Overview of semantic web standards and software

ESTP course on Introduction to Linked Open Data

Prof. Eero Hyvönen
University of Helsinki and Aalto University
Helsinki, Finland
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Later version of the cake model
Contents

• Data model standard: **RDF** and **RDF Schema**
• Query language standard: **SPARQL**
• Ontology standards: **SKOS** and **OWL**
• Rule standards
• Publishing “standards” for RDF: Linked Data model
• Some software tools
DATA MODEL STANDARD: RDF AND RDF SCHEMA
Things are identified by IRIs

URL: Uniform Resource Locator
- http://www.aalto.fi/fi/research/
- http://www.ask.com/web?qsrc=1&o=0&l=dir&q=Capital+of+Finland&qo=serpSearchTopBox
- http://urn.fi/urn:isbn:978-952-10-4171-6

URN: Uniform Resource Name
- urn:isbn:978-952-10-4171-6

URI: Uniform Resource Identifier
- http://dbpedia.org/resource/Helsinki

IRI: Internationalized Resource Identifier
Use HTTP URIs for identifying things:
They contain ID + URL for info!
Triples:

Predicates connect **resources** and **literals**
Example

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix dc: <http://purl.org/dc/elements/1.1/> .
@prefix wgs: <http://www.w3.org/2003/01/geo/wgs84_pos#> .
@prefix : <http://paikat.fi> .

