

# Linkitetyn datan verkkopalvelut: miten niitä hyödynnetään?

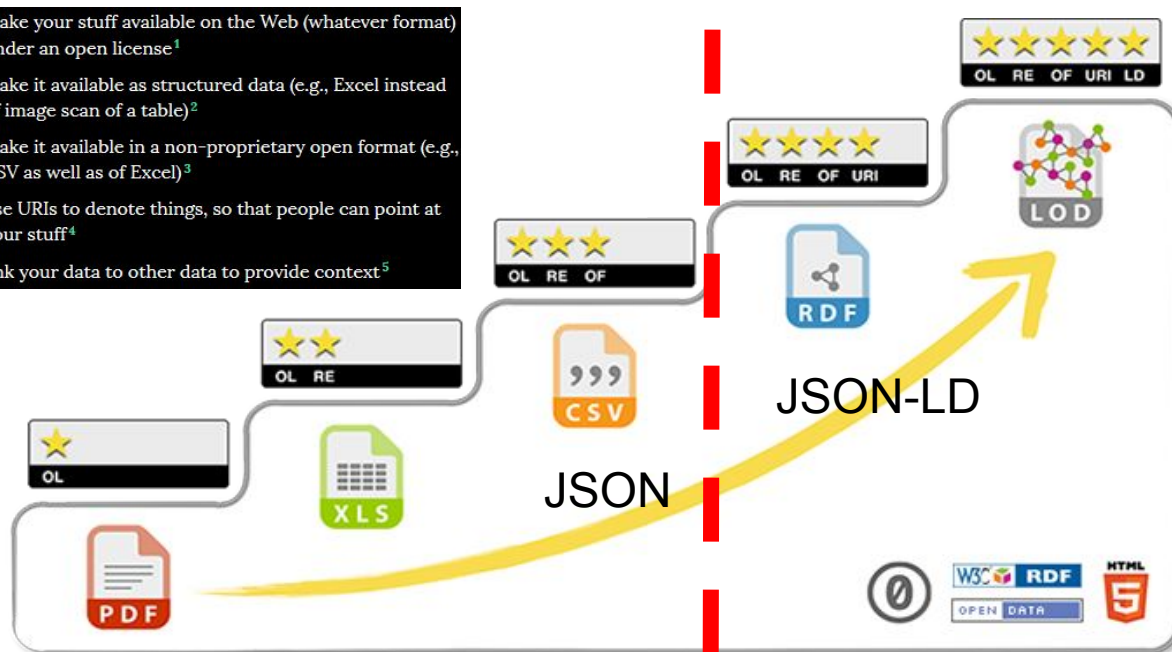
Jouni Tuominen, [jouni.tuominen@helsinki.fi](mailto:jouni.tuominen@helsinki.fi)

