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# Linked Data Publishing Principles: Four Principles and 5-star Model

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# Learning Objectives

**Understand how Linked (Open) Data is published on the Web as data services for applications**

# Outline

## Best W3C practices for publishing Linked (Open) Data

- Four Principles for Linked (Open) Data publishing
- 5-star model for Linked (Open) Data publishing

## Case: Linked Data Finland publishing platform LDF.fi

- A Linked Data publishing platform on the Web

# Four Linked Data Principles & 5-star Model

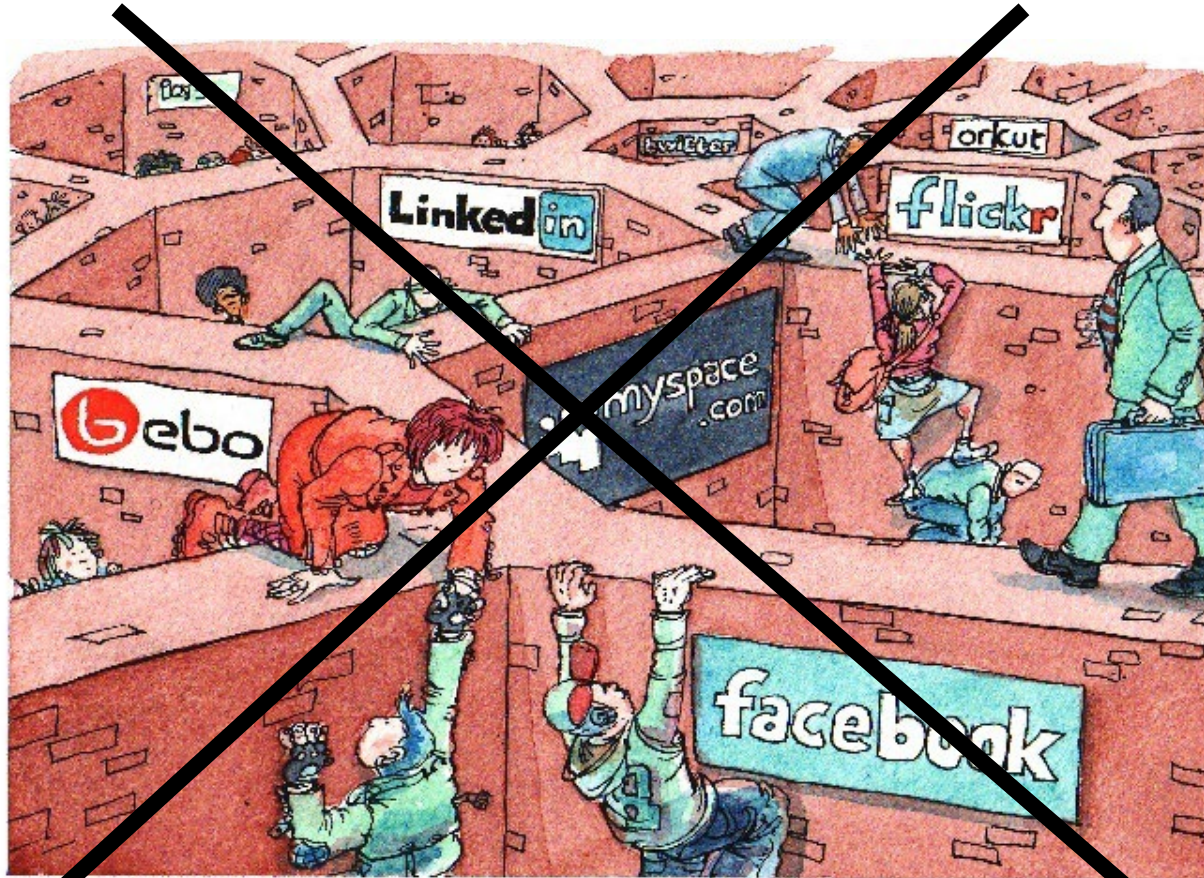


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# Traditional interoperability problem: data silos + data difficult to use



# ”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 Open Data? 5-star model

- ★ make your stuff available on the Web (whatever format) under an open license<sup>1</sup>
- ★★ make it available as structured data (e.g., Excel instead of image scan of a table)<sup>2</sup>
- ★★★ make it available in a non-proprietary open format (e.g., CSV as well as of Excel)<sup>3</sup>
- ★★★★ use URIs to denote things, so that people can point at your stuff<sup>4</sup>
- ★★★★★ link your data to other data to provide context<sup>5</sup>