:p7 rdfs:label "Helsinki" ;
   dc:location [ 
      rdf:type :Point;
      wgs:lat 25.1222;
      wgs:long 68.2344
   ] .
```

Namespaces:
- rdf: http://www.w3.org/1999/02/22-rdf-syntax-ns#
- rdfs: http://www.w3.org/2000/01/rdf-schema#
- dc: http://purl.org/dc/elements/1.1/
- wgs: http://www.w3.org/2003/01/geo/wgs84_pos#
- http://paikat.fi
RDF graph (knowledge graph)

RDF graph = set of triples (statements)
- \(<\text{start node, arc, end node}>\) i.e. \(<\text{subject, predicate, object}>\)

Multiple graphs can be merged with the union operation of set theory
- Cf. How to combine two XML documents!
RDF graph(s) as set(s) of triples

G =

{<:r1, dc:author, "Väinö Linna">,
 <:r1, rdf:type, :Romaani>,
 <:r1, dc:title, "Tuntematon sotilas"@fi>,
 <:r2, dc:author, "Väinö Linna">,
 <:r2, rdf:type, :Romaani>,
 <:r2, dc:title, "Täällä Pohjantähden alla"@fi>}

romaani (Finnish) = novel
Semantic Web combines graphs: Web of Data
• **Information is often available as tables in relational databases or CSV files**

• **RDF is a set of triples**
  – n-ary information can be represented as triples

• **RDF is a data model: directed named graph**

**RDF data model and relational databases**
RDF SCHEMA
Why **RDF Schema**?

Introducing **classes** and **individuals** (instances)
A class is a set of individuals
- E.g., John and Mary are individuals of class Person

Introducing **constraints on using properties**
Domain constraint: only certain classes of individuals can have certain properties
- **E.g., only persons have a social security number**
  Range constraint: certain properties may have value of a certain class only
  - **E.g., a person’s parent must be a person, too**

Introducing **class and property hierarchies**
Introducing **semantics** for validating data and for reasoning
RDFS Example

Figure 3.4. An RDF-Schema Example

(Maedche, 2002)
Semantics based on inference rules

Semantics in first-order logic
- Rules for adding RDF triples
- Sound and complete inference system

Rule form

**IF**  
KB contains certain triples  
**THEN**  
add to KB certain additional triples

where **KB** is a set of RDF triples (= Knowledge Base)
Examples of inference rules

IF E contains the triple (?x, ?p, ?y) THEN E also contains (?p, rdf:type, rdf:Property)

IF E contains the triples (?u, rdfs:subClassOf, ?v) and (?v, rdfs:subclassOf, ?w) THEN E also contains the triple (?u, rdfs:subClassOf, ?w)

IF E contains the triples (?x, rdf:type, ?u) and (?u, rdfs:subClassOf, ?v) THEN E also contains the triple (?x, rdf:type, ?v)

IF E contains the triples (?x, ?p, ?y) and (?p, rdfs:range, ?u) THEN E also contains the triple (?y, rdf:type, ?u)
RDF Schema 1.1
W3C Recommendation 25 February 2014

This version:
http://www.w3.org/TR/2014/REC-rdf-schema-20140225/

Latest published version:
http://www.w3.org/TR/rdf-schema/

Previous version:
http://www.w3.org/TR/2014/PER-rdf-schema-20140109/

Editors:
Dan Brickley, Google
R.V. Guha, Google

Previous Editors:
Brian McBride

Please check the errata for any errors or issues reported since publication.

This document is also available in this non-normative format: diff w.r.t. 2004 Recommendation

The English version of this specification is the only normative version. Non-normative translations may also be available.


Abstract

RDF Schema provides a data-modelling vocabulary for RDF data. RDF Schema is an extension of the basic RDF vocabulary.

Status of This Document

This section describes the status of this document at the time of its publication. Other documents may supersede this document.
QUERY LANGUAGE STANDARD: SPARQL
SPARQL Protocol and RDF Query Language “sparkle”
Inspired by SQL for relational databases

Example of SELECT query

PREFIX ns: <http://www.domain.com/namespace/>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
SELECT ?field ?length ?width
WHERE {
  ?field rdf:type ns:Field ;
  ns:length ?length ;
  ns:width ?width .
}
ORDER BY ASC(xsd:decimal(?length) * xsd:decimal(?width))

Results are ordered by their area in an ascending order
SPARQL query (+basic update) forms

Querying and using data

SELECT
- *Presented on previous slide*

CONSTRUCT
- *Returns an RDF graph specified by a graph template*

ASK
- *Test whether a query pattern has answers*

DESCRIBE
- *Returns RDF descriptions of the resources found*

Graph maintenance

INSERT adds new triples into an RDF graph
DELETE removes triples from an RDF graph
ONTOLOGY STANDARDS: SKOS AND OWL
SKOS ontology: Representing vocabularies in RDF

(SKOS Core Guide, 2005)
SKOS Simple Knowledge Organization System Reference

W3C Recommendation 18 August 2009

This version:  
http://www.w3.org/TR/2009/REC-skos-reference-20090818/