Semanttinen web Suomessa 20 vuotta -juhlaseminaari, 2.11.2021

# How to publish Linked Data?

## 5-star Linked Data 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>



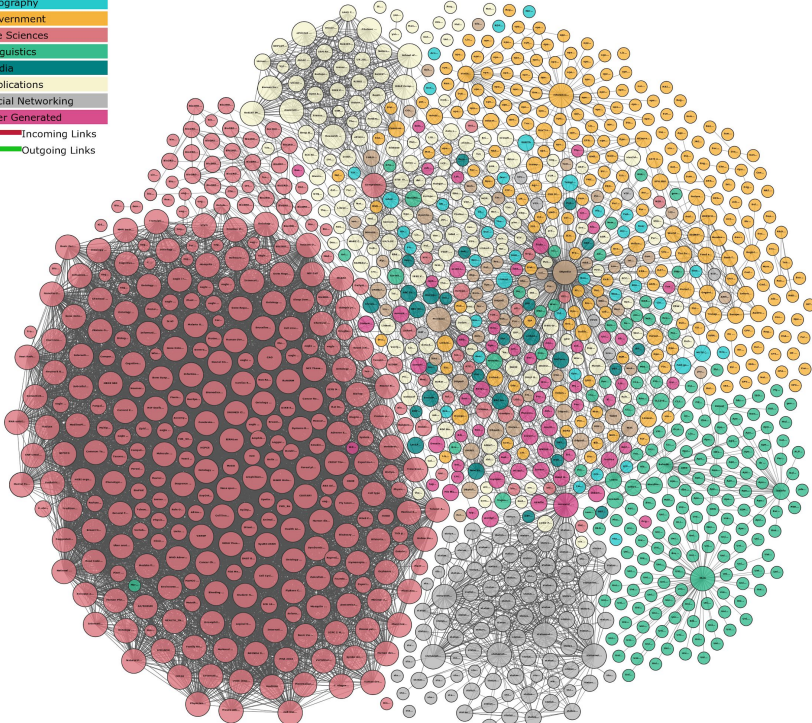
“Traditional” Open Data

Linked Open Data

(Tim Berners-Lee)  
<http://5stardata.info>



- Legend
- Cross Domain
  - Geography
  - Government
  - Life Sciences
  - Linguistics
  - Media
  - Publications
  - Social Networking
  - User Generated
  - Incoming Links
  - Outgoing Links



Linking Open Data cloud diagram 2017, by Andrejs Abele, John P. McCrae, Paul Buitelaar, Anja Jentzsch and Richard Cyganiak. <http://lod-cloud.net/>

Jery 1 x    Query 1 x    +

http://ldf.fi/warsa/sparql

```
# Events, photographs and articles that are situated in Vyborg
SELECT DISTINCT ?type ?resource ?prefLabel
WHERE {
  {
    # Events
    BIND (<http://ldf.fi/warsa/places/municipalities/m_place_614> as ?vyborg)
    ?resource crm:P7_took_place_at ?vyborg ;
      a ?typeURI ;
      crm:P4_has_time-span ?timespan .
    FILTER(?typeURI != wet:Photography)
    ?typeURI rdfs:subClassOf* crm:E5_Event .
  }
  UNION
  {

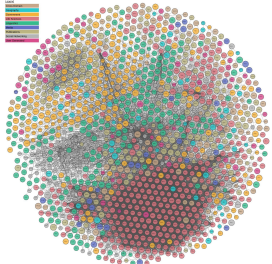
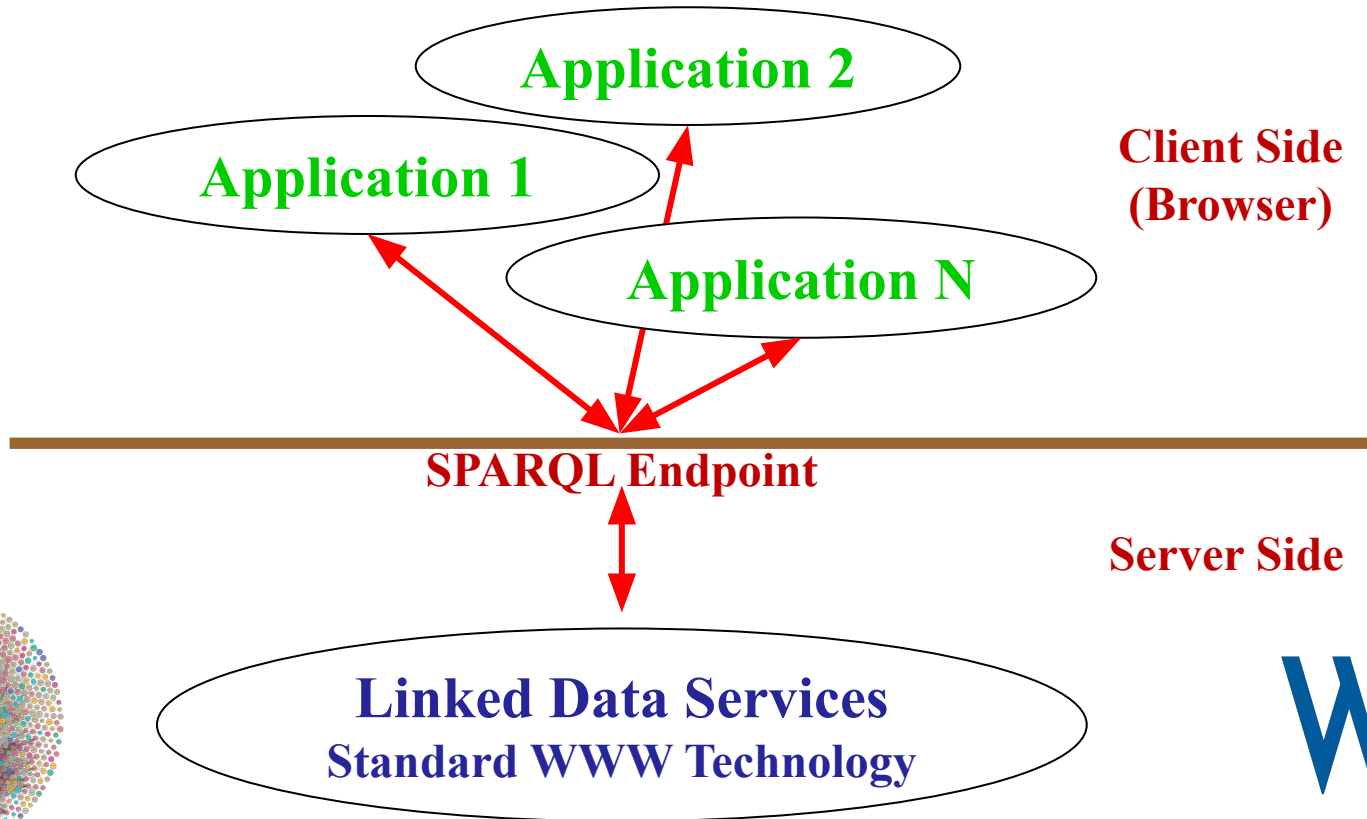
```

