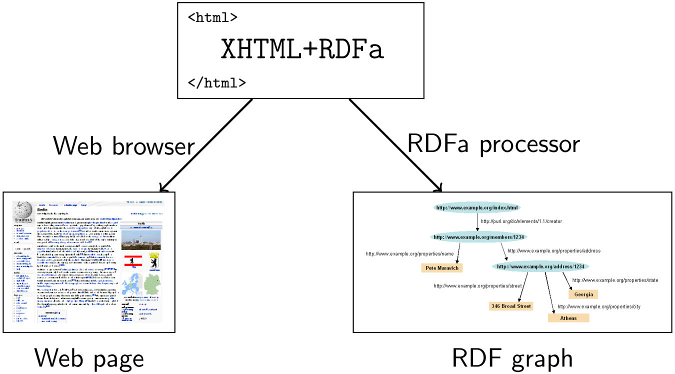
- XHTML in spec., but works with HTML and other XML
- RDFa adds a *fixed* set of attributes to (X)HTML
- Document type:

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML+RDFa 1.0//EN"
    "http://www.w3.org/MarkUp/DTD/xhtml-rdfa-1.dtd">
```

RDFa Processing

- Web browsers ignore RDFa attributes
- RDFa processors extract a *single* RDF graph from a document


<html>
XHTML+RDFa
</html>
Web browser
RDFa processor
Berlin
http://www.example.org/index.html
http://purl.org/dc/elements/1.1/creator
http://www.example.org/members/1234
http://www.example.org/properties/name
http://www.example.org/properties/address
Pete Maravich
http://www.example.org/address/1234
http://www.example.org/properties/state
http://www.example.org/properties/street
Georgia
346 Broad Street
http://www.example.org/properties/city
Athens
Web page
RDF graph

RDFa Concepts

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RDFa Concepts

- RDFa adds semantic annotations to
    - hyper-links (`href`)
    - textual content
- RDFa attributes can appear in (almost) any element
- As the XHTML is processed, there is always a “current subject” that generated triples refer to
- The current subject starts as the base URI of the document, but can change on the way

Reminder: (X)HTML Meta and Link

- Links and metadata in HTML header:

```
<html xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <title>Page 507</title>
    <meta name="author" content="Sigrid Undset" />
    <link rel="prev" href="page506.html" />
    <link rel="next" href="page508.html" />
  </head>
  <body>...</body>
</html>
```

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- Meaning of `name` and `rel` informal

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  </head>
  <body>...</body>
</html>
```

- Meaning of `name` and `rel` informal
- Only a few values defined by the standard

RDFa `property` and `rel`

- “semantic” `meta` and `link` in RDFa:

```
<html xmlns="http://www.w3.org/1999/xhtml"
      xmlns:foaf="http://xmlns.com/foaf/0.1/"
      xmlns:dc="http://purl.org/dc/elements/1.1/">
  <head>
    <title>MG’s home page</title>
    <meta property="dc:creator" content="Martin Giese" />
    <link rel="foaf:topic" href="foaf.rdf#me" />
  </head>
  <body>...</body>
</html>
```

RDFa `property` and `rel`

- "semantic" `meta` and `link` in RDFa:

```
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  </head>
  <body>...</body>
</html>
```

- Extracted triples: (`<>` is base URI!)

```
<> dc:creator "Martin Giese" .
<> foaf:topic <foaf.rdf#me> .
```

Attribute `rel` on `A` elements

- Any hyper-link can be given a “meaning”:

```
This document is licensed under a
<a xmlns:cc="http://creativecommons.org/ns#"
   rel="cc:license"
   href="http://creativecommons.org/licenses/by-nc-nd/3.0/">
  Creative Commons License
</a>.
```

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   rel="cc:license"
   href="http://creativecommons.org/licenses/by-nc-nd/3.0/">
  Creative Commons License
</a>.
```

- Extracted triple:

```
  <> cc:license <http://creativecommons.org/.../3.0/> .
```

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```
This document is licensed under a
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   rel="cc:license"
   href="http://creativecommons.org/licenses/by-nc-nd/3.0/">
  Creative Commons License
</a>.
```

- Extracted triple:

```
  <> cc:license <http://creativecommons.org/.../3.0/> .
```

- Can use `rev` instead of `rel` to swap subject and object

The property attribute

- rel is for resource objects, property for literal objects:

```
<html xmlns="http://www.w3.org/1999/xhtml"
      xmlns:dc="http://purl.org/dc/elements/1.1/">
  <head>...</head>
  <body>
    <h1 property="dc:title">Kransen</h1>
    Written in <span property="dc:created">1920</span>
  </body>
</html>
```