Latest version:  
http://www.w3.org/TR/skos-reference

Previous versions:  
http://www.w3.org/TR/2009/PR-skos-reference-20090615/

Editors:  
Alistair Miles, STFC Rutherford Appleton Laboratory / University of Oxford  
Sean Bechhofer, University of Manchester

Please refer to the errata for this document, which may include some normative corrections.

See also translations.

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OWL Web Ontology Language: more expressive power & reasoning!

RDF(S) semantics is limited
- Class membership (instance-class relations)
- Class and property hierarchies
- Domain and range of properties

OWL 2 introduces lots of features, e.g.
- Equivalence (classes) & Equality (individuals)
- Disjointness (classes) & Difference (individuals)
- Boolean combination of classes
- Local scope of properties
- Special relational characteristics of properties
- Cardinality of properties
Key idea: enriching ontology by reasoning
OWL 2 profiles

Problem: balancing efficiency vs. expressive power

OWL 2 includes three profiles for different use cases

- OWL 2 EL
- OWL 2 QL
- OWL 2 RL
RULE STANDARDS
Rules: Enriching data by reasoning

Reasoning (new triples)
Many different approaches to using rules

Rule formats
RuleML, Rule Interchange Format (RIF), ...

Logic programming using RDF data
E.g., SWI Prolog

OWL RL
Rule-based implementation of OWL is possible
Mixing rules and OWL

Semantic Web Rule Language SWRL
Certain kind of rich rules can be used in OWL DL

SPARQL-based rules
SPARQL Construct query -> generates triples
SPARQL Inference Notation SPIN
Logics of the Semantic Web

HLP = FOL & LP
DLP = DL & HLP

(Antoniou, van Harmelen, 2007)
PUBLISHING "STANDARD" FOR RDF: LINKED DATA MODEL
Web of Data = WWW + GGG

WWW = Web of Pages (for humans)
- Search/browse with a web browser
- Links connect pages

GGG = Giant Global Graph = Web of Data (for machines)
- Search/browse with a semantic web application
- Links connect data (e.g., parrot → bird)
WWW and GGG coexistence

WWW

GGG

(Anja Jentzsch, 2012)
Web of Data: content publishing

Embedded RDF in web pages
- Microdata
- RDFa

RDF data services
- Passive: RDF files
- Active: SPARQL endpoints
Microdata

Extension of the HTML5 specification

- Primitives for information representation in HTML
- Simpler model compared to the Semantic Web standards (e.g., no URIs)

http://schema.org

- Schemas for structured data mark-up on web
- Google, Yahoo, Microsoft
- Launched in June 2011
Schema.org ontology

**Thing**: description, image, name, url

**CreativeWork**: about, accountablePerson, aggregatesRating, alternativeHeadline, associatedMedia, audio, author, awards, comment, contentLocation, contentRating, contributor, copyrightHolder, copyrightYear, creator, dateCreated, dateModified, datePublished, discussionUrl, editor, encodings, genre, headline, inLanguage, interactionCount, isFamilyFriendly, keywords, mentions, offers, provider, publisher, publishingPrinciples, reviews, sourceOrganization, thumbnailUrl, version, video

**Article**: articleBody, articleSection, wordCount

**BlogPosting**:
- **NewsArticle**: dateline, printColumn, printEdition, printPage, printSection
- **ScholarlyArticle**

**Blog**: blogPosts


**ItemList**: itemListElement, itemListOrder

**Map**

**MediaObject**: associatedArticle, bitrate, contentSize, contentUrl, duration, embedUrl, encodesCreativeWork, encodingFormat, expires, height, interactionCount, offers, playerType, regionsAllowed, requiresSubscription, uploadDate, width

**AudioObject**: transcript

**ImageObject**: caption, exifData, representativeOfPage, thumbnail

**MusicVideoObject**

**VideoObject**: caption, productionCompany, thumbnail, transcript, videoFrameSize, videoQuality

**Movie**: actors, director, duration, musicBy, producer, productionCompany, trailer

**MusicPlaylist**: numTracks, tracks

**MusicAlbum**: byArtist

**MusicRecording**: byArtist, duration, inAlbum, inPlaylist

**Painting**

**Photograph**

**Recipe**: cookTime, cookingMethod, ingredients, nutrition, prepTime, recipeCategory, recipeCuisine, recipeInstructions, recipeYield, totalTime

**Review**: itemReviewed, reviewBody, reviewRating

**Sculpture**

**TVEpisode**: actors, director, episodeNumber, musicBy, partOfSeason, partOfTVSeries, producer, productionCompany, trailer

**TVSeason**: endDate, episodes, numberOfEpisodes, partOfTVSeries, seasonNumber, startDate, trailer

**TVSeries**: actors, director, endDate, episodes, musicBy, numberOfEpisodes, producer, productionCompany, seasons, startDate, trailer

**WebPage**: breadcrumb, isPartOf, mainContOfPage, primaryImageOfPage, significantLinks
Example: Microdata