Table    Response    Pivot Table    Google Chart    Geo      

wing 1 to 50 of 11,147 entries (in 3.195 seconds)

type	resource	prefLabel
"Battle"@en	<a href="http://ldf.fi/warsa/events/event_1078">http://ldf.fi/warsa/events/event_1078</a>	"Defensive battles of Viipuri"@en
"Battle"@en	<a href="http://ldf.fi/warsa/events/event_1080">http://ldf.fi/warsa/events/event_1080</a>	"Viipuri"@en
"Battle"@en	<a href="http://ldf.fi/warsa/events/event_1092">http://ldf.fi/warsa/events/event_1092</a>	"Battle of Vyborg, Pappilanniemi and Kärenmäki sub-blocks"@en
"Battle"@en	<a href="http://ldf.fi/warsa/events/event_1093">http://ldf.fi/warsa/events/event_1093</a>	"Battle of Vyborg, Pappilanniemi and Huhtiala sub-blocks"@en

# Linked Data application ecosystem



# Linked Data Finland service LDF.fi (2014–)



## 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 number 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 do our work on the [Linked Data](#) paradigm and stack of standards, which combines an expressive, semantic 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 data, consumers need more support in getting to know and access them, as well as a better grasp of their 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* 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

## WarSampo

### Linked Data Finland



This dataset includes harmonized data of different kinds concerning the Second World War in Finland, separated in different graphs representing events, actors, places, photographs, and other aspects and documentation of the war. To test and demonstrate its usefulness, this data service is in use in the semantic portal [WarSampo](#) explained in more detail in this [project page](#).

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](#)

### License

[CC BY 4.0](#)



See possible graph-specific licenses below.

### Detailed Dataset Contents

**Wartime Events (URI: <http://ldf.fi/warsa/events>)**

( [Browse data](#) / [View in Sotasampo.fi](#) / [Download](#) )



Information on the events of the Winter War and Continuation War were derived from the books Talvisodan pikkujätkälläinen, Jatkosodan pikkujätkälläinen, and the organization records of the Finnish Defence Force.

saari: Ukko

[\[edit\]](#)