The `property` attribute

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  <head>...</head>
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    Written in <span property="dc:created">1920</span>
  </body>
</html>
```

- Extracted triples:

```
  <> dc:title "Kransen" ; dc:created "1920" .
```

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- `rel` is for resource objects, `property` for literal objects:

```
<html xmlns="http://www.w3.org/1999/xhtml"
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  <body>
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    Written in <span property="dc:created">1920</span>
  </body>
</html>
```

- Extracted triples:

```
  <> dc:title "Kransen" ; dc:created "1920" .
```

- Can also use `content` attribute together with `property`:

```
<span property="dc:created" datatype="xsd:dateTime"
      content="2007-09-16T16:00:00-05:00">
  September 16th at 4pm
</span>
```

Changing the Subject

- about changes subject of contained rel and property annotations:

```
<div about="http://.../foaf.rdf#me"
     xmlns:foaf="http://xmlns.com/foaf/0.1/">
  <p property="foaf:name">Martin Giese</p>
  <p> Email:
    <a rel="foaf:mbox" href="mailto:mg@mail.no">
      mg@mail.no</a></p>
  <p> Phone:
    <a rel="foaf:phone" href="tel:+47-31415926">
      31 41 59 26</a></p>
</div>
```

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```
<div about="http://.../foaf.rdf#me"
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      31 41 59 26</a></p>
</div>
```

- Extracted triples:

```
<http://.../foaf.rdf#me> foaf:name "Martin Giese" ;
                         foaf:mbox <mailto:mg@mail.no> ;
                         foaf:name <tel:+47-31415926> .
```

Types and Blank Nodes

- `typeof` adds an `rdf:type` triple

Types and Blank Nodes

- `typeof` adds an `rdf:type` triple
- Missing URIs can lead to blank nodes:

```
<div typeof="foaf:Person"
     xmlns:foaf="http://xmlns.com/foaf/0.1/">
  <p property="foaf:name">Martin Giese</p>
  <p> Email:
    <a rel="foaf:mbox" href="mailto:mg@mail.no">
      mg@mail.no</a></p>
</div>
```

Types and Blank Nodes

- `typeof` adds an `rdf:type` triple
- Missing URIs can lead to blank nodes:

```
<div typeof="foaf:Person"
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  <p property="foaf:name">Martin Giese</p>
  <p> Email:
    <a rel="foaf:mbox" href="mailto:mg@mail.no">
     mg@mail.no</a></p>
</div>
```

- Extracted triples:

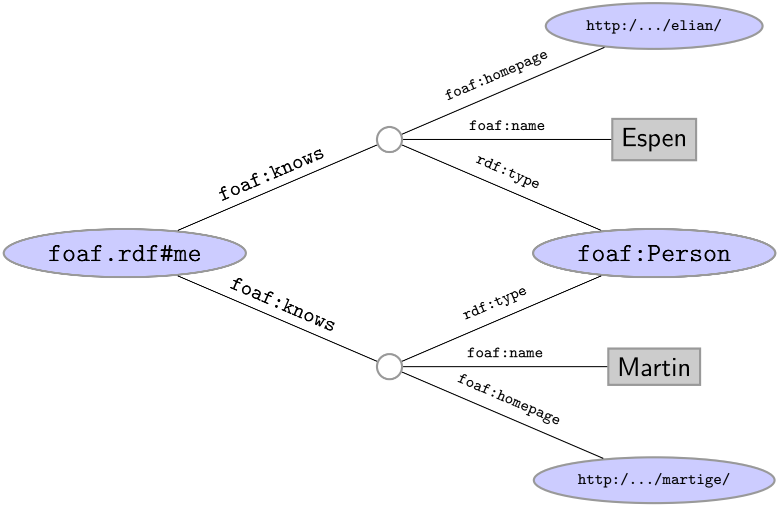
```
  [] a foaf:Person ;
     foaf:name "Martin Giese" ;
     foaf:mbox <mailto:mg@mail.no> ;
```

Know Your Friends

- Missing objects collected from contained elements (chaining):

```
<div xmlns:foaf="http://xmlns.com/foaf/0.1/"
     about="foaf.rdf#me" rel="foaf:knows">
  <ul>
    <li typeof="foaf:Person">
      <a property="foaf:name" rel="foaf:homepage"
         href="http://heim.ifi.uio.no/elian/">Espen</a>
    </li>
    <li typeof="foaf:Person">
      <a property="foaf:name" rel="foaf:homepage"
         href="http://heim.ifi.uio.no/martige/">Martin</a>
    </li>
  </ul>
</div>
```

Triples From Chaining Example



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- Can be convenient to have information in one place

Next Lecture

- How to publish a relational DB as RDF with D2R
- Maybe Ontology-based Data Access