

# Semantic Web

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# Outline

## The idea of Semantic web

### Core of Semantic web

- Metadata, ontologies, reasoning
- Review of the technological solutions and standards

### Application domains

# Fundamental barrier for the development of the web: machine-processability

**The web contents are created for human readers**

- HTML, PDF, JPEG, ...

**Machine mediates and displays, but does not “understand” contents of the web**

- E.g., a Finnish text article

**A web service  $\approx$  machine helps human**

- Requires machine-”understandability” of the contents

**➔ A fundamental contradiction**

# How can we build a more intelligent web?

## 1. Applications are programmed to be more intelligent

- The contents stay as they are
- The machines operate more human-like (Artificial Intelligence)

## 2. Contents are represented in a more intelligent way

- The contents are easier to understand
- Machines stay more or less as they are

## In practice, both ways are needed

- More intelligent systems process more intelligently represented contents

# Approach 1: More intelligent applications

## Automatic interpretation of natural language is difficult

- Free form of the documents
- Semantics of the content

## Non-textual contents

- Pictures, sound, music, video, software, ...
- How to interpret algorithmically?

## More than the document itself is needed for interpretation

- Context + common sense needed
- Fundamental problems of Artificial Intelligence, easy for humans!
- Great scientific and technological challenges

# Approach 2: Contents represented in a more intelligent way

## The foundation of Semantic web

- The information is stored in a way that a machine understands it!
- Human helps the machine
  - *Machine can also help in this (user-friendly tools for semantic content creation)*

## The development began in the beginning of the 2000s

- W3C Semantic Web Activity 2001
- W3C Web Services Activity 2002

# Web generations

## 1G WWW:

- WWW pages for human interpretation
- HTML language

## 2G WWW:

- Structures for human/machine interpretation
- XML language

## 3G WWW: Semantic Web

- Meanings for human/machine use
- RDF(S) language

## 4G WWW: Ubiquitous web for humans and machines

⇒ **Semantics = new foundation for intelligent web services**

- Semantic = “understandable” to machines

# Limitations of non-semantic web: case MuseumFinland

```
<artifact>  
  <id>NBA:H26069:467</id>  
  <target>cup and plate</target>  
  <material>porcelain</material>  
  <creationLocation>Germany</creationLocation>  
  <creator>Meissen</creator>  
</artifact>
```



- This metadata cannot answer the following questions:
  - Find all vessels?
  - Find all ceramic products?
  - Find artifacts manufactured in Europe?
  - Does the city of Meissen manufacture ceramics?



# Semantic web solution: ontologies

NBA-H26069-467

:object "cup and plate" ;

:object\_concept **object:cup** ;

:object\_concept **object:plate** ;

:material "porcelain" ;

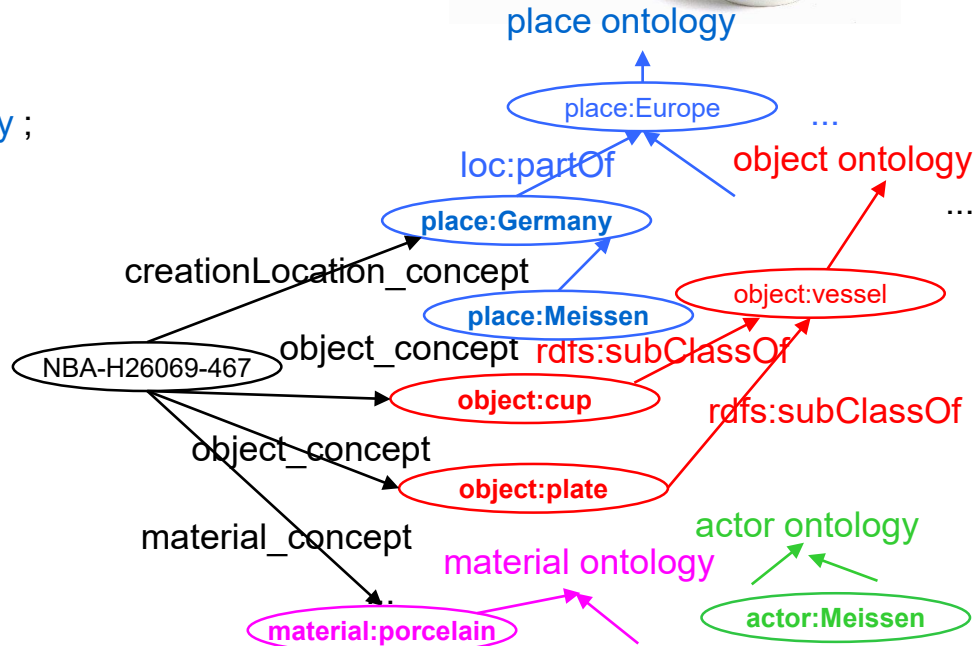
:material\_concept **object:porcelain** ;

:creationPlace "Germany" ;

:creationPlace\_concept **place:Germany** ;

:creator "Meissen"

:creator\_concept **actor:Meissen** .



Find all vessels?  
Find all ceramic products?  
Find artifacts manufactured in Europe?  
Does the city of Meissen manufacture ceramics?

# Case Rijksmuseum Amsterdam: CHIP Demonstrator

## Example in Turtle notation

- VRA metadata schema  
(extension of Dublin Core)
- (Aroyo et al., 2007)

```
rijks:artefactSK-C-K
  vra:type vra:Work ;
  vra:title "The Night Watch" ;
  vra:date "1642" ;
  vra:creator: 500011051 ;           # Rembrandt
  vra:subject iconclass:45F31 ;     # Call to arms
  vra:culture tgn:7006952 ;         # Amsterdam
  vra:material aat:30015050 .      # Oil paint
```

A resource in the TGN  
ontology / vocabulary



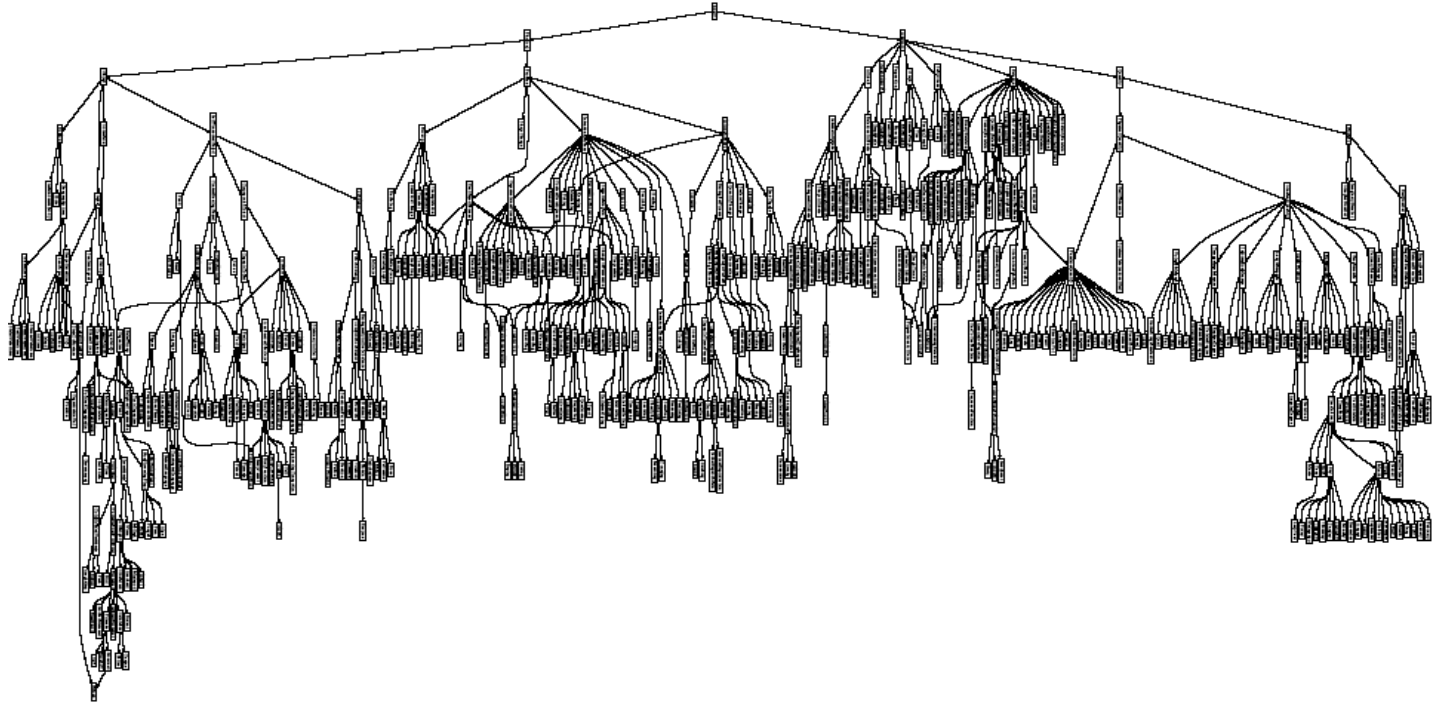
# Amsterdam in TGN



This screenshot shows the 'TGN Full Record Display' for 'Amsterdam (inhabited place)'. The browser address bar shows the URL: [http://www.getty.edu/vow/TGNFullDisplay?find=Amsterdam&place=&nation=&prev\\_page=1&english=Y&](http://www.getty.edu/vow/TGNFullDisplay?find=Amsterdam&place=&nation=&prev_page=1&english=Y&). The page contains the following information:

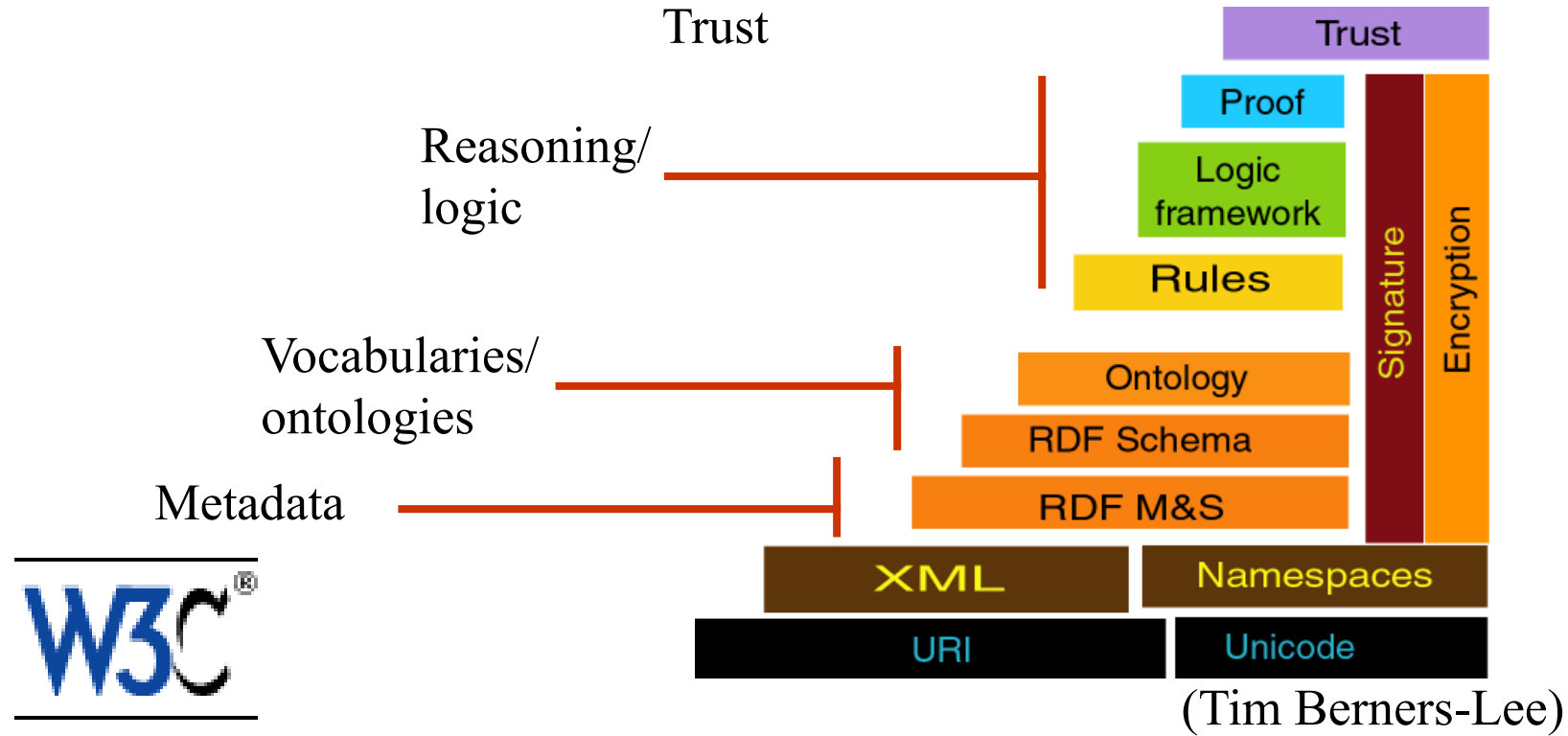
- Coordinates:** Lat: 52 21 00 N degrees minutes; Lat: 52.3500 decimal degrees; Long: 004 54 00 E degrees minutes; Long: 4.9000 decimal degrees.
- Notes:** Located on over 90 islands in the IJ arm of the IJsselmeer. Early inhabitants built dikes on both sides of the Amstel River to prevent flooding, and a dam was built between the dikes in 1270. Chartered in 1306. Became affluent in the 15th century due to trade with Baltic seaports, and was the financial center of the world by 17th century. United Dutch East India Company was founded in 1602, followed by the West India Company in 1621. Capital of the Batavian Republic under Napoleon, later of the kingdom of Holland, and became part of the French Empire in 1810. Under German occupation from 1940-1945. Center of the world's diamond trade.
- Names:**
  - Amsterdam** (preferred, C, V, English-P, Dutch-P)
  - Amstel-dam** (N, J, V) ..... documented in 13th cen., meaning 'dam on the Amstel River'
  - Amsteldam** (N, J, V)
  - Amsteldamme** (N, J, V) ..... earliest form of the name, 13th cen.
  - Amsteddamum** (N, J, V)
  - Amsterdamum** (N, J, V)
  - Amstredamum** (N, J, V)
  - Amstredamense oppidum** (N, J, V)
- Hierarchical Position:**
  - World (face)
  - Europe (continent)
  - Netherlands (nation)
  - North Holland (province)
  - Amsterdam (inhabited place)
- Place Types:**
  - inhabited place** (preferred, C) ..... there possibly was a Roman settlement in the area; modern town probably originated as a fishing village in 13th century
  - city** (C)
  - capital** (C) ..... nominal capital of The Netherlands, though government is located in s-Gravenhage
  - port** (C)
- Sources and Contributors:**
  - Amsterdamum** [VP] ..... Orbis Latinus (1971) 18
  - Amstel-dam** [VP] ..... Encyclopaedia Britannica (1988) 1:357
  - Amsterdam** [VP] ..... Knopf Guides, Amsterdam (1993) 28
  - Amsteldamme** [VP] ..... Knopf Guides, Amsterdam (1993) 28
  - Amsteldamum** [VP] ..... Orbis Latinus (1971) 18
  - Amstredamense oppidum** [VP] ..... Orbis Latinus (1971) 18
  - Amstredamum** [VP] ..... Orbis Latinus (1971) 18
  - Amsterdam** [BNA, GRIPSC, VP] ..... Canby, Historic Places (1984) 1:30; Columbia Lippincott Gazetteer (1961); Encyclopaedia Britannica (1988) 1:357-358; Times Atlas of the World (1992) 12; Webster's Geographical Dictionary (1984)
  - Amsterdamum** [VP] ..... Orbis Latinus (1971) 18
- Subject:** [BNA, GRIPSC, VP] ..... Canby, Historic Places (1984) 1:30; Columbia Lippincott Gazetteer (1961); Encyclopaedia Britannica (1988) 1:357-358; Knopf Guides, Amsterdam (1993) 28; Orbis Latinus (1971) 18; Phadon Art Guide: Holland (1987) 18; Times Atlas of the World (1992) 12; Webster's Geographical Dictionary (1984); Webster's Geographical Dictionary (1988) 46
- Notes:** [VP]

# An Ontology Concept Hierarchy: Standard Upper Merged Ontology SUMO



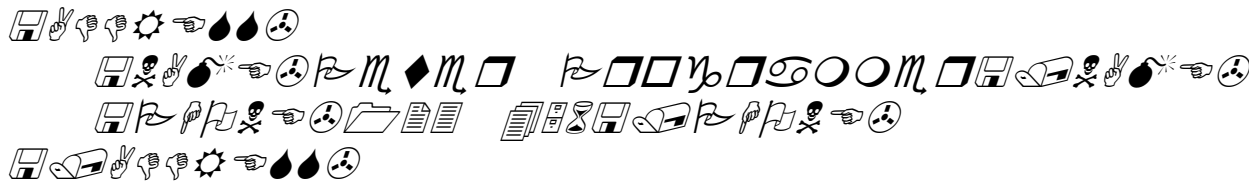
# Technological basis of Semantic Web

# The classical "layer cake model"



# Metadata level

# Why isn't XML alone sufficient for the basis of Semantic web?

- Interpretation of XML languages has to be defined in a domain-specific way
- Combining different XML languages is often difficult
- We need a markup language, whose interpretation is:
  - *Commonly agreed*
  - *Shared across different application domains*
  - *Machine-”understandable”*
- The semantics of XML is only in human brain
  - `<ADDRESS>`
    - `<NAME>Peter Programmer</NAME>`
    - `<PHONE>123 456</PHONE>`
    - `</ADDRESS>`
  - 



# The Semantic web solution: RDF Resource Description Framework

- General metadata description language for web resources
- Relational model, *not* a syntax (as opposed to XML)
  - *RDF description = directed graph*
- Semantics is defined based on logic
- Syntax/serialization
  - *XML-based RDF/XML, especially for machines*
  - *Simple triple notations (N3, Turtle, N-triples) for humans*
- Standardized and commonly used
  - *W3C draft 1999*
  - *W3C recommendation RDF 1.0, 10.2.2004*
  - *W3C recommendation RDF 1.1, 25.2.2014*



# RDF Example

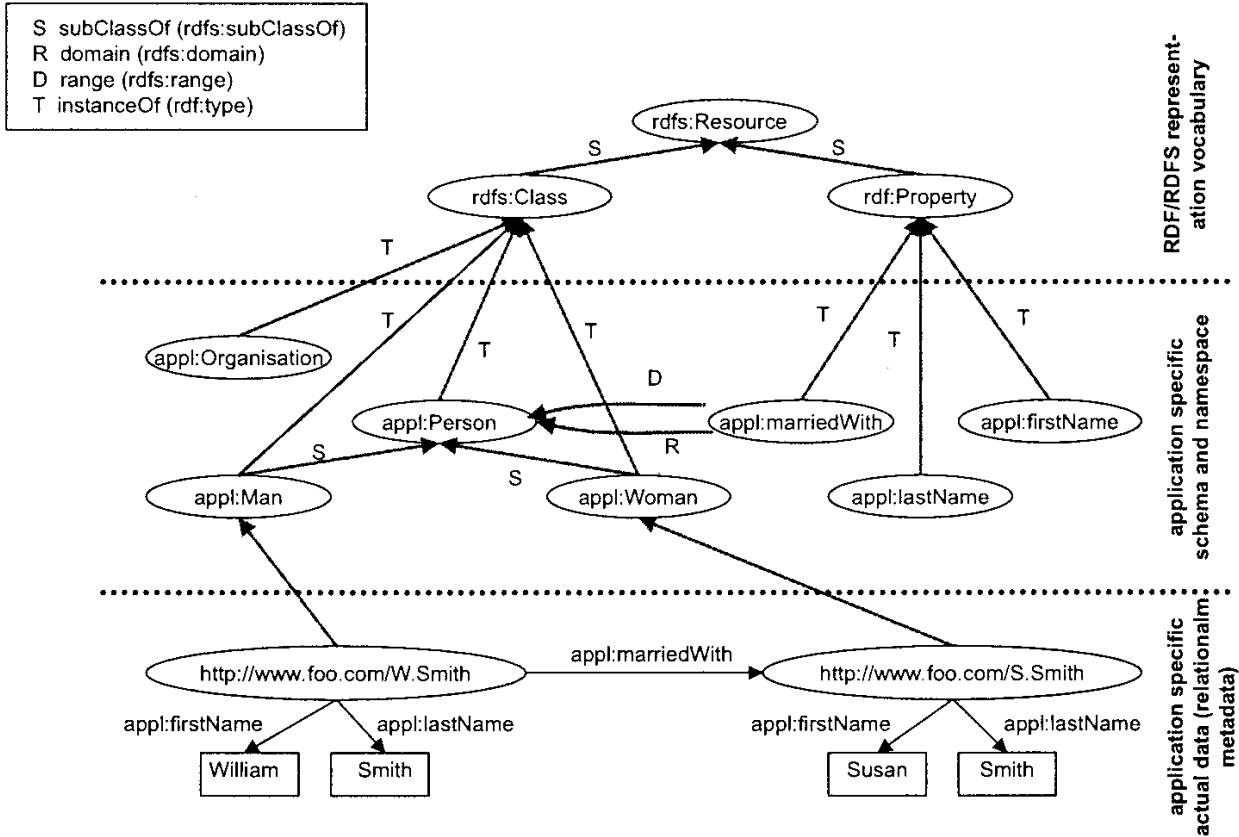


Figure 3.4. An RDF-Schema Example

(Maedche, 2002)