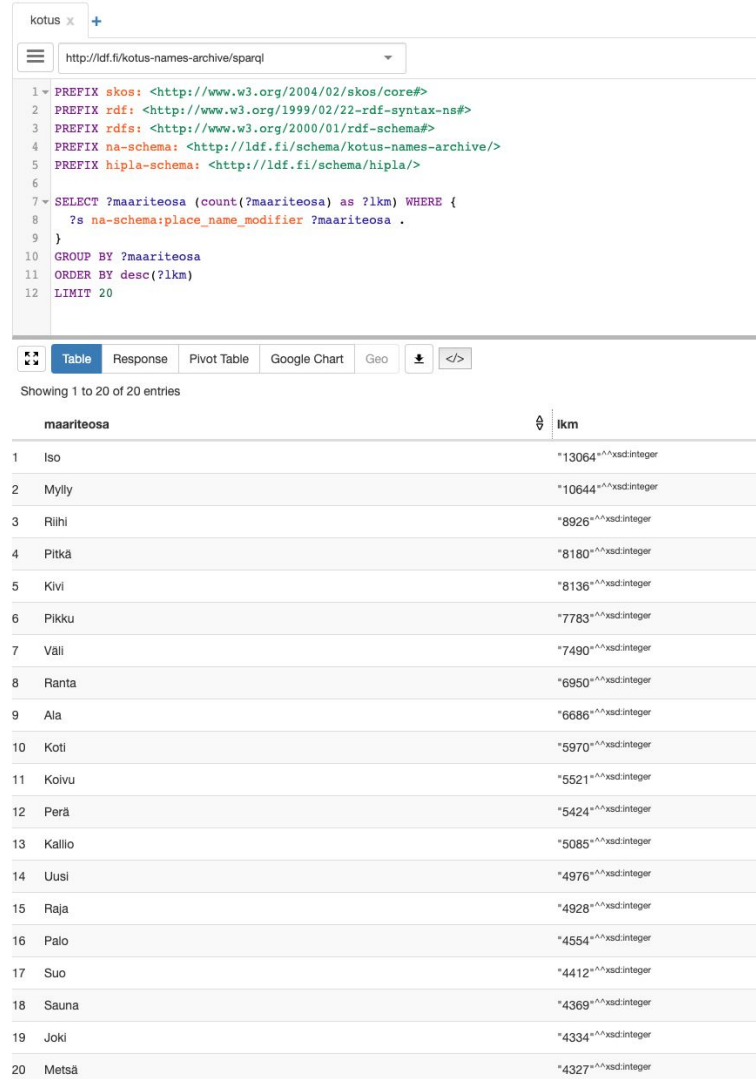
68.936487, 27.282297

<b>Collection</b>	1-kokoelma
<b>Collection parish (in ca 1938)</b>	Inari
<b>Collector</b>	Portti, Reija
<b><a href="http://ldf.fi/schema/kotus-names-archive/positioning_accuracy">http://ldf.fi/schema/kotus-names-archive/positioning_accuracy</a></b>	Paikka sijaitsee keruukartalla tämän karttaruudun alueella.
<b>Latitude</b>	68.936487
<b>Longitude</b>	27.282297
<b>Name</b>	Ukko
<b>Name type</b>	paikannimi
<b>Same as</b>	<a href="https://nimiarkisto.fi/wiki/Q5601617">https://nimiarkisto.fi/wiki/Q5601617</a>
<b>Stamp date</b>	1990
<b>Type</b>	<u>saari</u>

# Linked Data browsing for humans and machines

# SPARQL endpoints for querying data for analysis, visualization, mash-up apps

e.g. CSV



The screenshot shows a web interface for a SPARQL endpoint. The URL in the address bar is `http://ldf.fi/kotus-names-archive/sparql`. The query text is as follows:

```
1 PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
4 PREFIX na-schema: <http://ldf.fi/schema/kotus-names-archive/>
5 PREFIX hipla-schema: <http://ldf.fi/schema/hipla/>
6
7 SELECT ?maariteosa (count(?maariteosa) as ?lkm) WHERE {
8   ?s na-schema:place_name_modifier ?maariteosa .
9 }
10 GROUP BY ?maariteosa
11 ORDER BY desc(?lkm)
12 LIMIT 20
```

Below the query, there are tabs for 'Table', 'Response', 'Pivot Table', 'Google Chart', 'Geo', and a download icon. The 'Table' tab is selected, showing 1 to 20 of 20 entries. The table has two columns: 'maariteosa' and 'lkm'.

