Semantic Web Applications

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LINKED OPEN DATA

- Connect Distributed Data across the Web
- http://linkeddata.org/
- Federated SPARQL queries:
  - Searching Multiple Datasets with One Query

```
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX movie: <http://data.linkedmdb.org/resource/movie/>
PREFIX dcterms: <http://purl.org/dc/terms/>

SELECT ?film ?label ?subject WHERE {
   SERVICE <http://data.linkedmdb.org/sparql> {
      ?film a movie:film .
      ?film rdfs:label ?label .
      ?film owl:sameAs ?dbpediaLink
      FILTER(regex(str(?dbpediaLink), "dbpedia", "i"))
   }
   SERVICE <http://dbpedia.org/sparql> {
      ?dbpediaLink dcterms:subject ?subject
   }
}
LIMIT 50
```

$ arq --query query.sparql --data data.n3

SEMANTIC DATA MASHUP

- http://sig.ma/
- Sig.ma does on the fly, interactive information visualization with bits coming from up to hundreds of sources at the same time. Sig.ma pages have permalinks and can be embedded in web pages.

WIKIS

- Wikis are the most popular **collaborative "informal" knowledge building editors**

- Ward Cunningham et al (1995). The Wiki Way: Quick Collaboration on the Web
  - "Wiki" (/wiːkiː/) is a Hawaiian word for "fast »
  - Wikis are social software
  - Everyone can participate in building global knowledge
  - Quality is the result of social filtering, discussion, negotiation…

WIKIS

- Wiki are simple to use
  - No technical skills
- Wikipedia:
  - 4,106,036 articles in English, 1 321 926 articles in French (November 2012)
  - 6.8 million of registered users
  - In the Top 5 of Web sites…
- MediaWiki

WIKIS: MAIN FUNCTIONALITIES

- Navigation over the page set
- Page creation, edition, linking (simplified syntax)
- History and versioning
- Full-text search

- Users, access control, extensibility

PAGE CREATION, EDITION, LINKING

- Link definition embedded in the wiki text
- Brackets [[a link]]: creates a link to the wiki page named "a_link"

European Union

European Union is an economic and political union of (actually) 27 states, located in Europe.

Germany

Germany is a European Country, and is a member of the European Union.

Germany has borders with France, Belgium, Switzerland capital : Berlin

Belgium

Belgium is a European Country, and is a member of the European Union.

Belgium has borders with France, Germany, luxembourg

capital : Bruxelles

Bruxelles

Bruxelles is a city in Belgium.

Bruxelles is the capital of Belgium.

Bruxelles has around "1200000" people living in.

France

France is a european country and is a member of the European Union

France is bordered by Germany, Belgium, Switzerland, luxembourg

Wiki pages : Text content + links

CATEGORIES AND NAMESAPCES

- Page Category:
  - Organize and structure the content of the wiki
  - Example
    - [[Category:country]]
- Namespace: Like a folder (16)
  - Main namespace
  - User namespace
  - Category namespace
  - Template namespace