# Metadata schemas

## Standardized templates for representing (meta)data

- A set of elements describing object types (e.g., books in a library)
- Values for the properties describing individual objects (e.g., “War and Piece”)

**Different content types typically require different properties**

# Example: Dublin Core for web documents

## Set of 15 general properties for different content types

- Dublin Core Metadata Element Set (ISO Standard 15836)
  - *Title*
  - *Creator*
  - *Subject*
  - *Description*
  - *Publisher*
  - *Contributor*
  - *Data*
  - *Type*
  - *Format*
  - *Identifier*
  - *Relation*
  - *Source*
  - *Language*
  - *Coverage*
  - *Rights*

# Metadata Schema in HealthFinland

**Table 1.** HEALTHFINLAND Metadata Schema. Obligatory fields are marked in **bold**. Cardinalities are presented in the column C.

	Name	QName	C	Value type	Value range
General metadata	<b>Identifier</b>	<b>dc:identifier</b>	1	URI	
	Locator	ts:url	0..1	URL	
	<b>Title</b>	<b>dc:title</b>	1 <sup>a</sup>	Free text	Non-empty string.
	<b>Abstract</b>	<b>dcterms:abstract</b>	1 <sup>a</sup>	Free text	Non-empty string.
	<b>Language</b>	<b>dc:language</b>	1..*	String	RFC 3066
	<b>Publication time</b>	<b>dcterms:issued</b>	1	String	W3CDTF (ISO 8601)
	Acceptance time	dcterms:dateAccepted	0..*	String	W3CDTF (ISO 8601)
	Modification time	dcterms:modified	0..*	String	W3CDTF (ISO 8601)
	<b>Publisher</b>	<b>dc:publisher</b>	1..*	Instance	foaf:Organization
	Creator	dc:creator	0..*	Instance	foaf:Organization, foaf:Person or foaf:Group
Content classification	<b>Subject</b>	<b>dc:subject</b>	1..*	Concept	YSO, MeSH and HPMulti Ontologies
	<b>Audience</b>	<b>dcterms:audience</b>	1..*	Concept	Audience Ontology
	<b>Genre</b>	<b>ts:genre</b>	1..*	Concept	Genre Ontology
	<b>Presentation type</b>	<b>dc:type</b>	1..*	Concept	DCMI Type vocabulary
	<b>Format</b>	<b>dc:format</b>	1	String	IANA MIME types
	<b>Medium</b>	<b>dcterms:medium</b>	1	Concept	Medium Ontology
	Spatial coverage	dcterms:spatial	0..*	String or concept	DCMI Point, DCMI Box or Location Ontology
Relations	Temporal coverage	dcterms:temporal	0..*	String or concept	W3CDTF, DCMI Period or Time Ontology
	Part of	dcterms:isPartOf	0..*	Document	URI
	Rights	dc:rights	0..*	Free text or document	URI or textual description
	Source	dc:source	0..*	Free text or document	URI (e.g., ISBN) or bibliographical reference
	Reference	dcterms:references	0..*	Free text or document	URI (e.g., ISBN) or bibliographical reference
Translation of Format of	Translation of	ts:isTranslationOf	0..*	Document	URI
	Format of	dcterms:isFormatOf	0..*	Document	URI

<sup>a</sup> Multilingual values are allowed, but only one value in each language.

# HealthFinland portal: Maija's eyeglasses – PDF document on the web



The screenshot shows a Windows Internet Explorer browser window displaying a PDF document. The address bar shows the URL: [http://www.ttl.fi/NR/rdonlyres/142A177B-FE02-4A77-A434-3049C37EBC61/0/maijan\\_lasit\\_tulosta.pdf](http://www.ttl.fi/NR/rdonlyres/142A177B-FE02-4A77-A434-3049C37EBC61/0/maijan_lasit_tulosta.pdf). The document content is as follows:

TTL - Maijan uudet näyttöpäätelasit <http://www.ttl.fi/ergonomia>

## Maijan uudet näyttöpäätelasit

Sopivien silmälasien hankinta tietotyöhön voi useinkin olla pulmallista. Seuraavassa näet, miten ikäniuköinen Maija päätyi silmälasiratkaisuunsa.

Maija sai lähinäön huonoutuessa ahuksi lukulasit. Hän hankki kymmenen vuoden aikana kolmet lukulasit: uudet aina hiukan entistä vahvemmät.

Päätteitä lukeminen alkoi käydä ongelmalliseksi. Maija ei osannut kirjoittaa sokkona joten näppäimistölle näkeminen oli myös välttämätöntä. Niska ja hartat jomottivat, silmiä kurveli ja vasemmassa silmässä oli elohiiri vuokkoauksia.

Lukulasit käytössä.  
Maija joutuu istumaan epämiellyttävään lähellä päätettä. Kynnäpäiden voimakas koukistaminen sitoo käsiä ja vaikeuttaa näppäilytyötä.

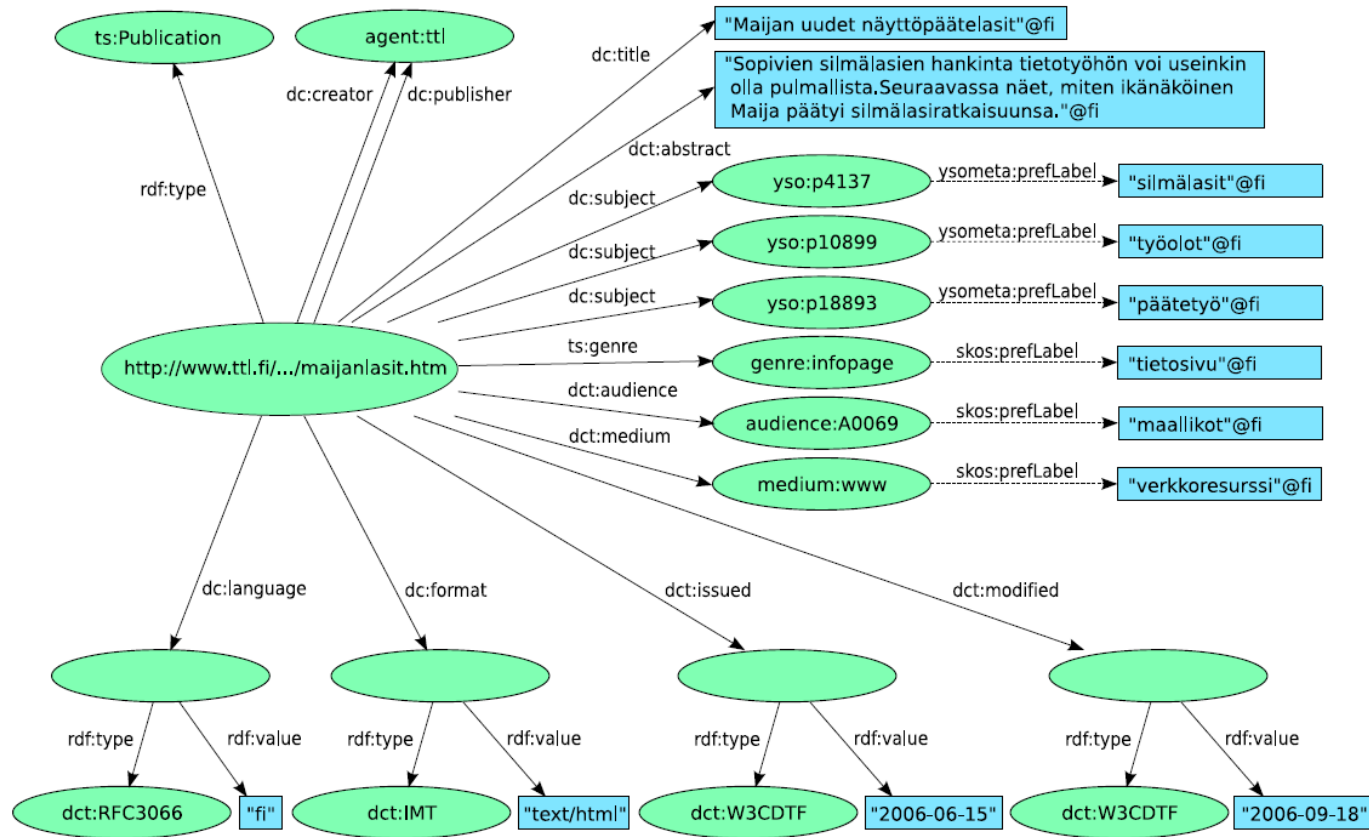


Lukulasit käytössä.  
Maija joutuu taivuttamaan niskaa voimakkaasti eteen ahdakseen näppäimet. Päätteen ja näppäimistön vuorottainen katselu aiheuttaa jatkuvaa niskan liikettä.