maariteosa	lkm
1 Iso	*13064 <sup>xsd:integer</sup>
2 Mylly	*10644 <sup>xsd:integer</sup>
3 Riihi	*8926 <sup>xsd:integer</sup>
4 Pitkä	*8180 <sup>xsd:integer</sup>
5 Kivi	*8136 <sup>xsd:integer</sup>
6 Pikku	*7783 <sup>xsd:integer</sup>
7 Valli	*7490 <sup>xsd:integer</sup>
8 Ranta	*6950 <sup>xsd:integer</sup>
9 Ala	*6686 <sup>xsd:integer</sup>
10 Koti	*5970 <sup>xsd:integer</sup>
11 Koivu	*5521 <sup>xsd:integer</sup>
12 Perä	*5424 <sup>xsd:integer</sup>
13 Kallio	*5085 <sup>xsd:integer</sup>
14 Uusi	*4976 <sup>xsd:integer</sup>
15 Raja	*4928 <sup>xsd:integer</sup>
16 Palo	*4554 <sup>xsd:integer</sup>
17 Suo	*4412 <sup>xsd:integer</sup>
18 Sauna	*4369 <sup>xsd:integer</sup>
19 Joki	*4334 <sup>xsd:integer</sup>
20 Metsä	*4327 <sup>xsd:integer</sup>

# Download data dumps

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix schema: <http://schema.org/> .
@prefix skos: <http://www.w3.org/2004/02/skos/core#> .
@prefix xml: <http://www.w3.org/XML/1998/namespace> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

<http://urn.fi/URN:NBN:fi:bib:me:W00003542600> schema:author <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:contributor <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Mikael Agricolan teokset : 1, ABC kiria ; Rucoufkiria",
    "Mikael Agricolan teokset : 1, Abckiria, rucouskiria",
    "Mikael Agricolan teokset : 2, Se Wfi Teftamenti",
    "Mikael Agricolan teokset : 2, Se wsi testamentti",
    "Mikael Agricolan teokset : 3, Käsikiria, Messu eli Herran echtolinen, Se meiden Herran Iesusen Christusen pina, Davidin
psaltari, Weisut ia ennustoxet, Ne prophetat, Haggaj, Sacharia, Maleachi",
    "Mikael Agricolan teokset : 3, Käsikirja",
    "Mikael Agricolan teokset : Tekstien selvennys" .

<http://urn.fi/URN:NBN:fi:bib:me:W00023266800> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Suomalaisia suurmiehiä" .

<http://urn.fi/URN:NBN:fi:bib:me:W00025575600> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Mikael Agricolan edelläkävijä : Pyhän Stefanin, Perman ensimmäisen piispan, elämäntyö" .

<http://urn.fi/URN:NBN:fi:bib:me:W00028705000> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Nuori Mikael Agricola" .

<http://urn.fi/URN:NBN:fi:bib:me:W00029465400> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Mikael Agricolasta E. W. Pakkalaan : Suomen kirkon paimenien elämäkerrasto" .

<http://urn.fi/URN:NBN:fi:bib:me:W00031602000> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "En väg till en av världslitteraturens stora namnlösa skaldar : vem var Michael Agricola?" .

<http://urn.fi/URN:NBN:fi:bib:me:W00041137700> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Fiskaresonen : Finlands oförgätlige wälgörare" .

<http://urn.fi/URN:NBN:fi:bib:me:W00041920500> schema:contributor <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Mikael Agricola ja Erasmus Rotterdamlainen" .

<http://urn.fi/URN:NBN:fi:bib:me:W00046892800> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Mikael Agricola : bibliografinen opas" .

<http://urn.fi/URN:NBN:fi:bib:me:W00047053600> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Vanhan kirjasuomen lukemisto" .

<http://urn.fi/URN:NBN:fi:bib:me:W00047350200> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Michael Agricola : der Reformator Finnlands : sein Leben und sein Werk" .

<http://urn.fi/URN:NBN:fi:bib:me:W00047843300> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Mikael Agricola, der erste finnische Bibelübersetzer" .