```html
<section itemscope itemtype="http://data-vocabulary.org/Person">
  Hello, my name is
  <span itemprop="name">John Doe</span>,
  I am a
  <span itemprop="title">graduate research assistant</span> at the
  <span itemprop="affiliation">University of Dreams</span>.
  My friends call me
  <span itemprop="nickname">Johnny</span>.
  You can visit my homepage at
  I live at
  <span itemprop="street-address">1234 Peach Drive</span>,
  <span itemprop="locality">Warner Robins</span>,
  <span itemprop="region">Georgia</span>.
</section>
```
RDFa

W3C’s way to embed semantic data in HTML
Schema.org supports RDFa, too
- *RDF data can be embedded also as JSON-LD*

Open Graph Protocol (OGP)
- **Significant user of RDFa**
- **Used in Facebook**

Already in 2012 25% web pages contained RDFa (Mika, Potter, 2012)
Example: Open Graph Protocol RDFa

```html
<html prefix="og: http://ogp.me/ns#">
<head>
<title>The Rock (1996)</title>
<meta property="og:title" content="The Rock"/>
<meta property="og:type" content="video.movie"/>
<meta property="og:url" content="http://www.imdb.com/title/tt0117500/"/>
<meta property="og:image" content="http://ia.media-imdb.com/images/rock.jpg"/>
...
</head>
...
</html>
```
Linked Open Data Story so Far: Starting 2005

(Tim Berners-Lee)
More datasets...

(Tim Berners-Lee)
Eurostat

Linked Open Data cloud 2010

(http://linkeddata.org, 2010)
Linked Open Data (LOD) Cloud in 2017

Eurostat

http://linkeddata.org
Knowledge Graph utilized by Google
“Linked Data principles” (Tim Berners-Lee)

1. Use URIs as names for things
2. Use HTTP URIs, so that people can look up those names
3. When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL)
4. Include links to other URIs, so that they can discover more things
How to publish Linked Data: 5-star model

- ★ make your stuff available on the Web (whatever format) under an open license
- ★★ make it available as structured data (e.g., Excel instead of image scan of a table)
- ★★★ make it available in a non-proprietary open format (e.g., CSV as well as of Excel)
- ★★★★ use URIs to denote things, so that people can point at your stuff
- ★★★★★ link your data to other data to provide context

(Tim Berners-Lee)  
http://5stardata.info
Our "7-star" model and LDF.fi data hotel

7-star Linked Data Service

However, in our opinion, providing 5-star Linked Data is just the beginning. To actually make use of the datasets, consumers need more support in getting to know and access them, as well as a better grasp of their quality and provenance. To this end, we extend the model with two additional stars:

★★★★★★ Provide your data with a schema and documentation so that people can understand and re-use your data easily.
★★★★★★★ Validate your data and denote its provenance so that people can trust the quality of your data.

This added support should come with as little extra work as possible to the data publisher. Our hypothesis is that a lot of this can be done automatically, basing on the Linked Data core. A data publisher needs only to provide their data in the RDF format, and the LDF.fi portal will do the rest automatically. See the overview paper (in ESWC 2014 Proceedings, Springer-Verlag) for some more details about the underlying ideas.
Linked Data interfaces and APIs

Human application interface. Ordinary browsing/searching of application HTML pages

Reading RDF data of a URI. Based on URI dereferencing

Linked Data browsing. Linked Data browser interface based on URI dereferencing

- Browsing based on RDF properties, rendered in HTML
- Using LD browsers for the Web of Data
  - E.g., http://uriburner.com/

Download. Downloading the data as an RDF data dump

SPARQL endpoint. For querying the data in a standard way for, e.g., mash-up applications
Developers View to Linked Data: Rich Internet Applications (RIA)

Linked Data Service
W3C Standard Model

SPARQL End Point

Application 1

Application 2

Application N

Client Side
(Browser)

Server Side
EXAMPLE: DBPEDIA.ORG
WIKIPEDIAS IN RDF

10 billion triples
DBpedia.org URI model

Using several URIs

- a URI for the real-world object itself
- a URI for a related information resource that describes the real-world object and has an HTML representation
- a URI for a related information resource that describes the real-world object and has an RDF representation

Example:
- [http://dbpedia.org/resource/Helsinki](http://dbpedia.org/resource/Helsinki) # Object