Semantic Wikis

- Objective
  - Structure the Wikis for better search and navigation
  - Machine accessible
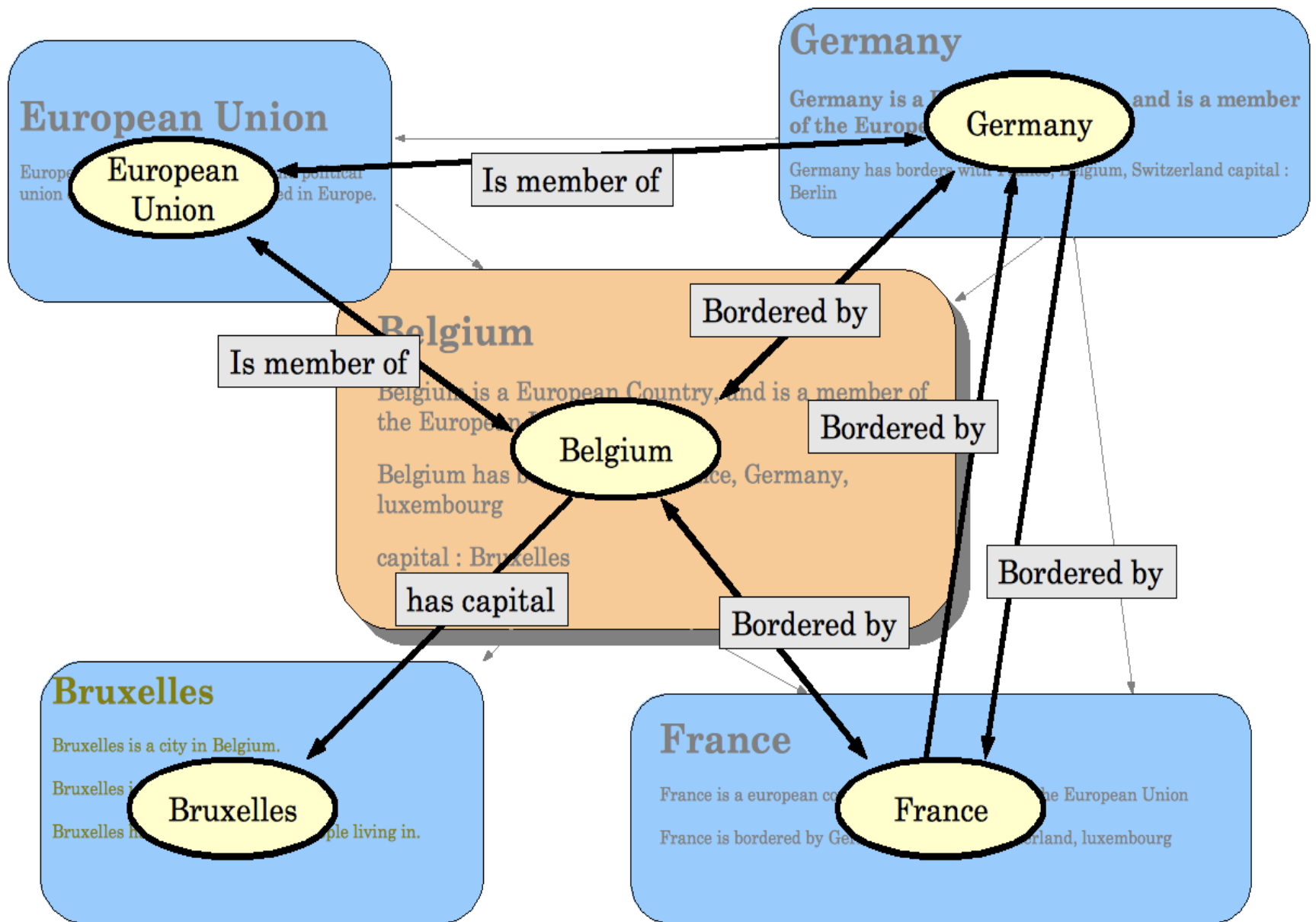   - Efficient data search
    - Reusable knowledge
- How ?
  - Adding formal structures to wikis
  - By using Semantic Web technologies : RDF, SPARQL
  - Integrate inline requests in wiki pages to generate content.

SEMANTIC MEDIA WIKI (SMW)

- Extension of MediaWiki
- No predefined ontology
- Annotations are embedded in wiki text
- One subject for one page
- Mapping semantic annotations to OWL DL
- Query language: SPARQL
- Extensions
  - Halo
  - DSMW

Völkel et al. Semantic Wikipedia. 15th International *Conference on World Wide Web, (WWW), 2006*. ACM.

European Union

European ... political union ... ed in Europe.

Germany

Germany is a ... and is a member of the Europe...

Germany has borders with ... Belgium, Switzerland capital : Berlin

Belgium

Belgium is a European Country, and is a member of the European ...

Belgium has b... ce, Germany, luxembourg

capital : Bruxelles

Bruxelles

Bruxelles is a city in Belgium.

Bruxelles i...

Bruxelles h... ple living in.

France

France is a european c... he European Union

France is bordered by Ger... rland, luxembourg

Is member of

Is member of

Bordered by

Bordered by

Bordered by

Bordered by

has capital

European Union

Germany

Belgium

Bruxelles

France

Semantic wiki : wiki pages + concepts & data connected by relations

ANNOTATIONS OF WIKI PAGES

- [[property::value]]

Properties in the wiki ...

- ... can be introduced as needed
- ... have their own wiki pages
- ... may be given a datatype

Examples: Capital of, Population, Startdate, Name, Homepage, ...