# How to name things with URI/IRIs (to get the 4th and 5th star!)

*“1. Use URIs as names for things”*

## **Use HTTP URIs**

- Domain name system makes distributed unique URI minting easy
  - *E.g., only Aalto University can mint URIs of form <http://aalto.fi/>...*
- HTTP URIs can be used to access more information
- Avoid URNs, DOIs, etc. for these reasons

## **Avoid confusion between**

- Objects themselves and
- Web documents that describe them
- E.g. <http://aalto.fi>
  - *A university or a document about it?*

**“Cool URIs do not change” = stable, simple, manageable URIs**



# Data linking across datasets (to get the 5th star!)

## Relationship links

- Pointers to additional information
  - *E.g., persons to places where they lived*

## Data mapping and sameAs links

- Pointers to similar resources in other datasets
  - *E.g., sameAs -links*

## Vocabulary links

- Pointers to vocabulary terms (in metadata models) in related datasets
  - *E.g., using Dublin Core dump-down principle*

## Ontology links

- Pointers to concepts in ontological vocabularies used in metadata
  - *E.g., keyword thesauri for subject descriptions*

# URI content negotiation

“2. Use HTTP URIs, so that people can look up those names”

**How to provide information about a URI/IRI to the user?**

**Return desired information about a URI/URL using HTTP**

- This can be specified by HTTP header request fields
  - *E.g., “Accept: text/html” for a web page or “Accept: text/turtle” for data*
  - *E.g., a web browser requests an HTML page*
- Server decides what to return
- This is called **content negotiation**

# Dereferencing Strategies

**Two strategies for the server to decide what to return for a URI/IRI**

- Hash URIs
- 303 URIs

# Hash URI Strategy

## Hash HTTP URIs end in # and fragment identifier

- E.g., <http://www.w3.org/1999/02/22-rdf-syntax-ns#Description>  
E.g., <http://example.fi/vocab/course#Seminar>

## Resolving procedure

- Client truncates URI at #
  - *E.g., remove #Description*
- Client sends a HTTP GET request to the server
  - *E.g., <http://www.w3.org/1999/02/22-rdf-syntax-ns>*
- The result is an RDF or an HTML document
  - *Depending on content negotiation*
- Notice: an entire document is returned, not only info about a concepts, e.g., #Description
  - *Since the fragment is not seen by the server!*

# 303 URI Strategy

## Alternative for hash URIs

- **The whole URI/IRI is sent from client to server**
- **Server returns a “303 See Other” response code, i.e., HTTP redirect**
  - *Client can find a related document by following the redirect*
    - *E.g., RDF data or an HTML page depending on the situation*
- **Used for example in DBPedia.org**
  - <http://dbpedia.org/page/Helsinki> # returns a HTML page about Helsinki.
  - <http://dbpedia.org/data/Helsinki> # returns RDF data about Helsinki
  - *It would be impossible to return the whole DBPedia data file (as when using hash URIs)!*

## 303 URI strategy needs two requests due to redirect

- Hash URIs avoid this

# Hash URIs vs. 303 URIs

**Hash URIs good for only small RDF descriptions (e.g., schemas)**

- Extra HTTP request of 303 URIs can then be saved
- The client must filter response further

**303 URIs are used to access parts of RDF descriptions**

- Extra HTTP call is needed
- Only relevant data is transmitted
- Further filtering not needed

# Linked Data services provide several interfaces and APIs

- **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*
    - *E.g., [http://dbpedia.org/page/Jean\\_Sibelius](http://dbpedia.org/page/Jean_Sibelius)*
  - *Using LD browsers for the Web of Data*
    - *E.g., <http://uriburner.com/>*
- **SPARQL endpoint.** For querying the data in a standard way for, e.g., mash-up applications
- **Download.** Downloading the data as an RDF data dump
  - *See, e.g., Museum Finland data: <http://www.ldf.fi/dataset/mufi/>*

# Example: DBpedia.org URI model

## Uses several kinds 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> # Object
- <http://dbpedia.org/page/Helsinki> # HTML represent.
- <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*
  - *Battle of Albert (1916) (1–13 July 1916)*
    - *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 Albert \(1914\)](http://dbpedia.org/resource/Battle_of_Albert_(1914))
- Web page URL
  - [http://dbpedia.org/\*\*page\*\*/Battle of Albert \(1914\)](http://dbpedia.org/page/Battle_of_Albert_(1914))
- (Meta)data on the web
  - [http://dbpedia.org/\*\*data\*\*/Battle of Albert \(1914\)](http://dbpedia.org/data/Battle_of_Albert_(1914))

