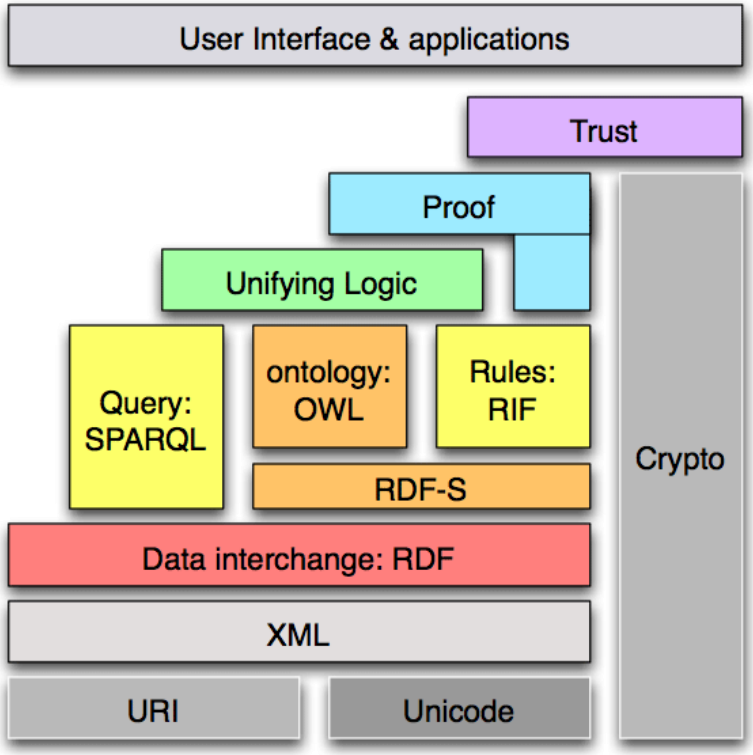
RDF and SPARQL

… with acknowledgements to the W3C's RDF primer, to SPARQL By Example, and to Wolfgang Kienreich for slides from year 2012

Semantic Web Stack revisited



RDF – Resource Description Framework

RDF is a language for making statements about resources

What resources?

RDF was created to make statements about resources in the WWW. Resources then are web pages or web documents.

By generalising what is a “web resource”, RDF can be used to make statements about things that are identified by a “web resource”, such as real persons, real enterprises, etc.

Resources are identified by URIs

Example from http://www.w3.org/TR/rdf-primer/#intro

Kinds of resources in RDF

Individuals (entities)

Kinds of things (classes, entity types)

Properties (relationships)

Data Values

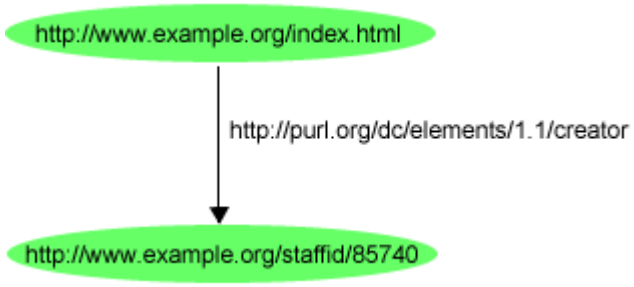
Example from http://www.w3.org/TR/rdf-primer/#intro

RDF as a labelled directed graph

Nodes and edges are labelled by URIs

Statements are triples

- start node – edge – end node
- In RDF-speak: subject – predicate – object



Picture taken from : http://www.w3.org/TR/rdf-primer/#rdfmodel

Subject: http://www.example.org/index.html

Predicate: http://purl.org/dc/elements/1.1/creator

Object: http://www.example.org/staffid/85740

QName shorthand for RDF

RDF statement:

<http://www.example.org/index.html> <http://purl.org/dc/elements/1.1/creator> <http://www.example.org/staffid/85740> .