Source:Semantic MediaWiki in 15 minutes Markus Krötzsch

ORGANIZING DATA IN SMW

Datatypes in the wiki …

- … affect how data values are displayed
- … influence searching and browsing
- … are usually not user-defined

Examples: Number, Text, Page, Date, URL, …

MAPPING SEMANTIC ANNOTATION INTO OWL DL

- Mapping

Formal grounding of SMW annotations: OWL DL mapping

SMW	DL	OWL
Simple Pages	Individual names	OWL-Individuals
Category pages	Class names	OWL-Classes
Property pages	Roles	OWL-Properties
Type pages	Individual names	OWL-Individuals

Mapping Semantic Annotation into OWL DL

Table 1. Representation of OWL constructs in Semantic MediaWiki.

OWL	Semantic MediaWiki
OWL individual	normal article page
owl:Class	article in namespace Category
owl:ObjectProperty	article in namespace Relation
owl:DatatypeProperty	article in namespace Attribute
Statement about element *page*	**Syntax in wiki-source of** *page*
object-property	[[property_name::object_article]]
attribute-property	[[property_name:=value_string]]
rdf:type *class_name*	[[Category:*class_name*]] (on article pages)
rdfs:subClassOf *class_name*	[[Category:*class_name*]] (on category pages)

Object Property

Object Property
hasCapital
borderedBy
locatedIn
memberOf

Attribute property

Attribute property
Population

Classe_name

Classe_name
Country
Europe
Asia
Est
West
EU
City

individual

individual
France
Germany
Belgium
Poland
Syria
Paris
Bruxelles
Berlin
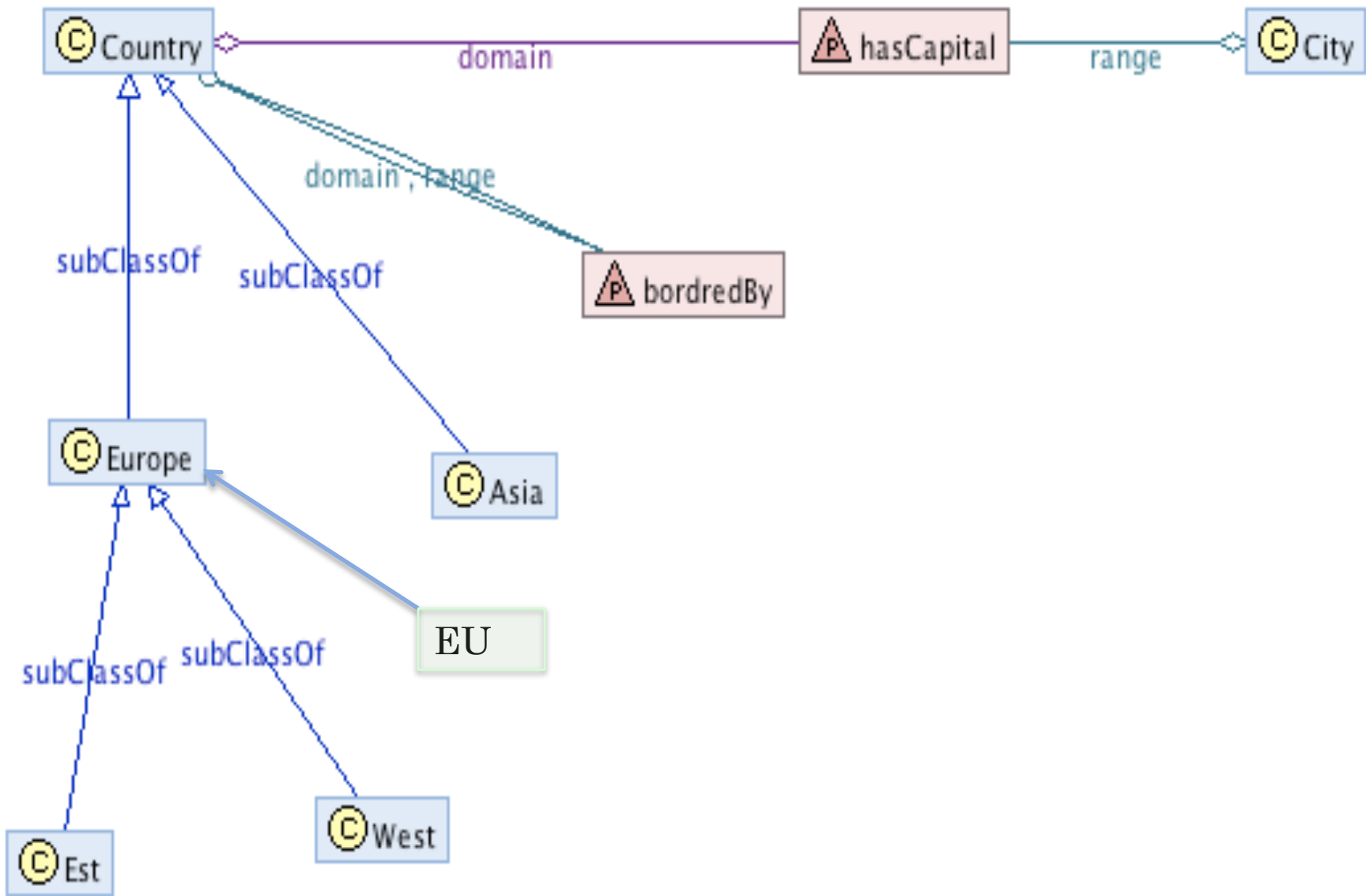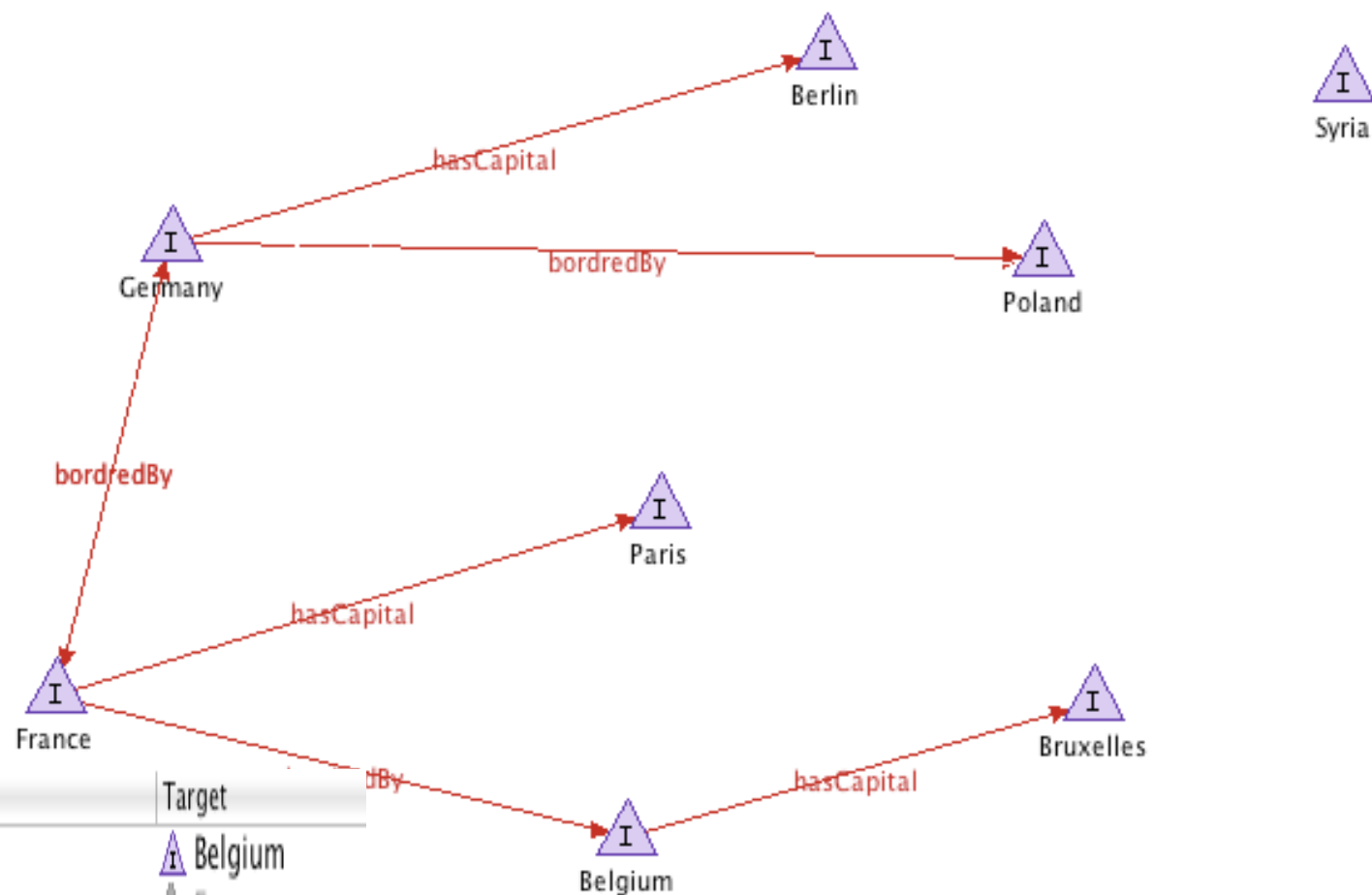
Belgium