# There is also...

## Wikipedia pages (WWW) for humans:

- The actual Wikipedia information page(s)
  - [http://en.wikipedia.org/wiki/Battle\\_of\\_Albert\\_\(1914\)](http://en.wikipedia.org/wiki/Battle_of_Albert_(1914))

## Wikidata shared by different wikis

- Collaboratively edited knowledge base
  - <http://www.wikidata.org/wiki/Q786656>

## And application interfaces for the battle...

# [http://dbpedia.org/page/Battle\\_of\\_Albert\\_\(1914\)](http://dbpedia.org/page/Battle_of_Albert_(1914))

Starlight Xpr... TS Guiding... Skywatcher... SKOS/XML... The CIDOC... FINLEX... About: B...

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## About: [Battle of Albert \(1914\)](#)

An Entity of Type : [Battles of World War I involving Germany](#), from Named Graph : <http://dbpedia.org>, within Data Space : [dbpedia.org](#)



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 Marna ed alla prima battaglia dell'Aisne. La 10 Armata francese iniziò ad ammassarsi ad Amiens a partire dalla metà di settembre, ed il 25 iniziò a spingersi verso est.

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100%

# [http://dbpedia.org/resource/Battle\\_of\\_Albert\\_\(1914\)](http://dbpedia.org/resource/Battle_of_Albert_(1914)) → [http://dbpedia.org/page/Battle\\_of\\_Albert\\_\(1914\)](http://dbpedia.org/page/Battle_of_Albert_(1914))

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<a href="#">dcterms:subject</a>	<ul style="list-style-type: none"><li><a href="#">category:Battles of the Western Front (World War I)</a></li><li><a href="#">category:Somme</a></li><li><a href="#">category:Battles of World War I involving Germany</a></li><li><a href="#">category:1914 in France</a></li><li><a href="#">category:Race to the Sea</a></li><li><a href="#">category:Battles of World War I involving France</a></li><li><a href="#">category:Conflicts in 1914</a></li></ul>
<a href="#">rdf:type</a>	<ul style="list-style-type: none"><li><a href="#">yago:BattlesOfWorldWarIInvolvingFrance</a></li><li><a href="#">yago:BattlesOfTheWesternFront(WorldWarI)</a></li><li><a href="#">yago:BattlesOfWorldWarIInvolvingGermany</a></li></ul>
<a href="#">rdfs:comment</a>	<ul style="list-style-type: none"><li>The Battle of Albert began on September 25, 1914 as part of the Race to the Sea during World War I. It directly followed the First Battle of the Marne and the First Battle of the Aisne as progress toward advancing the trench lines to the sea continued. The French Tenth Army began to assemble at Amiens from mid-September and on September 25 began to push eastwards.</li><li>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 Marna ed alla prima battaglia dell'Aisne. La 10 Armata francese iniziò ad ammassarsi ad Amiens a partire dalla metà di settembre, ed il 25 iniziò a spingersi verso est.</li><li>Битва при Альберте — сражение между французами и германскими войсками во время Первой мировой войны, часть т. н. «Бега к морю». Французская 10-я армия с середины сентября концентрировалась у Амьена, и с 25 сентября начала продвижение на восток. После того, как попытка удлинить линию фронта на север провалилась, Де Кастельно по приказу Жоффра организовал фронтальную атаку германских позиций возле Альберта.</li><li>La bataille d'Albert commença le 25 septembre 1914, dans le cadre de la Course à la mer, au début de la Première Guerre mondiale. Elle eut lieu dans le prolongement immédiat de la première bataille de la Marne et de la première bataille de l'Aisne alors que le creusement des tranchées vers la mer avait débuté. La nuit commença à se rassembler à Amiens depuis la mi-septembre et le 25 septembre elle fit marche à l'est.</li></ul>
<a href="#">rdfs:label</a>	<ul style="list-style-type: none"><li>Bataille d'Albert (1914)</li><li>Battaglia di Albert (1914)</li><li>Battle of Albert (1914)</li><li>Битва при Альберте (1914)</li></ul>