QName for URI: Prefix:localName

Often-used prefixes are:

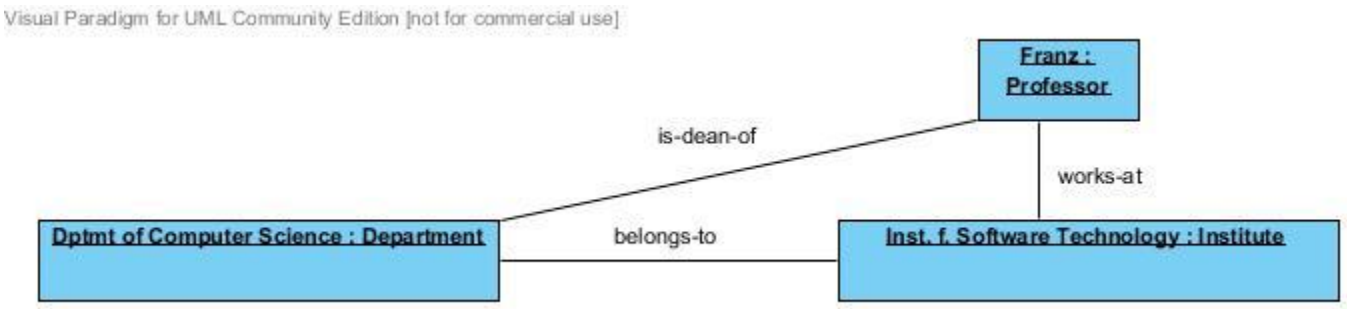
prefix rdf:, namespace URI: http://www.w3.org/1999/02/22-rdf-syntax-ns#
prefix rdfs:, namespace URI: http://www.w3.org/2000/01/rdf-schema#
prefix dc:, namespace URI: http://purl.org/dc/elements/1.1/
prefix owl:, namespace URI: http://www.w3.org/2002/07/owl#
prefix ex:, namespace URI: http://www.example.org/ (or http://www.example.com/)
prefix xsd:, namespace URI: http://www.w3.org/2001/XMLSchema#

QName statement:

Ex:index.html dc:creator http://www.example.org/staffid/85470 .

Example: Transform ER model into RDF

Franz works at the Institute of Software Technology, which belongs to the Dptmt of Computer Science, and Franz is also dean of the Dptmt of Computer Science.



Step 1

Make resources out of entities and entity tpyes

Franz: http://kti.tugraz.at/examples/Franz
IST: http://kti.tugraz.at/examples/IST
Dptmt. of CS: http://kti.tugraz.at/examples/CS
Works-At: http://kti.tugraz.at/examples/works-at
Belongs-to: http://kti.tugraz.at/examples/belongs-to
Is-dean-of: http://kti.tugraz.at/examples/is-dean-of

Could I have used the URLs of the websites of Franz, IST, Dtpmt of CS as resource identifiers?

YES

Step 2

Translate binary relationships between entities into RDF triples

Prefix: ex:, namespace URI http://kti.tugraz.at/examples/

ex:Franz ex:works-at ex:IST .

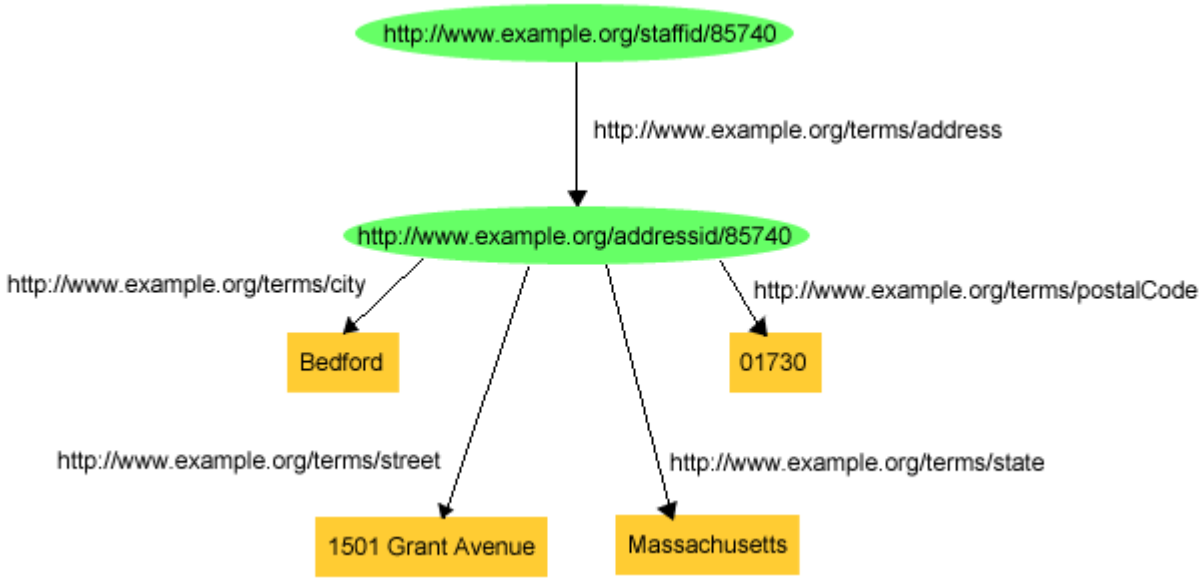
ex:Franz ex:is-dean-of ex:CS .