Belgium is a European Country and member of European Union. Belgium has borders with France, Germany, Luxembourg.

Capital: Bruxelles

Facts about Belgium			RDF feed
BorderedBy	France +	, Germany +	and Luxembourg +
Has Capital	Bruxelles +		
IsMemberOf	European Union +		

Editing Belgium

B / Ab 🌐 A 🚫 ✍ —

Belgium is a European Country and member of [[isMemberOf:: European Union]]. Belgium has borders with [[BorderedBy::France]], [[BorderedBy::Germany]], [[BorderedBy::Luxembourg]].

Capital: [[has Capital::Bruxelles]]

Storage

Belgium

Belgium is a European Country, and is a member of the European Union.

Belgium has borders with France, Germany, luxembourg

capital : Bruxelles

Wiki Text

➕

Belgium	Has capital	Bruxelles
Belgium	Is member of	European Union
Belgium	Bordered by	France
Belgium	Bordered by	Germany

Triples

Semantic Search

- Easy to use query language
- Syntax similar to annotations
- The query language cane be used in
  - The special page Special:Ask,
  - concepts,
  - and in inline queries.

- Or Use SPARQL query

SPECIAL:ASK

EXAMPLE

- *Give All countries bordered by "France"*
  - [[bordered by ::France]]
  - *Select all pages with the "bordered by" property with a value of "France"*
- Give all countries "Europe"
  - [[Category:Europe]]
  - Select all pages directly or <u>indirectly</u> (through a sub-, subsub-, etc. category) in the category.
- Give all countries with 100000 habitants
  - [[population::100000]]
  - Select all pages annotated as being about countries with population is 100000

EXAMPLE

- AND Logic
  - [[bordered by ::France]] [[Category:Country]]
  [[population::100000]]
- OR Logic
  - [[bordered by::France]] OR [[bordered By::Germany]]
  - [[bordered by::France||Germany]]

- "+" and allow any value for a given condition.
  - [[hasCapital::+]]
  - returns all pages that have any value for the property "hasCapital"

Sub_query

o Find cities that are located in something which is a member of the EU

o [[Category:City]] [[located in::<q>[[member of::EU]]</q>]]

o Chained property
  • [[Category:City]] [[located in.member of::EU]]

EXAMPLES: QUERY ON CATEGORY

- [[Category:Country]]
  - Return all countries
- [[:Category:Country]]
  - return the page category "Country"

EXAMPLE

```
[[Category:City]] <q> [[population::>500,000]] ||
 [[located in::
   <q>[[Category:Country]] [[member of::EU]]</q>
 ]] </q>
```

Expressive features:

- Category (class) and property statements
- Conjunction and disjunction
- Data ranges
- Nesting

No variables, universal statements, negation, number restrictions.
⤳ Queries can be mapped to DL:

```
City ⊓ (∃population.ge(500000) ⊔
   ∃located_in.(Country ⊓ ∃member_of.{EU}))
```

Inline Queries

Basic idea:

Allow dynamic views on wiki data to be embedded into pages.

INLINE QUERIES

{{#ask: *argument 1 | argument 2 | …* }}

{{#ask : [[Category:Country]]
| ?Population
}}

{{#ask: [[Category:City]] [[located in::Germany]]
 | ?Population
| format=ul }}

{{#ask : [[Category:Country]]
| ?Population
| sort = Population
}}

INFERENCES

- Subcategories
  - When asking for all pages that belong to a category, it will also find all pages that belong to any subcategory of that category
  - [[Category:Europe]]
  - [[Category:Europe]] OR [[Category:Est]] OR [[Category:West]]
- **Subproperties**
  - on the page Property:Capital of: [[subproperty of::Property:located in]]
  - a query [[located in::Germany]] will also return the capital Berlin even if no «located in» property is given on that page.