# [http://dbpedia.org/data/Battle\\_of\\_Albert\\_\(1914\)](http://dbpedia.org/data/Battle_of_Albert_(1914))

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  <rdfs:comment xml:lang="ru">Битва при Альбере — сражение между французскими и германскими войсками во время Первой мировой войны, часть т. н. «Бега к морю». Французская 10-я армия с середины сентября концентрировалась у Амьена, и с 25 сентября начала продвижение на восток. После того, как попытка удлинить линию фронта на север провалилась, Де Кастельно по приказу Жозефа организовал фронтальную атаку германских позиций возле Альбера.</rdfs:comment>
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  <dbpedia-owl:abstract xml:lang="it">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 Marna ed alla prima battaglia dell'Aisne. La 10 Armata francese iniziò ad ammassarsi ad Amiens a partire dalla metà di settembre, ed il 25 iniziò a spingersi verso est. Edouard De Castelnau, sotto il comando di Joseph Joffre, lanciò un attacco frontale contro le linee tedesche presso Albert dopo che i tentativi di forzare la linea del fronte in direzione nord fallirono. De Castelnau incontrò immediatamente resistenza e subì il contrattacco, dato che la 6 Armata tedesca aveva raggiunto Bapaume il 26 settembre ed avanzò in direzione di Thiepval il 27, nel mezzo di quella che era diventata il terreno della battaglia della Somme. Lo scopo tedesco era di dirigersi a occidente verso la Manica, conquistando le regioni industriali ed agricole della Francia settentrionale, tagliando così fuori le rotte di rifornimento del Corpo di Spedizione inglese ed isolando il Belgio. Nessuno dei due lati riuscì a fare alcun significativo progresso sul campo, e gli scontri intorno ad Albert terminarono intorno al 29 settembre, mentre il vivo della battaglia si spostò verso nord in direzione di Arras e Lille e nelle Fiandre occidentali. Questo scontro e quelli che seguirono furono tentativi senza costrutto, dato che il panorama bellico andò rapidamente verso la guerra di trincea.</dbpedia-owl:abstract>
  <dbpedia-owl:abstract xml:lang="fr">La bataille d'Albert commença le 25 septembre 1914, dans le cadre de la Course à la mer, au début de la Première Guerre mondiale. Elle eut lieu dans le prolongement immédiat de la première bataille de la Marne et de la première bataille de l'Aisne alors que le creusement des tranchées vers la mer avait débuté. La avait commencer à se rassembler à Amiens depuis la mi-septembre et le 25 septembre elle fit marche à l'est. Le général de Castelnau, sous le commandement du général Joffre, lança une attaque frontale sur les positions allemandes près d'Albert, après que des tentatives d'étendre le front au nord eurent échoué. De Castelnau dut faire face à une forte résistance et à la contre-offensive de la Vimodécie. L'armée allemande qui atteint Bapaume le 26 septembre et Thiepval le jour suivant, dans une région qui allait être le théâtre de la bataille de la Somme, en 1916. L'objectif des Allemands était de pousser vers l'ouest, vers la Manche, pour s'emparer des régions industrielles et agricoles du Nord de la France, coupant ainsi le ravitaillement du Corps expéditionnaire britannique et isolant la Belgique. Aucun des deux camps ne fut capable de réaliser des gains significatifs lors de cet affrontement, et la bataille d'Albert se termina le 29 septembre avec le déplacement des combats au nord, vers Arras, Lille et dans la Flandre-Occidentale. Cette confrontation et celles qui suivirent ne dégagèrent pas de grands vainqueurs, et la guerre ne tarda guère à se transformer en guerre de tranchées.</dbpedia-owl:abstract>
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Wikipedia article page for "Battle of Albert (1914)".

Browser: Internet Explorer, URL: http://en.wikipedia.org/wiki/Battle\_of\_Albert\_(1914)

Search: battle of albert 1914

## Battle of Albert (1914)

From Wikipedia, the free encyclopedia

*Not to be confused with [Battle of Albert \(1916\)](#) or [Battle of Albert \(1918\)](#).*

 This article **does not cite any references or sources**. Please help [improve this article](#) by adding citations to [reliable sources](#). Unsourced material may be [challenged](#) and removed. *(April 2008)*

The **Battle of Albert** began on September 25, 1914 as part of the **Race to the Sea** during World War I. It directly followed the **First Battle of the Marne** and the **First Battle of the Aisne** as progress toward advancing the trench lines to the sea continued.