1 of 4

# Maija's eyeglasses: metadata in RDF form



# Ontology Level



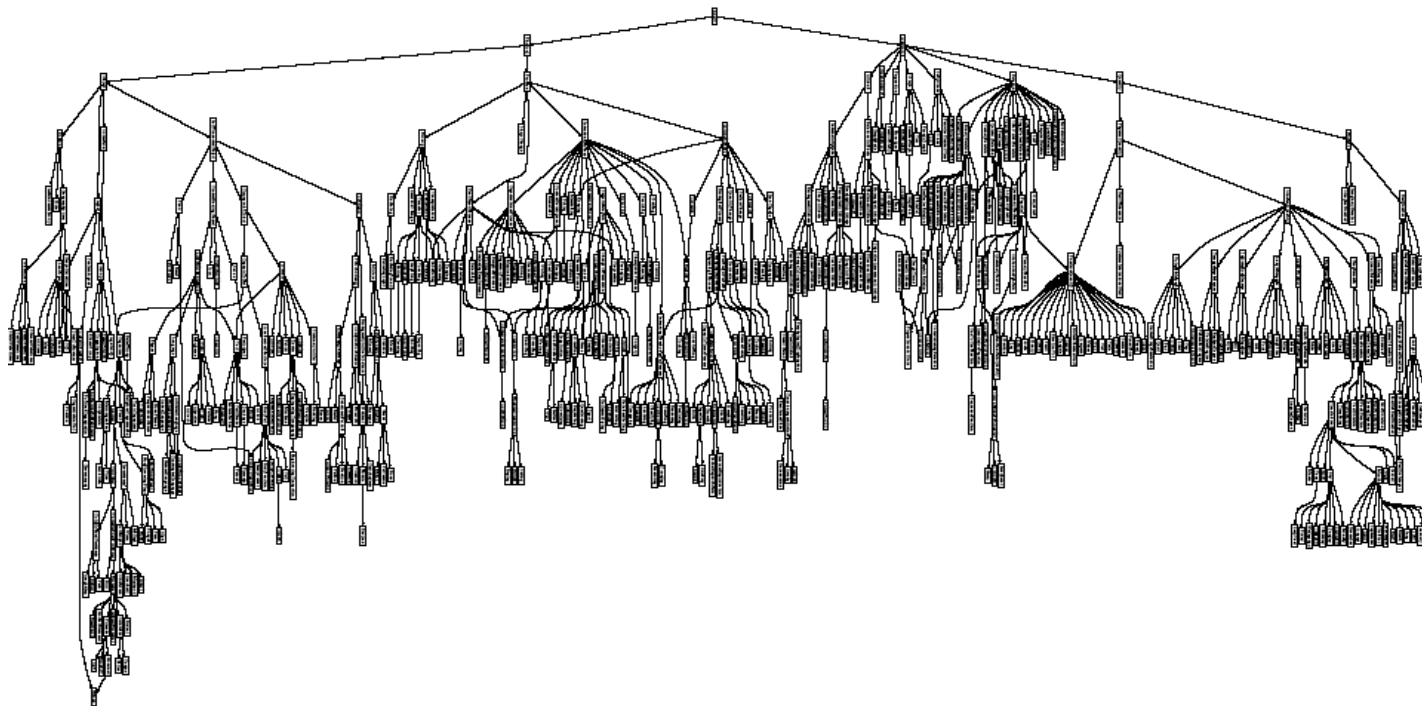
# What is an ontology?

**“An ontology is an explicit specification of a conceptualization  
...definitions need to be couched in some common formalism”**

**(Gruber, 1993)**

- *Explicit: machine can understand*
- *Common (shared): communication is possible*
- *Formal: precisely defined*
- **Defines the concepts/objects and their relations in a given domain**
- **A first requirement for the humans and machines to understand each other**

# Standard Upper Merged Ontology SUMO



# SUMO principal distinctions

- [Entity](#)
  - [Physical](#)
    - [Object](#)
      - [SelfConnectedObject](#)
        - [Substance](#)
        - [CorpuscularObject](#)
        - [Food](#)
      - [Region](#)
      - [Collection](#)
      - [Agent](#)
    - [Process](#)
  - [Abstract](#)
    - [SetOrClass](#)
    - [Relation](#)
    - [Quantity](#)
      - [Number](#)
      - [PhysicalQuantity](#)
    - [Attribute](#)
    - [Proposition](#)

# SUMO Object:

- [Object](#)
  - [SelfConnectedObject](#)
    - [Substance](#)
      - [PureSubstance](#)
        - [ElementalSubstance](#)
          - [Metal](#)
          - [Atom](#)
          - [SubatomicParticle](#)
            - [AtomicNucleus](#)
            - [Electron](#)
            - [Proton](#)
            - [Neutron](#)
        - [CompoundSubstance](#)
          - [Water](#)
          - [Molecule](#)
      - [Mixture](#)
        - [Solution](#)
        - [Mineral](#)
        - [BodySubstance](#)
      - [BiologicallyActiveSubstance](#)
        - [Nutrient](#)
        - [Hormone](#)
    - [CorpuscularObject](#)
      - [OrganicObject](#)
        - [Organism](#)
        - [AnatomicalStructure](#)
      - [Artifact](#)
      - [ContentBearingObject](#)
    - [Food](#)
  - [Region](#)
    - [GeographicArea](#)
    - [AstronomicalBody](#)
    - [Hole](#)
  - [Collection](#)
    - [Group](#)
      - [GroupOfPeople](#)
      - [Organization](#)
  - [Agent](#)
    - [Organism](#)
    - [Group](#)
    - [GeopoliticalAgent](#)
    - [SentientAgent](#)



### AAT Hierarchy Display

[NEW SEARCH](#)

[← back to previous page](#)

[VIEW CHECKED RECORD\(S\)](#)

[CLEAR ALL](#)

[HELP](#)

Click icons ( ) to view the hierarchy. Check boxes to view multiple records at once.

- [Top of the AAT hierarchies](#)
- ..... [Associated Concepts Facet](#)
- ..... [Associated Concepts](#)
- ..... [Physical Attributes Facet](#)
- ..... [Attributes and Properties](#)
- ..... [Conditions and Effects](#)
- ..... [Design Elements](#)
- ..... [Color](#)
- ..... [Styles and Periods Facet](#)
- ..... [Styles and Periods](#)
- ..... [Agents Facet](#)
- ..... [People](#)
- ..... [Organizations](#)
- ..... [Activities Facet](#)
- ..... [Disciplines](#)
- ..... [Functions](#)
- ..... [Events](#)
- ..... [Physical and Mental Activities](#)
- ..... [Processes and Techniques](#)
- ..... [Materials Facet](#)
- ..... [Materials](#)
- ..... [Objects Facet](#)
- ..... [Object Groupings and Systems](#)
- ..... [Object Genres](#)
- ..... [Components](#)
- ..... [Built Environment](#)
- ..... [Furnishings and Equipment](#)
- ..... [Visual and Verbal Communication](#)

**AAT Art & Architecture Thesaurus**  
 - maintained by J. Paul Getty Trust  
 - 7 main classes, 125 000 concepts

abstract concepts  
 agents  
 events  
 materials  
 items  
 archive and library material  
 organisms  
 environments