<http://urn.fi/URN:NBN:fi:bib:me:W00048912200> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:contributor <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Oma kieli : Mikael Agricolan tekstejä nykysuomeksi" .

<http://urn.fi/URN:NBN:fi:bib:me:W00049272700> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Agricolan aika" .

<http://urn.fi/URN:NBN:fi:bib:me:W00060415000> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Suomalaisen eksegetiikan ja orientalistiikan juuria : Roots of exegetics and oriental studies in Finland" .

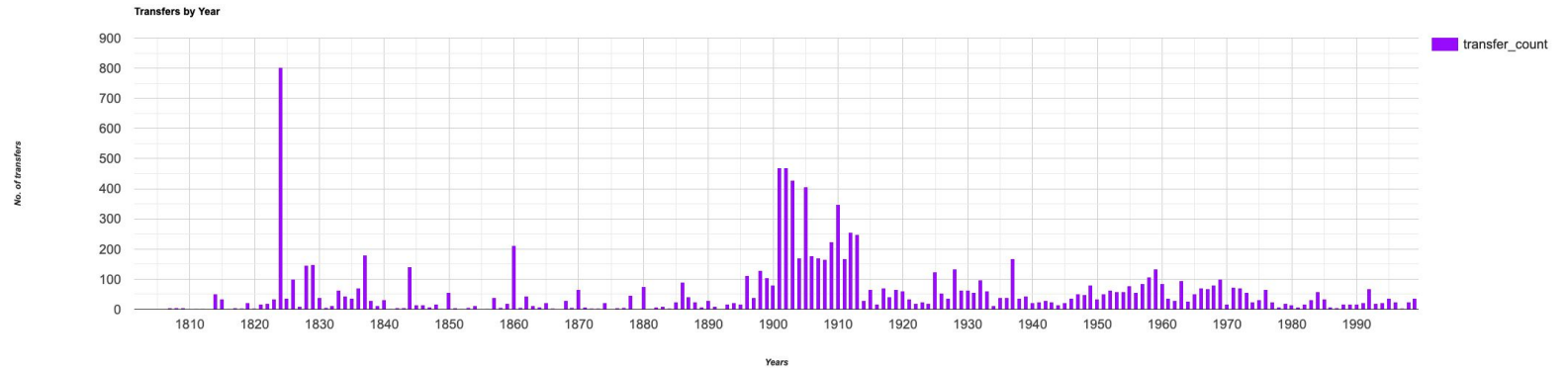
<http://urn.fi/URN:NBN:fi:bib:me:W0006062600> schema:about <http://urn.fi/URN:NBN:fi:au:pn:000103346> ;
  schema:name "Mikael Agricola",
    "Mikael Agricola : elämä ja teokset" .
```



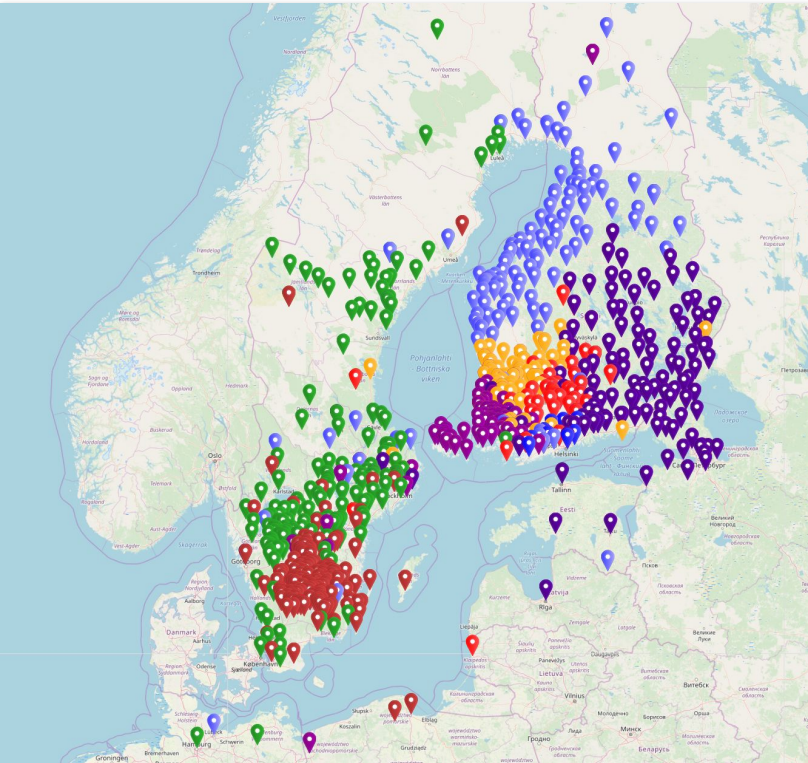
# Visualizations based on SPARQL