ex:IST ex:belongs-to ex:CS .

Beyond triples…

Triples represent binary relationships.

For n-ary relationships, nodes must be created that „collect“ the n relationships:

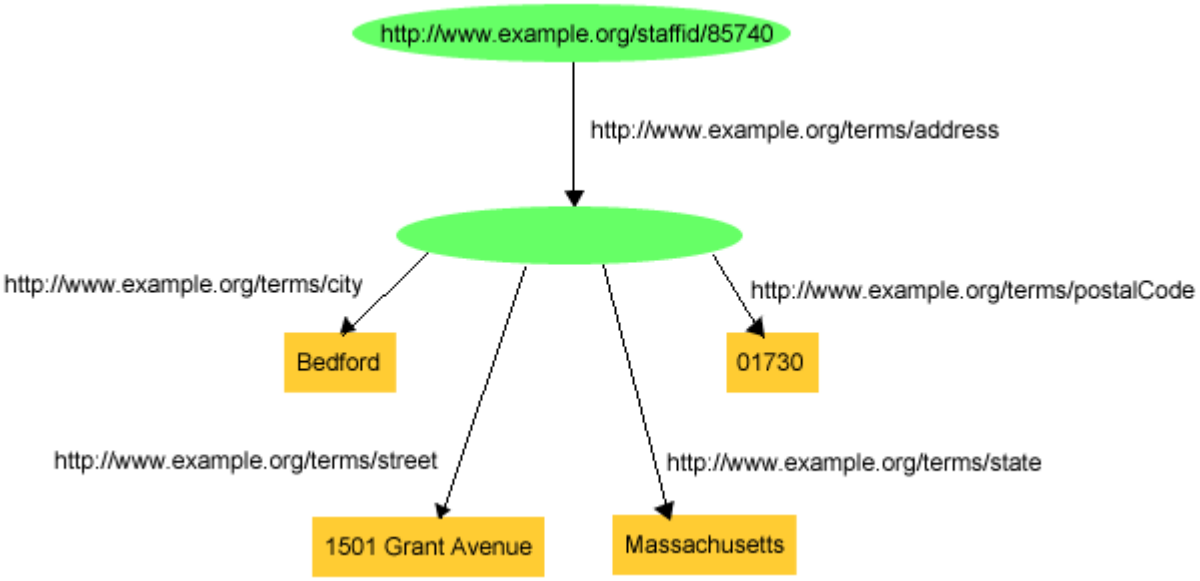


Picture taken from: http://www.w3.org/TR/rdf-primer/#structuredproperties

Triples for example from previous slide

exstaff:85740 exterms:address exaddressid:85740 .
exaddressid:85740 exterms:street "1501 Grant Avenue" .
exaddressid:85740 exterms:city "Bedford" .
exaddressid:85740 exterms:state "Massachusetts" .
exaddressid:85740 exterms:postalCode "01730" .