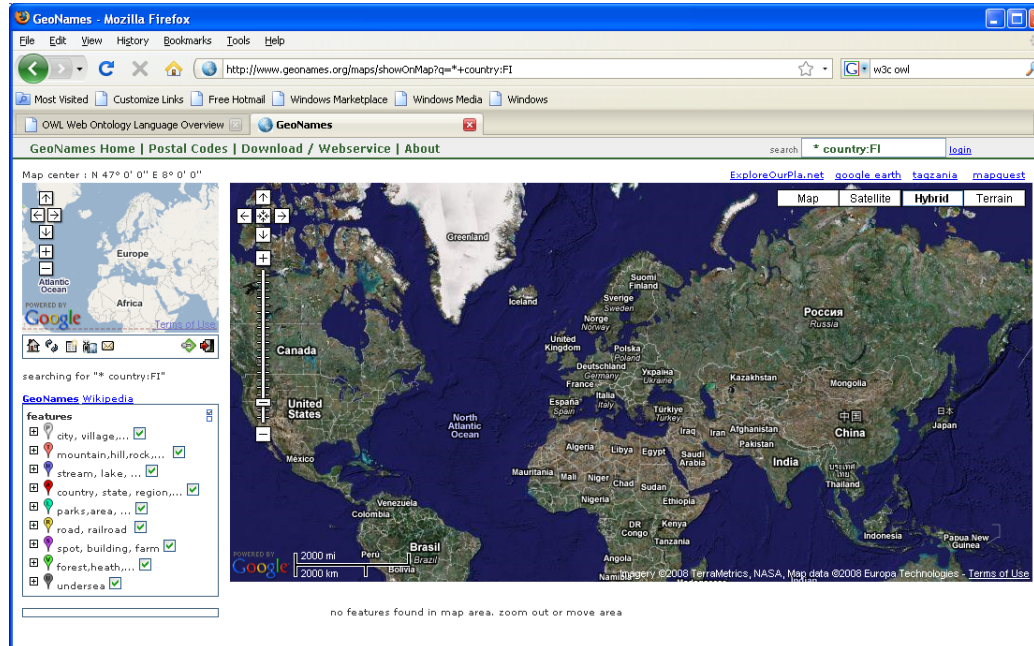
# Universal List of Artist Names ULAN

- 120,000 instances
- 293,000 names

The screenshot shows a web browser window titled "Index (-term:napoleon\*) - Windows Internet Explorer". The address bar shows the URL "http://wtk-4.seco.hu:8080/orkoimjia/main.htm?term=napoleon". The page is titled "Actor Ontology" and features a search bar with the text "Search" and a search input field. Below the search bar, there are two columns of filters. The left column is titled "nationality" and lists various nationalities with their respective counts: American (2), Belgian (1), Brazilian (1), Canadian (2), Corsican (1), French (7), German (2), Italian (11), Romanian (1), Scandinavian (1), SouthAmerican (1), and Swedish (1). Below this list is a "more..." link. The right column is titled "role" and lists various roles with their respective counts: Architect (2), Artist (21), Cardinal (1), Collector (1), DecorativeArtist (1), Draftsman (3), Emperor (1), FigurePainter (1), HistoryPainter (1), Illustrator (1), Landscapist (2), and Lithographer (1). Below this list is a "more..." link. The right column is titled "type" and lists "Person" with a count of 27. To the right of the filters, there is a section titled "Results (27)" which lists 27 search results, each with a name and a brief description. The results are: Angiolini, Napoleone (Italian painter, 1797-1864); Bellardel, Napoleon Joseph (French artist, active 19th century); Bonaparte (French artist, 1811-1832); Bonaparte, Roland-Napoleon (French photographer, 1858-1924); Bourassa, Napoléon (Canadian painter, architect, and sculptor, 1827-1916); Coccetti, Napoleone (Italian painter, born ca. 1850); Coccetti, Napoléon (Italian painter, born ca. 1880); Delaunois, Alfred (Belgian painter 1876-1941); Eugen (Swedish painter and printmaker, 1865-1947); Finni, Napoleone G. (Italian artist, born 1898); Gimbrede, Joseph Napoleon (American engraver, born 1820, active 1841-1860); Heigel, Franz Napoleon (German portraitist, 1813-1888); Le Brun, Napoleone (American architect, 1821-1901); Lepic, Ludovic (French painter, 1839-1889); Maillart, Diogene Ulyssee Napoleon (French artist, 1840-1926); Martinuzzi, Napoleone (Italian sculptor, 1892-1977); Nani, Napoleone (Italian painter, 1841-1899); Napoleon I, Emperor of the French (French ruler, patron, and collector, 1769-1821); Neureuther, Eugen Napoleon (German lithographer, illustrator, and painter, 1806-1882); Orsini, Napoleone (Italian patron and cardinal, ca. 1263-1342); Parisani, Napoleone (Italian painter, 1854-after 1884); Poty (Brazilian engraver, born 1924); Primoli, Giuseppe (Italian photographer, 1851-1927); and Saroni, Napoleon (Canadian photographer, 1821-1896, active in Great Britain). The page number "30" is visible in the bottom right corner.

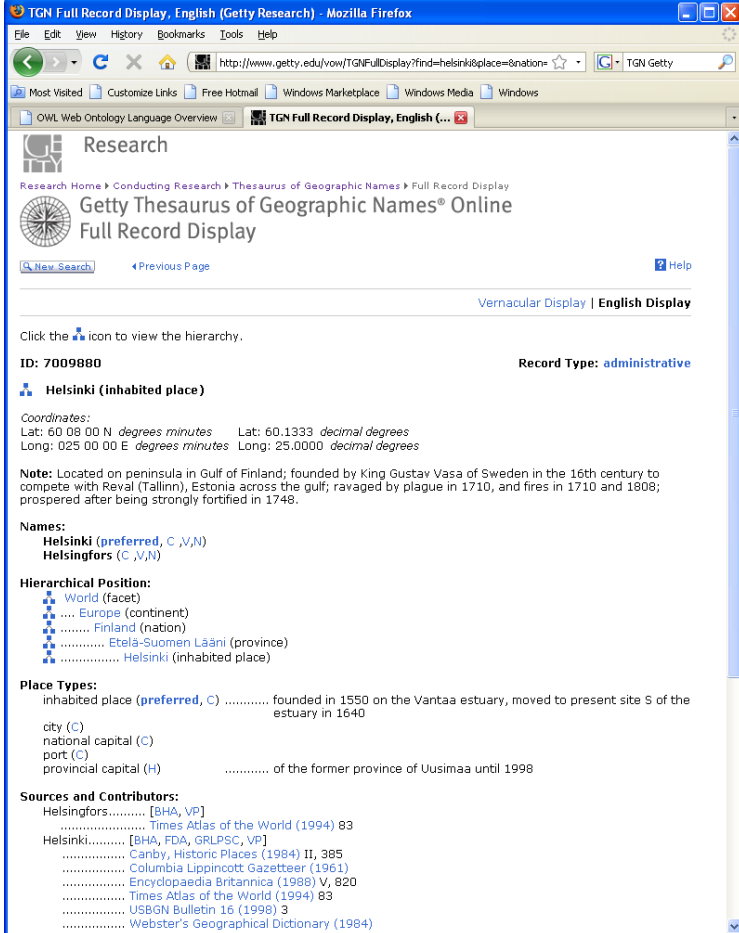
# Geonames

- Classes: 9 feature classes, 645 feature codes
- Instances:
  - 8 million geographical names, 6.5 million unique features, 2.2 million populated places, 1.8 million alternate names
  - Registries and Wiki used for populating the ontology









# TGN Thesaurus of Geographical Names

- 912,000 records
- 1.1 million names, place types, coordinates, and descriptive notes
- Places important for the study of art and architecture

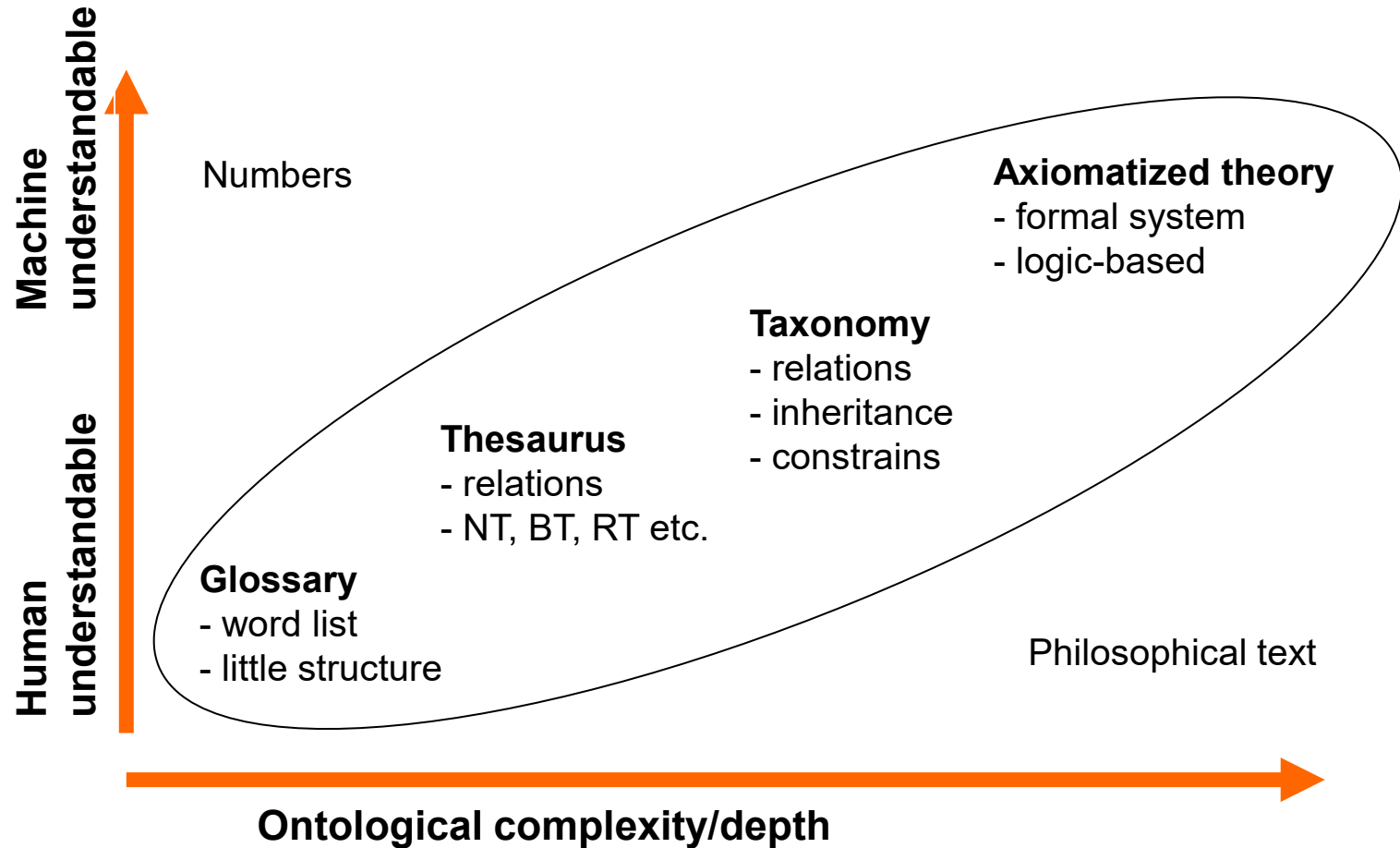


The screenshot shows a web browser window displaying the TGN Full Record Display for Helsinki. The page is titled "TGN Full Record Display, English (Getty Research) - Mozilla Firefox". The browser address bar shows the URL: <http://www.getty.edu/vow/TGNFullDisplay/Find=helsinki&place=&nation=>. The page content includes the following information:

- Research Home** > Conducting Research > Thesaurus of Geographic Names > Full Record Display
- Getty Thesaurus of Geographic Names® Online**
- Full Record Display**
- Buttons: [New Search](#), [Previous Page](#), [Help](#)
- Language options: [Vernacular Display](#) | [English Display](#)
- Instruction: Click the  icon to view the hierarchy.
- ID: 7009880** **Record Type: administrative**
- Helsinki (inhabited place)**
- Coordinates:**  
Lat: 60 08 00 N *degrees minutes*    Lat: 60.1333 *decimal degrees*  
Long: 025 00 00 E *degrees minutes*    Long: 25.0000 *decimal degrees*
- Note:** Located on peninsula in Gulf of Finland; founded by King Gustav Vasa of Sweden in the 16th century to compete with Reval (Tallinn), Estonia across the gulf; ravaged by plague in 1710, and fires in 1710 and 1808; prospered after being strongly fortified in 1748.
- Names:**  
**Helsinki (preferred, C, V, N)**  
**Helsingfors (C, V, N)**
- Hierarchical Position:**
  -  World (facet)
  -  ... Europe (continent)
  -  ..... Finland (nation)
  -  ..... Etelä-Suomen Lääni (province)
  -  ..... Helsinki (inhabited place)
- Place Types:**
  - inhabited place (**preferred, C**) ..... founded in 1550 on the Vantaa estuary, moved to present site S of the estuary in 1640
  - city (C)
  - national capital (C)
  - port (C)
  - provincial capital (H) ..... of the former province of Uusimaa until 1998
- Sources and Contributors:**
  - Helsingfors ..... [BHA, VP]
  - ..... Times Atlas of the World (1994) 83
  - Helsinki ..... [BHA, FDA, GRLPSC, VP]
  - ..... Canby, Historic Places (1984) II, 385
  - ..... Columbia Lippincott Gazetteer (1961)
  - ..... Encyclopaedia Britannica (1988) V, 820
  - ..... Times Atlas of the World (1994) 83
  - ..... USBGN Bulletin 16 (1998) 3
  - ..... Webster's Geographical Dictionary (1984)



# Ontology types



# W3C standards for Semantic web ontologies/vocabularies

## SKOS Simple Knowledge Organization System

- Light-weight semantics
- E.g., for representing existing glossaries, classification schemes, thesauri

## OWL Web Ontology Language

- Rich semantics based on logic
- Supports more reasoning

# Finnish Ontologies: ONKI.fi

**ONKI**   Ontologies and vocabularies   Schema library   Data library   Administration   suomeksi   på svenska   in English

Username:  Password:

**Welcome to the Finnish Ontology Library Service ONKI!**

The ONKI service contains Finnish and international ontologies, vocabularies and thesauri needed for publishing your content cost-efficiently on the Semantic Web. Ontologies are conceptual models identifying the concepts of a domain. They contain machine "understandable" descriptions of the relations between the concepts.