```
Query ✕ +  
http://df.fi/mmm/sparql  
1 PREFIX skos: <http://www.w3.org/2004/02/skos/core#>  
2 PREFIX ecrm: <http://erlangen-crm.org/current/>  
3 PREFIX efrbroo: <http://erlangen-crm.org/efrbroo/>  
4  
5 # transfers of custody in 1800-2000  
6  
7 SELECT ?transfer_year (COUNT (*) AS ?transfer_count) WHERE {  
8   ?transfer ecrm:P4_has_time-span ?transfer_timespan ;  
9     ecrm:P701_is_documented_in ?source .  
10  ?transfer_timespan skos:prefLabel ?timespan_label ;  
11    ecrm:P92a_begin_of_the_begin ?timespan_datetime .  
12  BIND(YEAR(?timespan_datetime) AS ?transfer_year)  
13  FILTER(?transfer_year < 2000 && ?transfer_year > 1800)  
14  
15  ?source skos:prefLabel ?source_title .  
16  
17  ?transfer ecrm:P30_transferred_custody_of ?manuscript .  
18  ?manuscript a efrbroo:P4_Manifestation_Singleton ;  
19    skos:prefLabel ?manuscript_name .  
20  
21 } GROUP BY ?transfer_year  
22 ORDER BY ?transfer_year
```

Table Response Gallery **Chart** Geo Geo-3D Geo events Pivot Timeline 193 results in 9.526 seconds Configure Download Help



# Build your own application!



### Tutki henkilöön liittyviä tapahtumia

Sivellä näytetään ista henkilöön liittyviä tapahtumia, niihin liittyvät paikat kartalla sekä tapahtumasarja aikajanailla. Tapahtumat on pommitu biografiakausien tekijänsä.

Henkilöllä on 63 tapahtumaa:

- Syntynyt 20.8.1873 Rantasalmi
- Käynyt kaksi luokkaa Vipurin suomalaisista klassisista lyseosta 1883 - 1887, komee luokkaa Vipurin Aleksisluokasta 1887 - 1900
- ylöopilas Tampereen reaalilyseosta 1900
- ylöopiston pinnusteluksi: 1894 - 1897
- Akkreditointimato Gesellius, Lindgren & Saarinen, perustajajäsen, osakas: 1896 - 1907
- Akkreditointimato Gesellius, Lindgren, Saarinen, Tallbergin talo: 1896 - 1898
- akkreditointi Suomen Polyteknillisessä opistossa 1897
1. palkinto Suomen Ikätyön Ystävien kolmasen työn tuotoistaikajanaissa 1897
- Mark Brandenburg, Saksa Kalustusajajat koti: 1897
- puoliso Mathilda Tony Charotta Oydyin (sittenin Gesellius), 1898-1902
- Parisin maanmantalytöin 1900 palkinnon: 1898 - 1900
- Sipolismen stipendiaatti Saksassa, Ruotsissa 1898 - 1899

### Eiel Saarinen

Map Satellite

A world map with pins indicating event locations. Pins are concentrated in Europe, particularly in Scandinavia and Central Europe, with some pins in North America and Australia.

Google

Elinaikaan: 1880 1890 1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000

Ura

Teokset

Kunniamaininnat

### Eiel Saarinen

A network diagram with Eiel Saarinen at the center, connected to various other individuals. The nodes are color-coded by event type: blue for birth, green for education, red for work, purple for family, and orange for other events.

- Karl Herman Renu
- Jrjo Kekkonen
- Niilo Heino
- Jean Sibellius
- Jyry Blomsleed
- Emil Wikström
- Gösta Serlachius
- Osseil Gahrn-Rallela
- Armas Lindgren
- Eric Otto Woldemar Ehrnrooth
- Johannes Tallberg
- Yrjö Harvia
- Mårten Gabriel Stenius
- Kirimo Mikkola
- Otto-Iivari Meurman
- Tauno Hannikainen
- Wilho Sjöström

- kuulutus, viestikortit
- intonsäädä, luonnontieteet ja tekniikka
- paikat, arvonnien saaneet