… lie blank nodes



Picture taken from: http://www.w3.org/TR/rdf-primer/#structuredproperties

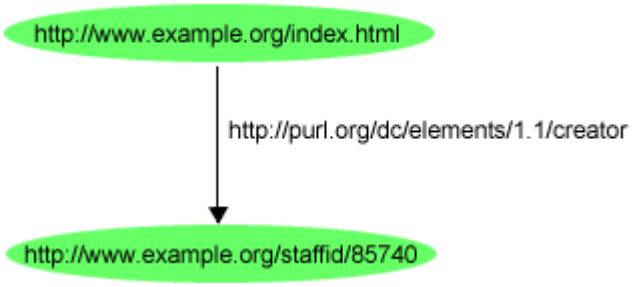
Triples for example from previous slide

exstaff:85740 exterms:address _:johnaddress .
_:johnaddress exterms:street "1501 Grant Avenue" .
_:johnaddress exterms:city "Bedford" .
_:johnaddress exterms:state "Massachusetts" .
_:johnaddress exterms:postalCode "01730" .

RDF/XML Syntax

RDF‘s conceptual model is a graph. The language itself does not depend on a particular syntax.

BUT: RDF/XML is the normative syntax for writing RDF.




```
<?xml version="1.0"?>
<rdf:RDF

xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:ex="http://www.example.org/"
xmlns:dc="http://purl.org/dc/elements/1.1/">

<rdf:Description rdf:about="http://www.example.org/index.html">

<dc:creator
rdf:resource="http://www.example.org/staffid/85740"/>

</rdf:Description>


</rdf:RDF>
```

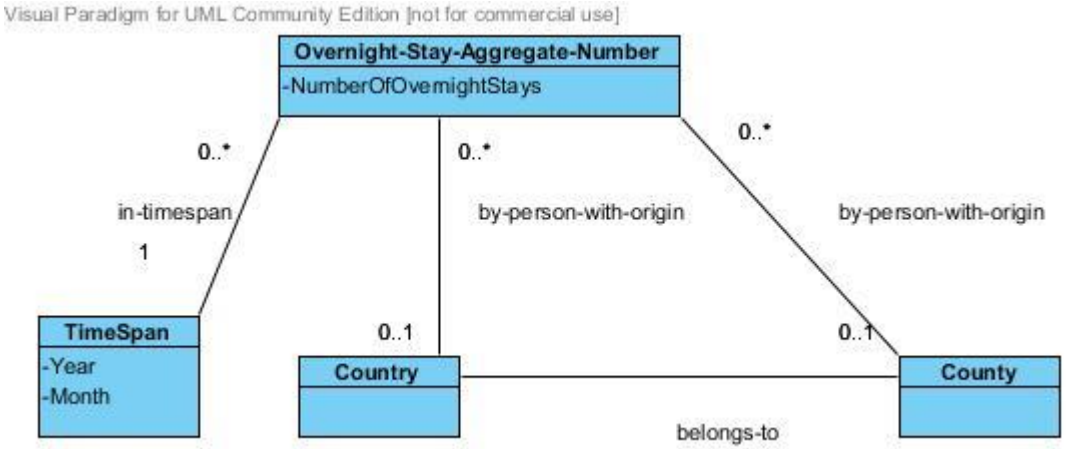
RDF in relation to ER

- RDF can express statements about entities
  - Provides only „rdf:type“ to state something like entity types
- RDF can express relationships and attributes

Exercise 1

Jahr	Monat	Herkunftsland	Naechtigungen
2012	1	Arabische Länder in Asien	74
2012	**1**	**Australien**	**188**
2012	1	Baden-Württemberg	1158
2012	1	Bayern	2699
2012	1	Belgien	180
…	…	…	…

„Triplify“ the highlighted row using the ER model below.



Exercise 2

1. Express in valid RDF/XML (use the W3C RDF Validator to check your RDF/XML):
   „Viktoria works at the Knowledge Technologies Institute of Graz Univ. of Technology, and her full name is Viktoria Pammer-Schindler.“

2. Which triples are expressed by the following RDF/XML?

```
<?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:editor>
  </rdf:Description>
</rdf:RDF>
```

SPARQL – Query Language for RDF

SPARQL Endpoints accept queries and return results via HTTP

Result formats

- XML
- JSON
- CSV
- RDF

SPARQL 1.0 and 1.1

SPARQL 1.0

- SPARQL 1.0 Query Language
- SPARQL 1.0 Protocol (for sending queries over HTTP)