ONKI is published and maintained by [Semantic Computing Research Group SeCo](#). It is part of the on-going project to build a national semantic web infrastructure to Finland (FinnONTO).

**Ontologies and vocabularies**

Browse and search all available ontologies and vocabularies with this online user interface. The ontologies and vocabularies are listed on the front page of this service.

[Browse ontologies and vocabularies](#) >

You can also access any of the available ontologies or vocabularies with the developer APIs listed below.

**Why not give it a go?**

See if any of the available ontologies or vocabularies match your annotation needs by searching with the quick search below. Please observe the selected search language.

Search language:

**Beta services**

The following ONKI services have been released, yet their content is being developed mostly during the project following FinnONTO 2.0.

**Data library**

Datasets published by FinnONTO projects in machine-readable formats (RDF and Linked Data) as well as API access using SPARQL.

**Schema library**

Metadata schema documentation as machine-readable schema descriptions for systems created in the FinnONTO projects.

# ONKI -> Finto.fi


suomeksi på svenska in English

## Finto

The national vocabulary and ontology service Finto opens here in January 2014. The service will provide a user interface for browsing and searching vocabularies. By using the open interfaces, anyone can integrate the provided vocabularies to their applications.

- ☑ The currently provided vocabularies include:
  - ☑ General Finnish thesaurus
  - ☑ General Finnish upper ontology
  - ☑ Medical Subject Headings
  - ☑ Finnish Ontology of Health and Welfare

[Try out the prototype service](#)



Finto is developed in the ONKI project by the Finnish National Library in collaboration with the Ministry of Finance and Ministry of Education and Culture.

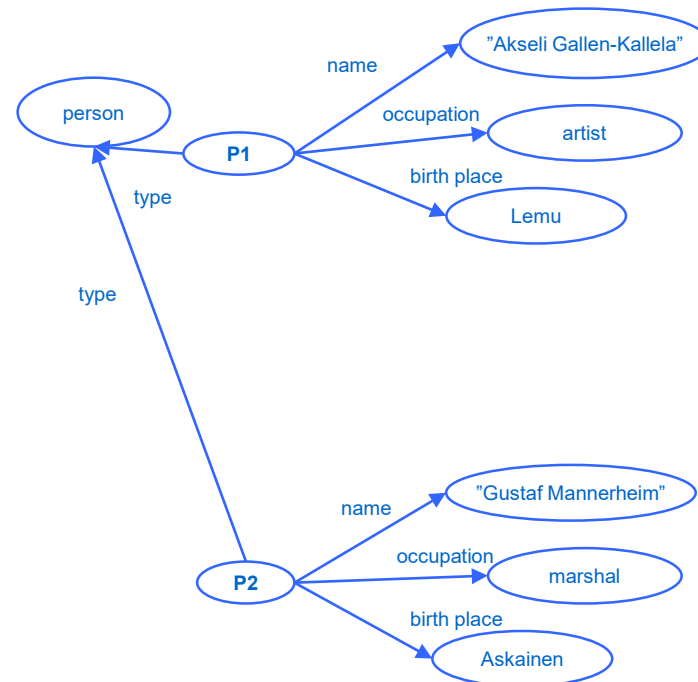
[Read more about the project](#)

The ONKI ontology service was originally developed by the Semantic Computing Research Group at Aalto University as part of the FinnONTO project (2002-2012). This service is available at the address [onki.fi](http://onki.fi).

# Metadata + Ontologies = Linked Data (Web of Data)

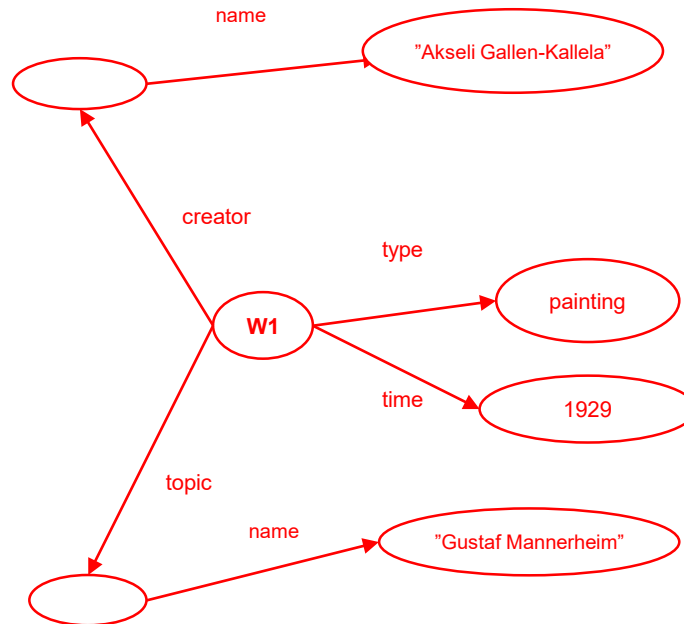
# Finnish Biography center and libraries collect historical data of people

person	name	occupation	birth place	...
P1	Akseli Gallen-Kallela	artist	Lemu	
P2	Gustaf Mannerheim	marshal	Askainen	
...				



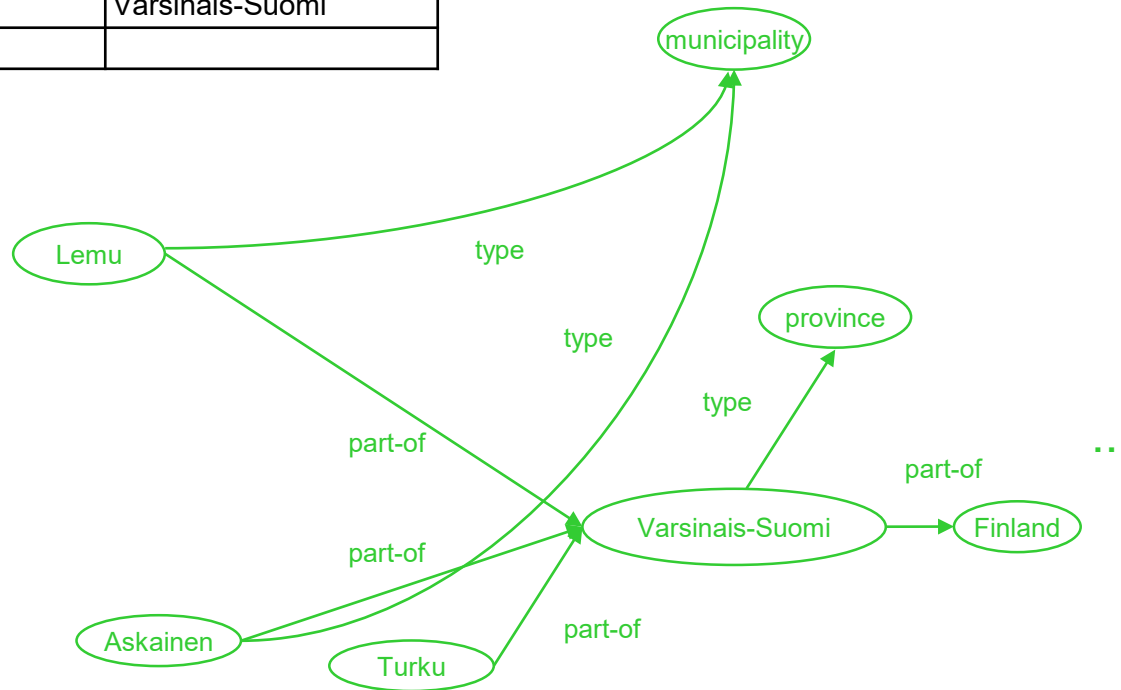
# Museum catalogues paintings

Work	name	creator	time	Topic	...
W1	Portrait of Mannerheim	Akseli Gallen-Kallela	1929	Gustaf Mannerheim	
W2	Aino Triptych	Akseli Gallen-Kallela	1891	Aino, Kalevala	
...					