- raamattutiede, ankariutum
- kauppa, palvelus, läänne, osuustoiminta
- kuulutus
- paikka- ja tiede
- matkailu ja valtiopäivät
- kasvatust ja kouluks
- maala-, metsä- ja laulutus
- paikallisuut

A grid of individual profiles, each with a photo and a brief bio. The profiles include names like Jella Luoma, Matti Luoma, and others, with their birth and death dates and a list of professions.

# Tools for consuming Linked Data

- Write your own SPARQL queries + info graphics: YASGUI
- Access and process data programmatically: RDFLib (Python), Apache Jena (Java)
- Wrap SPARQL endpoint in a simple REST API: grlc
- Visualize: ResearchSpace, Cytoscape, Palladio
- Build semantic portals: Sampo-UI
- Validate data: ShEx and SHACL validators
- Infer new data: RDFS, OWL reasoners

# Powered by LDF.fi!

- **Legislation and case law: Semantic Finlex**
- **War history: World War I Linked Open Data, WarSampo, WarVictimSampo**
- **Spatial data: place names from National Land Survey, National Archives, Institute for the Languages of Finland**
- **Biographies: BiographySampo, AcademySampo, Vanhat Norssit**
- **Epistolary data: LetterSampo**
- **Corpus linguistics: STRATAS project**
- **Cultural heritage: data from BookSampo, CultureSampo, Semantic Kalevala, MuseumFinland**
- **Bird and weather observations: data from Tiira.fi, Halias Station, Finnish Meteorological Institute**
- **Biological nomenclature: birds, mammals, insects, plants**
- **...and more...**
- **Your dataset?**

# Learn SPARQL! Thanks!

[https://www.wikidata.org/wiki/Wikidata:SPARQL\\_tutorial](https://www.wikidata.org/wiki/Wikidata:SPARQL_tutorial)

<https://programminghistorian.org/en/lessons/graph-databases-and-SPARQL>

The screenshot shows the Wikidata:SPARQL tutorial page. The page title is "Wikidata:SPARQL tutorial". It features a search bar and a navigation menu. The main content area includes a "Contents" table of contents with the following items:

- 1 Before we start
- 2 SPARQL basics
- 3 Our first query
  - 3.1 Autocompletion
- 4 Advanced triple patterns
- 5 Instances and classes
  - 5.1 Property paths
- 6 Qualifiers
- 7 ORDER and LIMIT
  - 7.1 Exercise
    - 7.1.1 Arthur Conan Doyle books
    - 7.1.2 Chemical elements
    - 7.1.3 Rivers that flow into the Mississippi
    - 7.1.4 Rivers that flow into the Mississippi II
- 8 OPTIONAL
- 9 Expressions, FILTER and BIND
  - 9.1 Data types
  - 9.2 Operators
  - 9.3 FILTER
  - 9.4 BIND, BOUND, IF

The screenshot shows the Programming Historian article titled "Using SPARQL to access Linked Open Data" by Matthew Lincoln. The article includes a diagram of a fish network and a table of metadata:

EDITED BY	REVIEWED BY
Fred Gibbs	Patrick Murray-John Jason Hoppler Will Inceley

Additional metadata includes: PUBLISHED 2015-11-24, MODIFIED 2019-07-16, DIFFICULTY Medium, and CC-BY 4.0 license.

This lesson has been translated into Spanish: [Usa de SPARQL para acceder a datos abiertos enlazados](#)

#### Lesson Goals

This lesson explains why many cultural institutions are adopting graph databases, and how researchers can access these data through the query language called SPARQL.