- [http://dbpedia.org/page/Helsinki](http://dbpedia.org/page/Helsinki) # HTML page
- [http://dbpedia.org/data/Helsinki](http://dbpedia.org/data/Helsinki) # RDF data
Example: identifying events in DBpedia

How to represent the "Battle of Albert" in WWI

What language to use?
- *Bataille d’Albert?* (fr)
- *Albertin taistelu?* (fi)

Which battle?

- **Battle of Albert (1914) (25–29 September 1914)**
  • encounter battle during the Race to the Sea
  • opening phase of the Battle of the Somme, 1916
- **Battle of Albert (1918) (21–23 August 1918)**
  • opening phase of the Second Battle of the Somme, 1918

Is “Battle of Albert (1914)” a web page, concept, or identifier?
Linked Data solution in DBpedia: dereferencing “Battle of Albert, 1914”

Web of Data (GGG) for machines:

- **URI identifier**
  http://dbpedia.org/resource/Battle_of_Alpert_(1914)

- **Web page URL**
  http://dbpedia.org/page/Battle_of_Alpert_(1914)

- **(Meta)data on the web**
  http://dbpedia.org/data/Battle_of_Alpert_(1914)
There is also...

Wikipedia page (WWW) for humans:
- The actual Wikipedia information page(s)

Wikidata shared by different wikis
- Collaboratively edited knowledge base
  http://www.wikidata.org/wiki/Q786656

And application interfaces...
La battaglia di Abettino si svolse il 25 settembre 1914 come parte della Casa al mare durante la prima guerra mondiale. E immediatamente precedente alla prima battaglia della Lizza ed alla prima battaglia dell'Alpe. La 10ª Armata francese iniziò ad ammassarsi ad Aime sur la piana di settembre, ed il 25 iniziò a organizzarsi verso est.

La battaglia di Abettino fu un scontro avvenuto il 25 settembre 1914 come parte della Casa al mare durante la prima guerra mondiale. E immediatamente precedente alla prima battaglia della Lizza ed alla prima battaglia dell'Alpe. La 10ª Armata francese iniziò ad ammassarsi ad Aime sur la piana di settembre, ed il 25 iniziò a organizzarsi verso est.

La 10ª Armata francese iniziò ad ammassarsi ad Aime sur la piana di settembre, ed il 25 iniziò a organizzarsi verso est. L'8º Fronte di Castellane, sotto il comando di Joseph Joffre, tentò un attacco frontale contro i Fronti italo-bosniaci, ma l'attacco fallì. I tedeschi risposero con una controffensiva alla Lizza ed alla prima battaglia dell'Alpe. La 10ª Armata francese iniziò ad ammassarsi ad Aime sur la piana di settembre, ed il 25 iniziò a organizzarsi verso est.
La battaglia di Albert iniziò il 25 settembre 1914 come parte della Corsa al mare durante la prima guerra mondiale. È immediatamente precedente alla prima battaglia della Marne ed alla prima battaglia dell’Aisne. L’8ª Armata francese iniziò ad avanzare a partire dalla notte del 24 settembre, il 25 iniziò a spingersi verso est. Il 29 settembre venne lanciato un attacco francese a sud di Albert, che venne ripreso da una seconda caccia alla Marne, causando una serie di scontri. Dopo il 30 settembre, il Fronte francese fu scomposto, e la battaglia di Albert terminò il 2 ottobre. La battaglia di Albert venne ufficialmente conclusa il 2 ottobre 1914. Il termine “Corsa al mare” è stato applicato a questo periodo del conflitto, in quanto le due nazioni si scontrarono lungo la costa occidentale della Francia. In questo modo, la battaglia di Albert fece parte di un’ampia campagna di trasferimento di forze tra le due nazioni. La battaglia di Albert ebbe luogo durante la prima guerra mondiale, e la battaglia di Albert diventò un punto di riferimento per la successiva Battaglia della Marne. La battaglia di Albert ebbe come risultato un’espansione della linea di fronte in direzione nord-occidentale. Dopo la conclusione della battaglia di Albert, le forze britanniche si ritirarono verso nord, in direzione di Armentières e Lille, e le forze francesi si prepararono per la successiva battaglia di Laon. La battaglia di Albert terminò il 2 ottobre 1914, e la battaglia di Albert diventò un punto di riferimento per la successiva Battaglia della Marne.
Using open SPARQL endpoint

Find people born in Berlin before 1900?
End-user interface: Events on the map and timeline: Battle of Albert 1914

(Mäkelä et al, 2016)
SOME TOOLS
RDF Data Creation and Cleaning

• Data Validation
• Data Conversion Tools
  • OCR, Python scripting, CVS2RDF tools, ...
• Data Cleaning Tools
  • OpenRefine.org
• Data Integration Tools
  • Karma
• Named Entity Linking Tools
  • DBPedia Spotlite etc.
• Ontology and Data Editors
  • Protege, TopBraidComposer
• Online Querying tools
  • yasgui.org