# Land survey maintains place registries

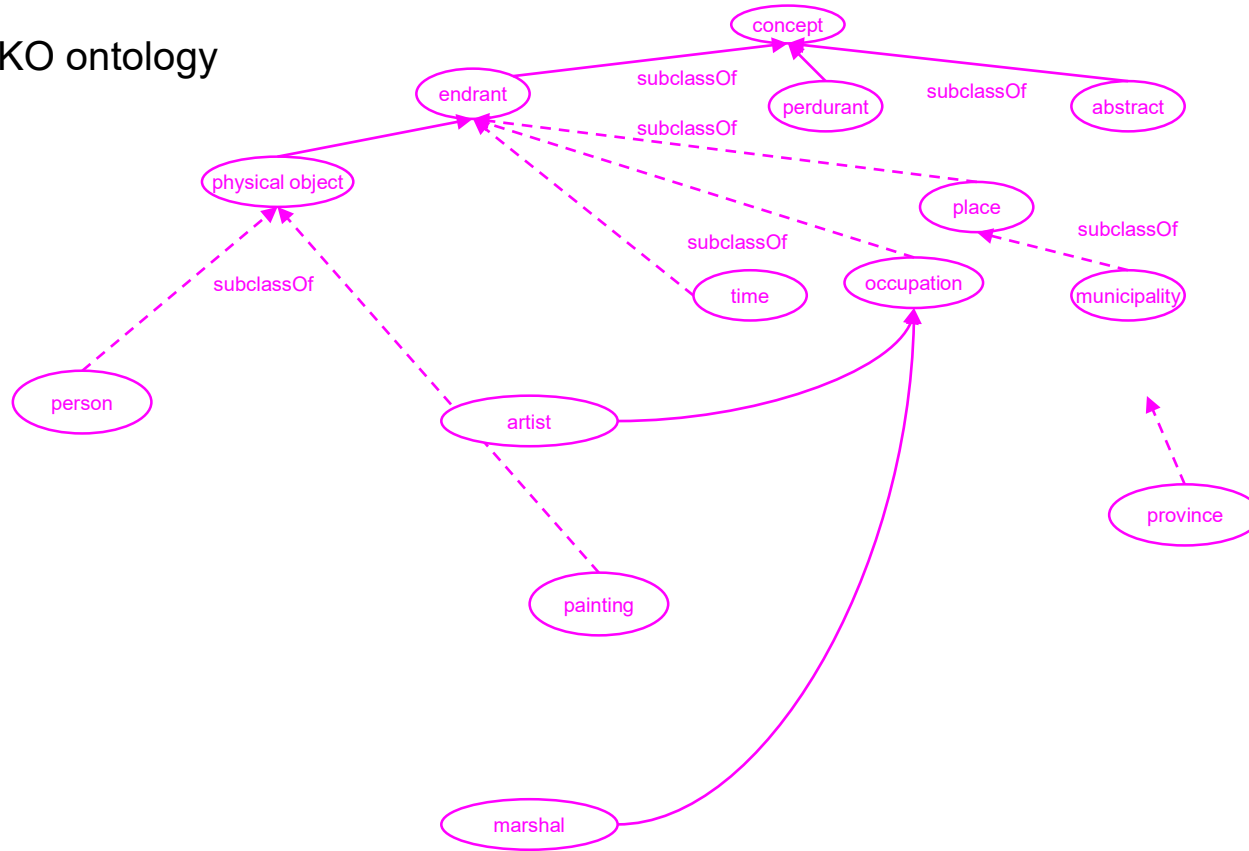
municipality	province
Askainen	Varsinais-Suomi
Helsinki	Uusimaa
Lemu	Varsinais-Suomi
Turku	Varsinais-Suomi
...	



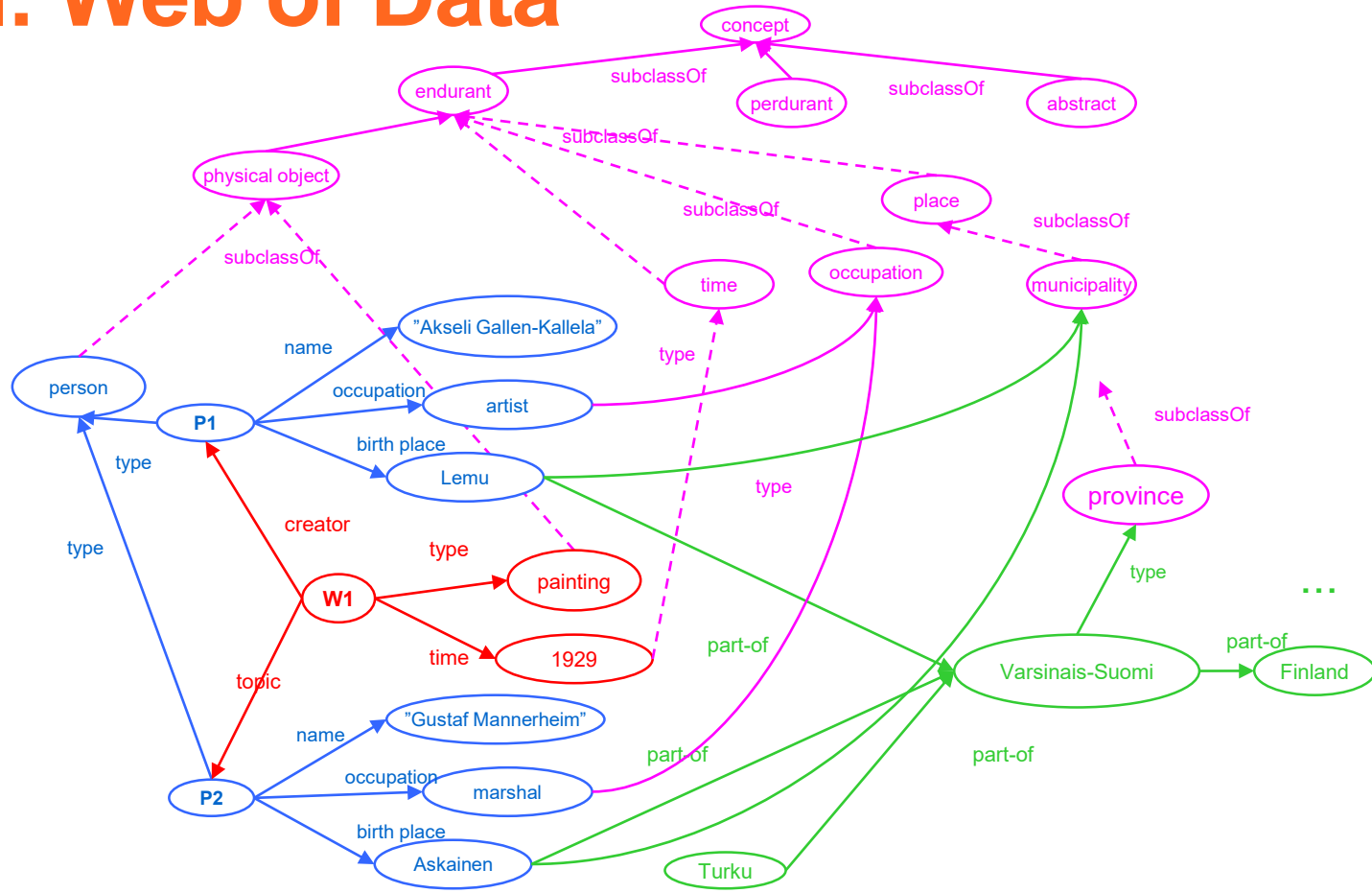


# National library builds ontologies

KOKO ontology



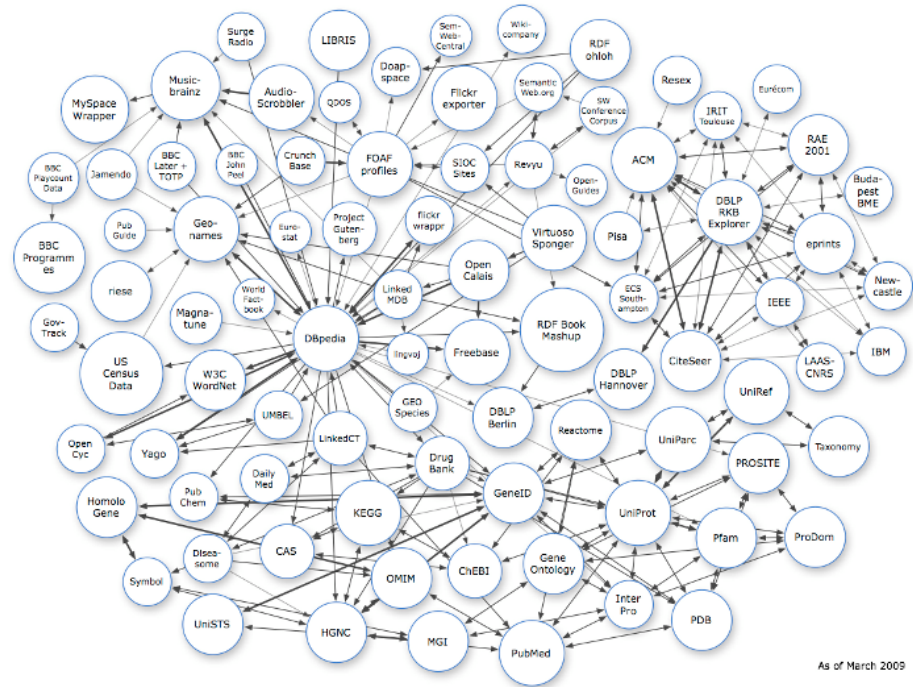
# Semantic RDF graph combines them all: Web of Data



# Linked Data – Web of Data

- Utilization of distributed work
- Aggregating massive cross-domain contents
- Linked Open Data thinking
- Semantic portals

<http://linkeddata.org>



# Rule level

# The idea of rules

- Semantic web semantics is based on **logic**
- Logic: “new” information can be derived from old by reasoning

# Rule Markup Language RuleML

## Standardized XML notation for rules

$\text{hasParent}(?x1, ?x2) \wedge \text{hasBrother}(?x2, ?x3) \Rightarrow \text{hasUncle}(?x1, ?x3)$

```
<ruleml:imp>
  <ruleml:_rlabel ruleml:href="#example1"/>
  <ruleml:_body>
    <swrlx:individualPropertyAtom swrlx:property="hasParent">
      <ruleml:var>x1</ruleml:var>
      <ruleml:var>x2</ruleml:var>
    </swrlx:individualPropertyAtom>
    <swrlx:individualPropertyAtom swrlx:property="hasBrother">
      <ruleml:var>x2</ruleml:var>
      <ruleml:var>x3</ruleml:var>
    </swrlx:individualPropertyAtom>
  </ruleml:_body>
  <ruleml:_head>
    <swrlx:individualPropertyAtom swrlx:property="hasUncle">
      <ruleml:var>x1</ruleml:var>
      <ruleml:var>x3</ruleml:var>
    </swrlx:individualPropertyAtom>
  </ruleml:_head>
</ruleml:imp>
```

# Application example: MuseumFinland recommends

## Inference rules tell machine about the world

- E.g., that "student's cap" is related to "parties"
- E.g., that entities are related to each other if their superclasses are related to each other
- Etc.