The **French Tenth Army** began to assemble at Amiens from mid-September and on September 25 began to push eastwards. **De Castelnau**, under the command of Joffre, launched a frontal attack on the German lines near **Albert** after attempts to stretch the line northward failed. De Castelnau was met with immediate resistance and counterattack as the **German Sixth Army** had reached **Bapaume** on September 26 and advanced to **Thiepval** on the 27th. In the midst of what was to become the **Somme** battlefield of 1916. The German aim was to drive westward to the **English Channel**, seizing the industrial and agricultural regions of Northern France, cutting off the supply route of the **British Expeditionary Force** (BEF) and isolating Belgium.

Neither side was able to make any decisive ground and the battle around Albert ended around September 29 as the fighting moved northwards towards **Arras** and **Lille** and into **West Flanders**. This confrontation and those to follow were deemed draws as the fighting settled into prolonged **trench warfare**.

 *This World War I article is a stub. You can help Wikipedia by expanding it.*

 *This article about a battle in French history is a stub. You can help Wikipedia by expanding it.*

 *This article about a battle in German history is a stub. You can help Wikipedia by expanding it.*

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I am highly knowledgeable about this topic (optional)

**Help improve this article** What's this?

Did you find what you were looking for?



Course of the "Race to the Sea" showing dates of encounters and highlighting the significant battles.

**Race to the Sea** [hide]

1st Picardy · Firey · **Albert** · Arras · La Bassée · Messines · Armentières · Yser · 1st Ypres

# End-user interface: Events on the map and timeline: Battle of Albert 1914

[+] agent

[-] combat related

no ..... 32

yes ..... 62

[-] deportations

no ..... 83

yes ..... 13

[+] destroyed buildings

[-] human shields

no ..... 70

yes ..... 26

[+] killings

[-] panic

no ..... 70

yes ..... 25

List Map

*agent* France, Germany

*dateModified* 2012-06-08T10:42:29.824Z

*description* The Battle of Albert began on September 25, 1914 as part of the Race to the Sea. Subsequent action to the Battle of the Marne, 1914 and the Battle of the Aisne, 1914, as progress toward advancing the trench lines to the sea continued.

*name* Battle of Albert, 1914

*place of action* Albert

*time of action* 9/25/1914

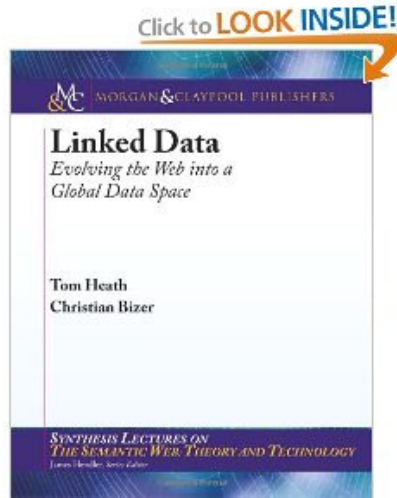
*type of instance* historical event

Event	Sep	Oct	Nov	Dec	1915	Feb	Mar	Apr	May
Atrocities in Herve									
Battle of Nonne Bosschen									
Atrocities in Linsmeau									
Atrocities in Baelen									
Atrocities in Francorchamps									
Battle of Albert, 1914									
Atrocities in St Truiden									

24



# More information: read the chapters 1–2 from the Linked Data book



- Openly available on the web: <http://linkeddatatbook.com/editions/1.0/>
- Printed book: Morgan & Claypool, Palo Alto, CA, USA, 2011

# A Linked Data Publishing Platform: Linked Data Finland LDF.fi

# Linked Data Finland Living Lab

## <http://ldf.fi>



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[Datasets](#)

[Schemas](#)

[Services](#)

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## 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

# WarSampo dataset page & SPARQL endpoint: <http://www.ldf.fi/dataset/warsa>



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[Linked Data School](#)

## WarSampo

*Sotasampo*

Linked Data Finland

★★★★★

WarSampo Knowledge Graph includes harmonized data of different kinds concerning the Second World War in Finland, separated in different subgraphs representing events, actors, places, photographs, and other aspects and documentation of the war. The data covers the Winter War 1939-1940 against the Soviet attack, the Continuation War 1941-1944 where the occupied areas of the Winter War were temporarily regained, and the Lapland War 1944-1945, where the Finns pushed the German troops away from Lapland.

To test and demonstrate its usefulness, this Knowledge Graph is in use in the semantic portal [WarSampo](#), explained in more detail in the [project page](#).