SPARQL 1.1

- 1.1 Versions of SPARQL Query (W3C Document) and Protocol
- SPARQL 1.1 Update (for inserting, deleting, modifying RDF data)
- SPARQL 1.1 Service Descriptons (how to describe capabilities of SPARQL Endpoints)
- SPARQL 1.1 Entailments (how to combine reasoning with SPARQL)

SPARQL Query Structure

A SPARQL query comprises, in order:

Prefix declarations for abbreviating URIs (PREFIX)

Dataset definition, stating what RDF graph(s) are being queried (FROM)

A **result clause**, identifying what information to return from the query (SELECT)

The **query pattern**, specifying what to query for in the underlying dataset (WHERE)

Query modifiers, slicing, ordering, and otherwise rearranging query results (ORDER BY, LIMIT, …)

SPARQL Query Structure

```
# prefixes
PREFIX kti: <http://kti.com/res/>
...
# results clause
SELECT ...
# datasets
FROM ...
# query pattern
WHERE
# query modifiers
ORDER BY ...
```

Example: Exploring DBPedia

http://dbpedia-live.openlinksw.com/sparql

```
# prefixes already defined
# see "namespace prefixes" at endpoint
# website

# datasets already defined
# implicit from dbpedia.org

# get me some triples
SELECT * WHERE { ?s ?p ?o } LIMIT 20
```

The result set is limitd to 20 results.

SELECT * is an abbreviation that selects all of the variables in a query. “SELECT ?s ?p ?o” is equivalent to “SELECT *” in this example query

Variables are prefixed by „?“ or „$“.

Pattern Matching

„a“ is shorthand for „rdf:type“ – try this in dbpedia SPARQL Endpoint!

```
# List rdfs:classes
SELECT DISTINCT ?o WHERE { ?s a ?o } LIMIT 20

# What about the unbound ?s
SELECT DISTINCT ?o WHERE { [] a ?o } LIMIT 20

# Select along multiple triples
SELECT DISTINCT * WHERE { [] a ?o .
                          ?o rdfs:label ?label }
                        LIMIT 20
```

SELECT returns all triples in the chosen dataset that match the triple pattern

Triple patterns are like triples, except they contain variables.

Dataset Selection

In generic SPARQL Endpoints the dataset is not predefined.

```
PREFIX …
SELECT *
FROM <http://www.w3.org/2002/07/owl.rdf>
WHERE {
      …
}
```

Modify Solution Sequence

ORDER BY put the solutions in order

DISTINCT: ensure solutions in the sequence are unique

LIMIT: restrict the number of solutions

```
select distinct  *
where {
[] a ?Concept .
?Concept rdfs:label ?label
}
ORDER BY ASC(?label)
LIMIT 20
```

Other queries

ASK returns true if the query has a solution; else false

Try at SPARQLer

```
ASK FROM
<http://dig.csail.mit.edu/2008/webdav/timbl/foaf.rdf>
{?x a <http://xmlns.com/foaf/0.1/Person>}
```

DESCRIBE returns an RDF graph with data about all resources that match

Try at DBPEDIA Virtuoso Endpoint

```
DESCRIBE
<http://dbpedia.org/resource/Leonardo_da_Vinci>

DESCRIBE ?x WHERE {?x rdf:type
<http://dbpedia.org/ontology/Artist> } LIMIT 20
```

CONSTRUCT returns an RDF graph (triples)

Exercise 3

1. Find me all the people in Tim Berners-Lee's FOAF file (http://dig.csail.mit.edu/2008/webdav/timbl/foaf.rdf) that have names and email addresses. Return each person's URI, name, and email address.
   Hint: Use Redland Rasqal Demo to test your query.
2. Find out everything about http://dbpedia.org/resource/Marie_Curie in DBPEDIA. Hint: Use the DBPEDIA Snorql Explorer to test your queries.
3. Find out all statements that describe http://dbpedia.org/resource/Marie_Curie (as subject).

RDF and SPARQL Tools

RDF Gravity to visualise RDF graphs

W3C RDF Validator

RDF Validator and Converter

Generic SPARQL Endpoint:

- Redland Rasqal Demo
- SPARQLer
- Yasgui

DBPEDIA SPARQL Endpoint:

- SNORQL Explorer
- Virtuoso Endpoint