## Based on the graph of metadata+ontologies, machine can:

- Reason interesting new relations between museum items, and
- Provide them to end users as recommendation links

# Application example: MuseumFinland



The screenshot shows the MuseumSuomi website in Internet Explorer. The page title is "MuseoSuomi - Suomen museot semanttisessa webissä". The search results show an item titled "Pullonsuojus, 2 kpl:istuva koira". The item description includes details about the material (glass bottle, knitted wool), manufacturer (Tapio Wirkkala), and date (1962-1970). The item is part of the collection at the Lahti Historical Museum. The page also features navigation links, a search bar, and a list of related items.

**MuseoSuomi**  
- Suomen museot semanttisessa webissä -

Uusi haku | Takaisin hakusivulle | Ohjeet | Tietoa ohjelmasta | MuseoSuomi-palautte | English Tutorial | About MuseumFinland

(←) Kohteet (4132) (→)  
(←) Pullonsuojus, 2 kpl:istuva koira (→ Ripustin:henkari, 'Finn Lassie')

**Pullonsuojus, 2 kpl:istuva koira**

**Materiaali:** viinapullo: lasi, pulonsuojus: lanka  
**Valmistaja:** Karhulan lasitehdas, Tapio Wirkkala  
**Valmistusaika:** 1962, 1970-1 n.  
**Valmistustekniikka:** viinapullo: tehdasvalmisteinen, pulonsuojus: käsityötä  
**Käyttäjät:** Eero Kallio  
**Käyttöpaikka:** Etelä-Suomen lääni, Suomi  
**Asiasana:** ALKOHOLJUOMAT, ELÄINHAHMOT, KORISTE-ESINEET  
**Mitat:** pullon pohjan halkaisija 6,5cm, korkeus 22,5cm, pulonsuojuksen korkeus 29,0cm  
**Museokokoelma:** LAHDEN HISTORIAALINEN MUSEO  
**Vastuumuseo:** LAHDEN KAUPUNGINMUSEO  
**Asiasanasto:** Lahden kaupunginmuseon sanasto  
**Eseen numero:** LKMLHMLHMES.95073:154  
**ID:** 95073154  
**Viinapullo:** Alkon Koskenkorvapullo. Lieriömäinen, loivat hartiat. Korkeat ja etiketti puuttuvat. Pulonsuojus: istuvan koiran muotoinen pulonsuojus. Muodossa kahdesta osasta: koiran vartalosta ja päästä. Koiran vartaloon on ommeltu viisi leikkatupsua (jalat ja häntä), ylhäällä lankakiristys. Koiran pää on virkattu talouspaperirullasta leikatun leriön ympärille. Kasvoissa mustat napit silminä, erillinen pieni kuono ja kolme lankatupsua (posket ja päälleä oleva otsanukka).

**Esinetyyppi:**

- [pukineet ja tekstiilit](#) (1803) > [tekstiilit](#) (338) > [sisustus- ja kodintekstiilit](#) (265) > [suojatekstiilit](#) (24) > [irtonaälliset](#) (8)

**Materiaali:**

- [materiaalit](#) (3777) > [tekstiilmateriaalit](#) (691) > [lanka](#) (191)
- [materiaalit](#) (3777) > [muut materiaalit](#) (611) > [lasi](#) (193)

**Valmistaja:**

- [yrietykset](#) (1247) > [Karhulan lasitehdas](#) (3)
- [henkilöt](#) (867) > [mies](#) (413) > [Tapio Wirkkala](#) (5)

**Valmistusaika:**

**Sama käyttäjä**

*Eero Kallio:*

- [Keräilykortti, 14 kpl:tuotemainoskortti, erilaisia](#)
- [Kulho, 4 kpl:jalkiruokakulho](#)
- [Päähine, miehen: turkislakki, 'suikka'](#)
- [Taskuliina, miehen: taskuliinan korvike](#)
- [Jalkineet, miehen: koripallokengät](#)

**Samaan aiheeseen liittyviä esineitä**

*alkoholijuoma:*

- [kanisteri:taskumatti](#)
- [kanisteri:taskumatti](#)
- [kanisteri:taskumatti](#)
- [viinipullo:lasipullo](#)
- [pullo:lasipullo](#)

*eläimet:*

- [kuvakirja: kuvakirja, kangasta](#)
- [helistin: purulelu](#)
- [muovikarhu: vinkuva karhulelu](#)
- [säästölipas: vanerilipas](#)
- [malja: purvati](#)

*koriste-esineet:*

- [luonontausta: mietelausetaulu](#)
- [lyhty: öljylamppu](#)
- [kannu: koristekannu](#)
- [kynntilänjalja](#)
- [maljakko: maljakko](#)

**Sama materiaali**

*lanka:*

- [neuletakki: naisen neuletakki](#)
- [tauhu: kehystetty kirjontatvo](#)



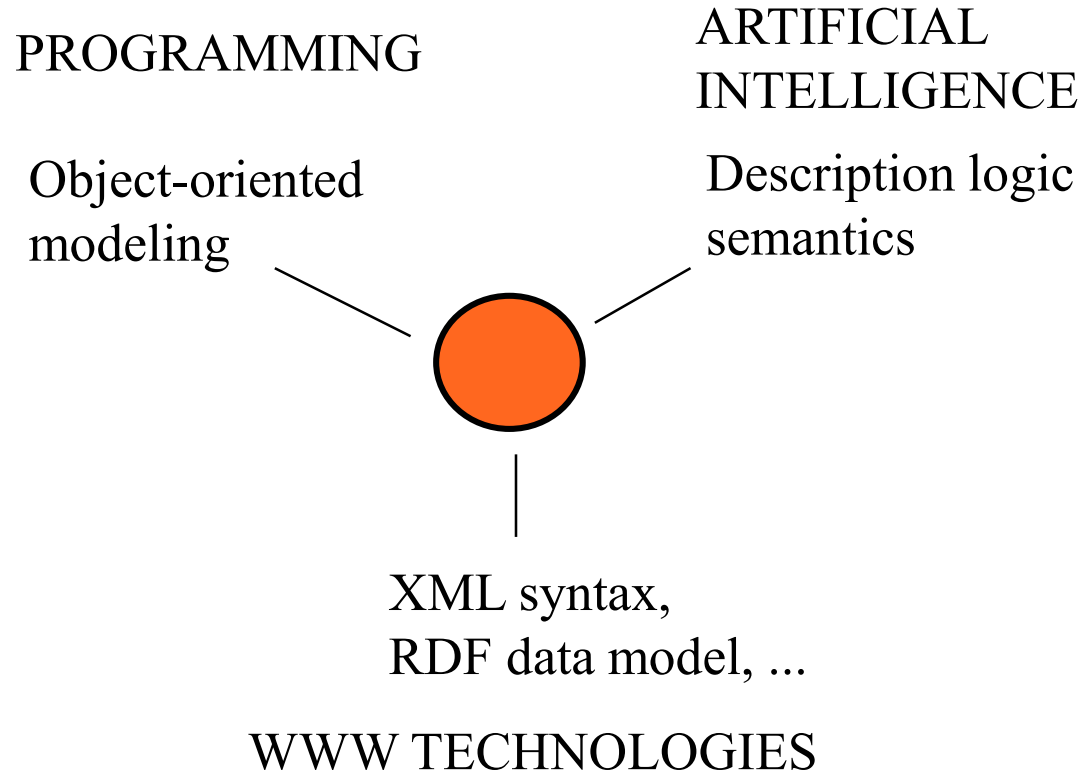
# Application domains of Semantic web

- Interoperability
- Information retrieval
- Recommender systems
- Knowledge management
- E-business and web services
- Profiling and customization

...

<https://www.w3.org/2001/sw/sweo/public/UseCases/>

# What is new?



# What is the Semantic web?

**Content perspective:** A new metadata layer on the web describing its contents in terms of shared vocabularies, i.e., ontologies

- Web as a global database system
- Web of Pages vs. Web of Data

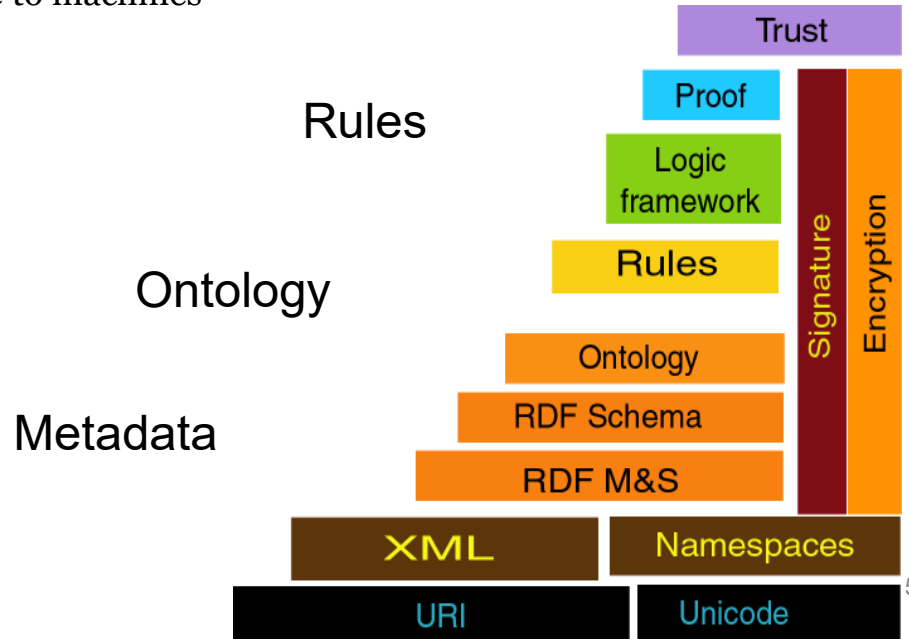
**Application perspective:** Machine-understandable web

- The meaning (semantics) of contents accessible to machines
- Enables human usage
  - *Intelligent web services*
  - *Semantic interoperability*

**Technological perspective:**

Next layers above XML

- W3C standards:  
RDF(S), OWL , SPARQL, etc.



# Questions