Programming and publishing

• Development frameworks

• Triple stores
  • Fuseki, OpenLink, Stardog, ...
  • [https://www.w3.org/wiki/SparqlImplementations](https://www.w3.org/wiki/SparqlImplementations)

• Programming environments
  • For virtually any programming language
RDF data validation

Checking validity of different RDF syntaxes
Visualizing as RDF graphs
E.g.:

https://www.w3.org/RDF/Validator/
RDFa 1.1 Distiller and Parser

- [http://www.w3.org/2012/pyRdfa/](http://www.w3.org/2012/pyRdfa/)

Warning: This version implements RDFa 1.1 Core, including the handling of the Role Attribute. The distiller can also run in XHTML+RDFa 1.0 mode (if the incoming XHTML content uses the RDFa 1.0 DTD and/or sets the version attribute). The package is available for download, although it may be slightly out of sync with the code running this service.
"Krav på egen laptop leder till ojämlighet"

Hem och Skolas verksamhetsledare Micaela Romantschuk-Pieliä tror att kravet på att nya gymnasieelever själva ska bekosta bärbar dator kan leda till att en del väljer bort gymnasiet.
Example: extracted RDF

http://svenska.yle.fi/artikel/2014/01/21/krav-ppaogen-laptop-leder-till-ojamlikhet?xml version="1.0" encoding="utf-8">

<rdf:RDF
xmlns:foaf="http://xmlns.com/foaf/0.1"
xmlns:aoclt="http://rdfs.org/sioc/types#"
xmlns:dc="http://purl.org/dc/elements/1.1"
xmlns:content="http://purl.org/rss/1.0/modules/content/
xmlns:sioc="http://www.w3.org/2007/03/vocabulary"
xmlns:s"http://www.w3.org/1999/xhtml/vocab#
xmlns:rdf="http://www.w3.org/2000/01/rdf-schema#"


<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p15016"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p9720"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p11326"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p8409"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p32775"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p38889"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p18768"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p5108"/>
<foaf:has_creator rdf:resource="http://www.yo.onto/koko/p5101"/>

<foaf:has_creator rdf:resource="http://www.ws.org/2001/XMLSchema#integer" rdf:comment="45">
<foaf:has_creator rdf:resource="http://www.ws.org/2001/XMLSchema#text" rdf:comment="data">
<foaf:has_creator rdf:resource="http://www.ws.org/2001/XMLSchema#uri" rdf:comment="item">
<foaf:has_creator rdf:resource="http://www.ws.org/2001/XMLSchema#uri" rdf:comment="encoded">
<foaf:has_creator rdf:resource="http://www.ws.org/2001/XMLSchema#uri" rdf:comment="encoded">
<foaf:has_creator rdf:resource="http://www.ws.org/2001/XMLSchema#uri" rdf:comment="encoded">
<foaf:has_creator rdf:resource="http://www.ws.org/2001/XMLSchema#uri" rdf:comment="encoded">

I hort förutsätta alla som börjar gymnasiet att ha en egen bärbar dator, och med den nya elektroniska undervisningen.

Michals Romantschuk-Pietila tror att kravet på att nya gymnasister inte börjar med samma som de befinner sig i i vetenskapliga undervisningsövningar.

Redan nu är yrkesutbildningarna för en del elever svåra, så jag är lite rädd för att de ganska höga kostnaderna i visser fall i

Men och pedagogik är också konstaterar att gymnasiestudier redan nu kostar en hel del för gymnasisterna, och av

Slovénien

Att gymnasieutbildningen innebär att höga kostnaderna kan påverka val av andra studier och utbildningar. Tjörn Romantschuk-Pietila. Själv

Peijer tycker att vi bör komma ifråga om att de elever är i grundsätt att de göra sina läsningar åt gymnasisterna gratis skulle få en bättre dator, och de ja

- Man vet att gymnasieutbildningarna är en sådan som kommun och kommuner är ett bättre alternativ. En gymnasielev kostar ungefär stjälken euro, av

Ett argument att det är uttrycks av en del av pedagogik om att det på något sätt blir billigare

Det finns också att några bärbara datorer på finlandssvenska håll. Dessutom är de inte helt gratis heller, utan eleverna ska

Läs också i åt måste alla gymnasister ha egen laptop

<content:encoded>
<content:encoded>
<content:encoded>
<content:encoded>
<content:encoded>
</foaf:Document>
Example of JSON-LD

JSON-LD Playground

Play around with JSON-LD markup by typing out some JSON below and seeing what gets generated from it at the bottom of the page. Pick any of the examples below to get started. The playground uses the jsonld.js JSON-LD processor which fully conforms to the JSON-LD Syntax and API specifications.

Example JSON-LD Input:

```json
```

Generated JSON-LD Output:

```json
_:o1o4n0 <http://schema.org/jobTitle> "Professor" .
_:o1o4n0 <http://schema.org/telephone> "(425) 123-4567" .
_:o1o4n0 <http://www.w3.org/1999/02/22-rdf-syntax-ns#type> <http://schema.org/Person>.
```
The Unknown Soldier (1955 film) is a Finnish film directed by Edvin Laine and premiered in December 1955. It is based on the Unknown Soldier novel by Vuoripainein Naamiaisleima. The story is about the Continuation War between Finland and the Soviet Union as told from the viewpoint of ordinary Finnish soldiers. The film was and remains the most successful movie ever in Finland: about 2.8 million people, or more than half the Finnish population, saw it in theaters. It was followed by a popular sequel, The Unknown Soldier Returns in 1957, which dealt with the postwar period. The film is a significant part of Finnish film history and has been included in the United Nations Educational, Scientific and Cultural Organization's list of cultural heritage.
SPARQL result in JSON

```json
[{
  "head": {
    "link": [],
    "vars": [
      "name",
      "title"
    ]
  },
  "results": {
    "distinct": false,
    "ordered": true,
    "bindings": [
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "The Egyptian"
        }
      },
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Die ägyptische Prinzessin"
        }
      },
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Die ägyptische Prinzessin"
        }
      },
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "The Egyptian"
        }
      },
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Die ägyptische Prinzessin"
        }
      },
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Die ägyptische Prinzessin"
        }
      },
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Die ägyptische Prinzessin"
        }
      },
      {
        "name": {
          "type": "literal",
          "xml:lang": "en",
          "value": "Mika Waltari"
        },
        "title": {
          "type": "literal",
          "xml:lang": "en",
          "value": "The Egyptian"
        }
      }
    ]
  }
}
```
Establishing Linked Data Services: [http://ldf.fi](http://ldf.fi)

### Linked Data Finland

**Living Laboratory Data Service for the Semantic Web**

This site is the Living Laboratory of the Linked Data Finland research initiative, conducted by the Semantic Computing Research Group at Aalto University in collaboration with University of Helsinki and a large consortium of Finnish public organizations and companies.

Our goal is to make life easier for both publishers as well as consumers of structured data on the Web. We base our work on the Linked Data paradigm and stack of standards, which combines an expressive, semantic data model (RDF) with standardized access mechanisms (SPARQL and live HTTP URIs).

### 5-star Linked Data

The baseline of our work is the 5-star Linked Data model, proposed originally by Tim Berners-Lee.

- ★ Make data available on the Web in whatever format.
- ★★ Make data available as structured data (e.g., Excel instead of an image scan of a table).
- ★★★ Use non-proprietary formats (e.g., CSV instead of Excel format).
- ★★★★ Use URIs to denote things, so that people can point at your data.
- ★★★★★ Link your data to other data to provide context.

### 7-star Linked Data Service

However, in our opinion, providing 5-star Linked Data is just the beginning. To actually make use of the datasets, consumers need more support in getting to know and access them, as well as a better grasp of their quality and provenance. To this end, we extend the model with two additional stars:

- ★★★★★★ Provide your data with a schema and documentation so that people can understand and re-use your data easily.
- ★★★★★★★ Validate your data and denote its provenance so that people can trust the quality of your data.

This added support should come with as little extra work as possible to the data publisher. Our hypothesis is that a lot of this can be done automatically, basing on the Linked Data core. A data publisher needs only to provide...
Implementation

Based on Fuseki SPARQL server
- [http://jena.apache.org/documentation/serving_data/](http://jena.apache.org/documentation/serving_data/)
- Easy to install on your own PC!

Varnish web application accelerator front-end for dereferencing URIs
- [https://www.varnish-cache.org](https://www.varnish-cache.org)

Dataset home pages are generated automatically
- Based on the metadata
- JavaScript and jQuery

Learning center for setting up a Linked Data service
CONCLUSIONS
What is new?

PROGRAMMING

Object-oriented modeling

ARTIFICIAL INTELLIGENCE

Logic semantics

XML syntax, RDF data model, ...

WWW TECHNOLOGIES
Learning more

W3C: https://www.w3.org/2013/data/
  • Authoratice place to start
Books: https://www.w3.org/2001/sw/wiki/Books
  • Lots of learning materials available
Journals: Journal of Web Semantics, Semantic Web, ...
  • Focus on scientific developments
Software: https://www.w3.org/2001/sw/wiki/Tools
  • Mostly open source, less commercial tools
Conferences: WWW, ISWC, ESWC, ...
  • There is an active Semantic Web community
Online learning: W3Schools, open university courses, ...
  • Our own site: http://linda.seco.cs.aalto.fi/