The Knowledge Graph is published on [Zenodo](#) with a version history

Example SPARQL queries for the data:

- [Events, photographs and articles that are situated in Vyborg](#)
- [Casualties of the 1st Division and its subunits in the time interval 13.2.-13.3.1940 by place and date](#)

### Data Download

The data can be downloaded at <https://zenodo.org/record/3431122/files/warsampo.zip>.

### License

CC BY 4.0

Licensors: [Kansallisarkisto](#), [Semanttisen laskennan tutkimusryhmä \(SeCo\)](#)

See possible graph-specific licenses below.

### Detailed Dataset Contents

*Karelian map names 1922-44 (URI: [http://df.fi/warsa/places/karelian\\_places](http://df.fi/warsa/places/karelian_places))*



# Our "7-star" model and LDF.fi data hotel

## Goals: enhance re-usability and data quality

### 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.



Burj Al Arab

# Why LDF.fi?

## Living Laboratory for publishing Linked Open Data

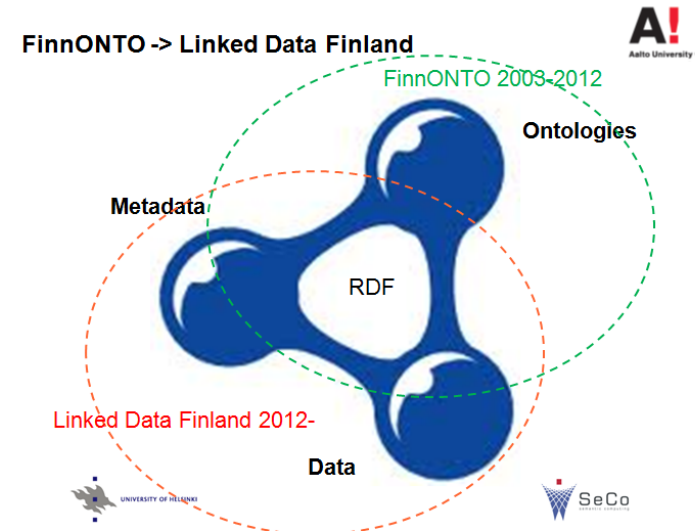
- Same idea as in **ontology services** (e.g., ONKI.fi and Finto.fi )
- But for **data** and **schemas**
- **Hosts, e.g., data services for all Sampo portals**

## Additional Data Services for

- Documentation
- Tools

## Learning Center

- For publishing and using Linked Data
- <http://linda.seco.cs.aalto.fi>



# Implementation

## Based on Fuseki SPARQL server

- [http://jena.apache.org/documentation/serving\\_data/](http://jena.apache.org/documentation/serving_data/)

## Varnish web application accelerator front-end for dereferencing URIs

- <https://www.varnish-cache.org>

## Dataset home pages are generated automatically

- Based on the dataset metadata (using Void)
- JavaScript and jQuery

## More Information – Questions?

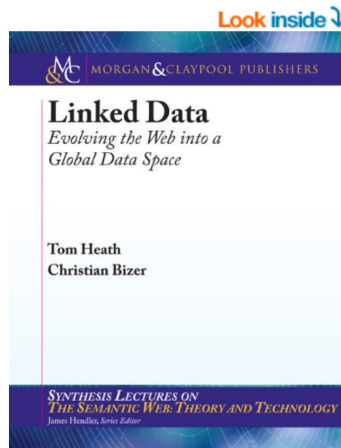


Semantic Web & Linked Data Standards

<http://www.w3.org/standards/semanticweb/>

T. Heath, C. Bizer: Evolving the Web into a Global Data Space

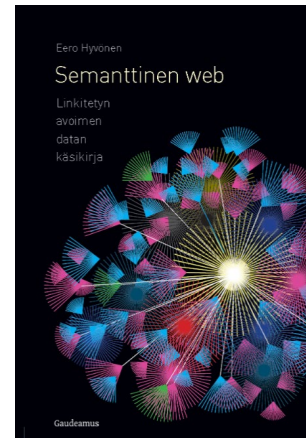
Free online version: <http://linkeddatabook.com/editions/1.0/>



In English

2011

<https://www.amazon.com/Linked-Data-Evolving-Global-Space-ebook/dp/B009KC1YM2>



In Finnish

2018

<https://www.gaudeamus.fi/semanttinen-web/>