INFERENCES

- **Inferencing features that are not supported**
  - Transitivity (subquery)
  - Inverse properties (some extension add this)
  - Domain and range restrictions
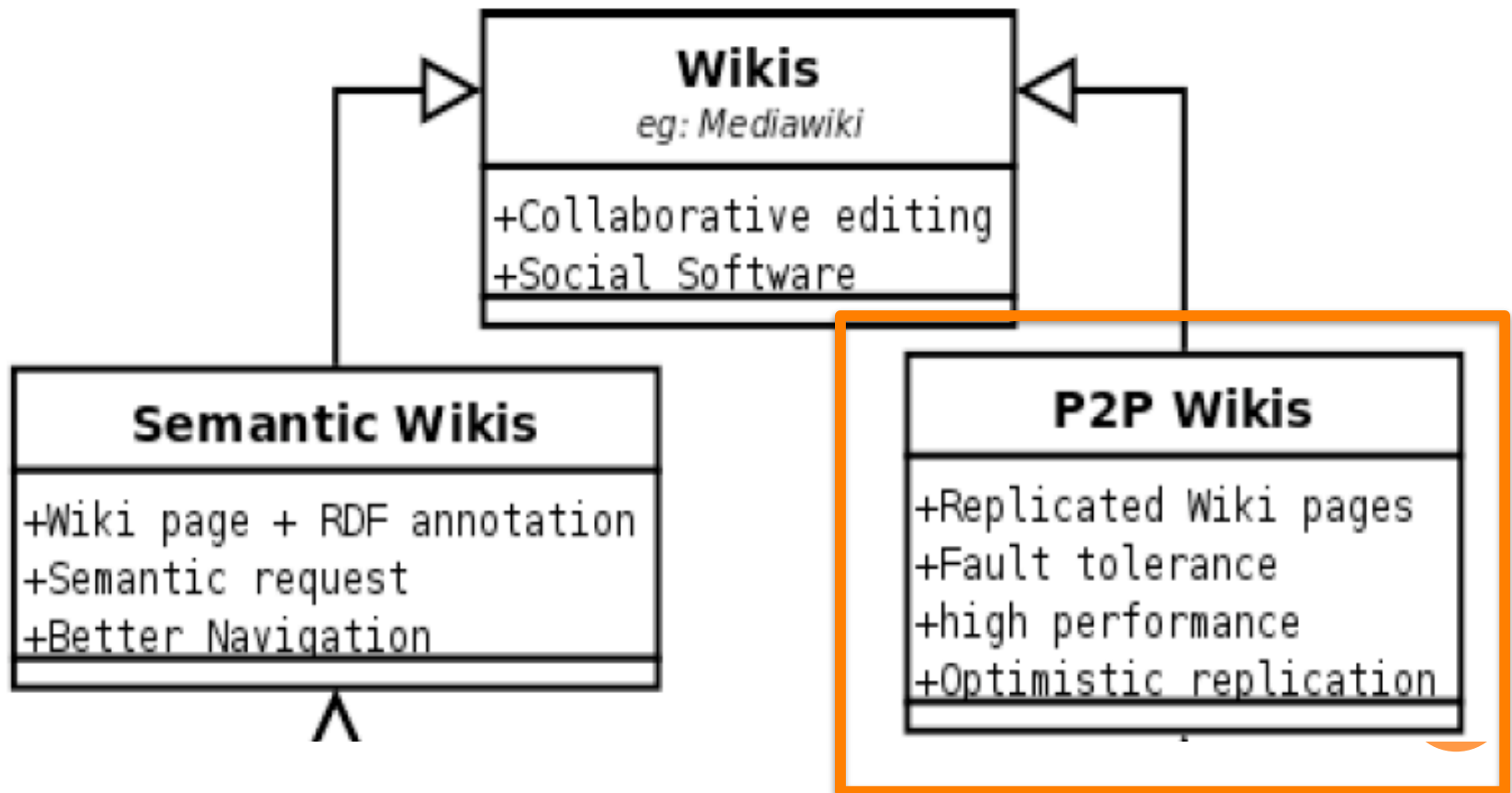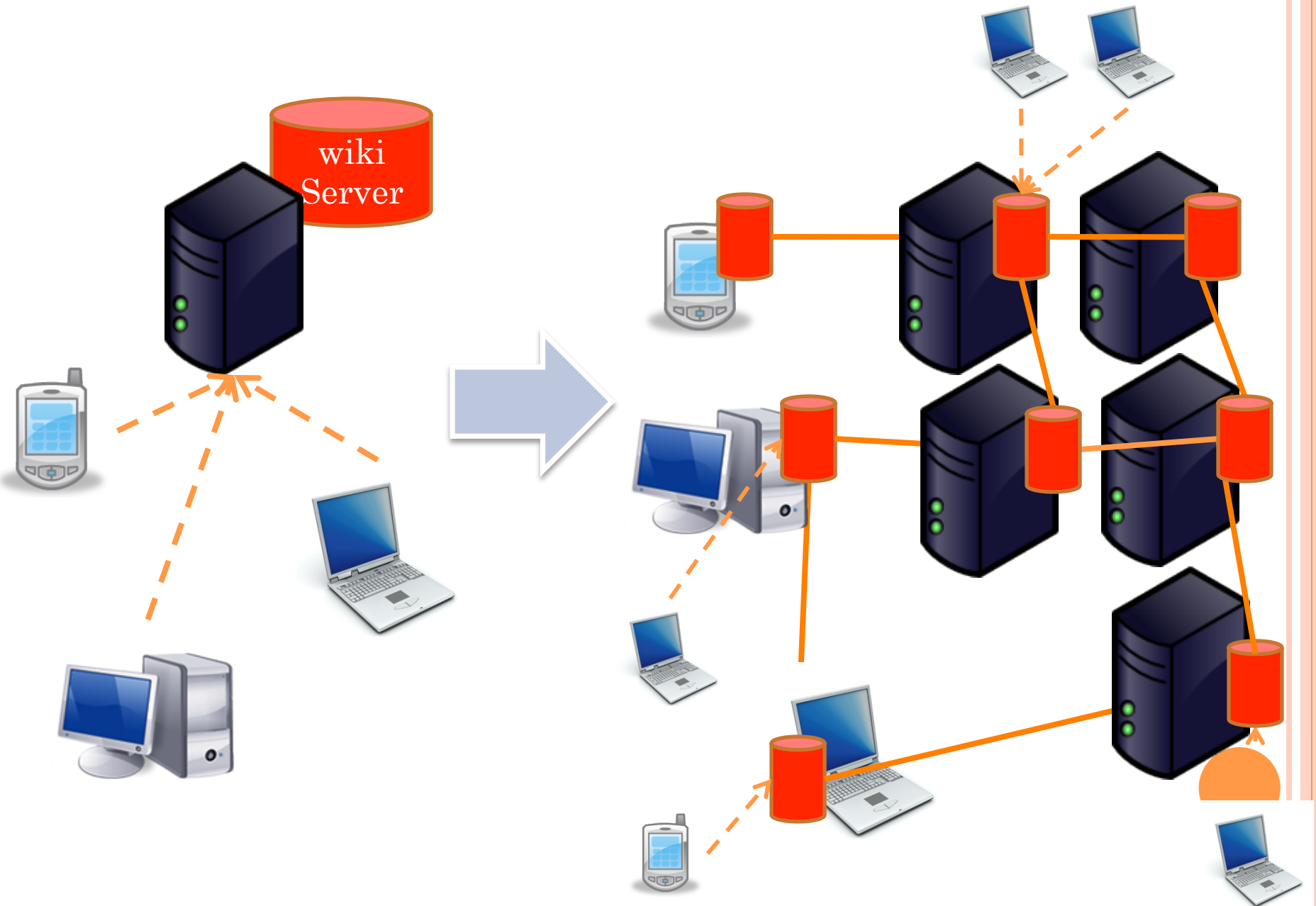 - Number restrictions and functional properties

SMW

- Annotations in context, embedded in wiki pages
- Human readable annotations
- Machines accessible annotations
- Enable the emergence of "Ontology"

- No reasoning, only querying
- Problem: vocabulary
- bordered by:: ; borderedBy:: ; has border with::
- has border:: ; has_border:: ; border:: ;
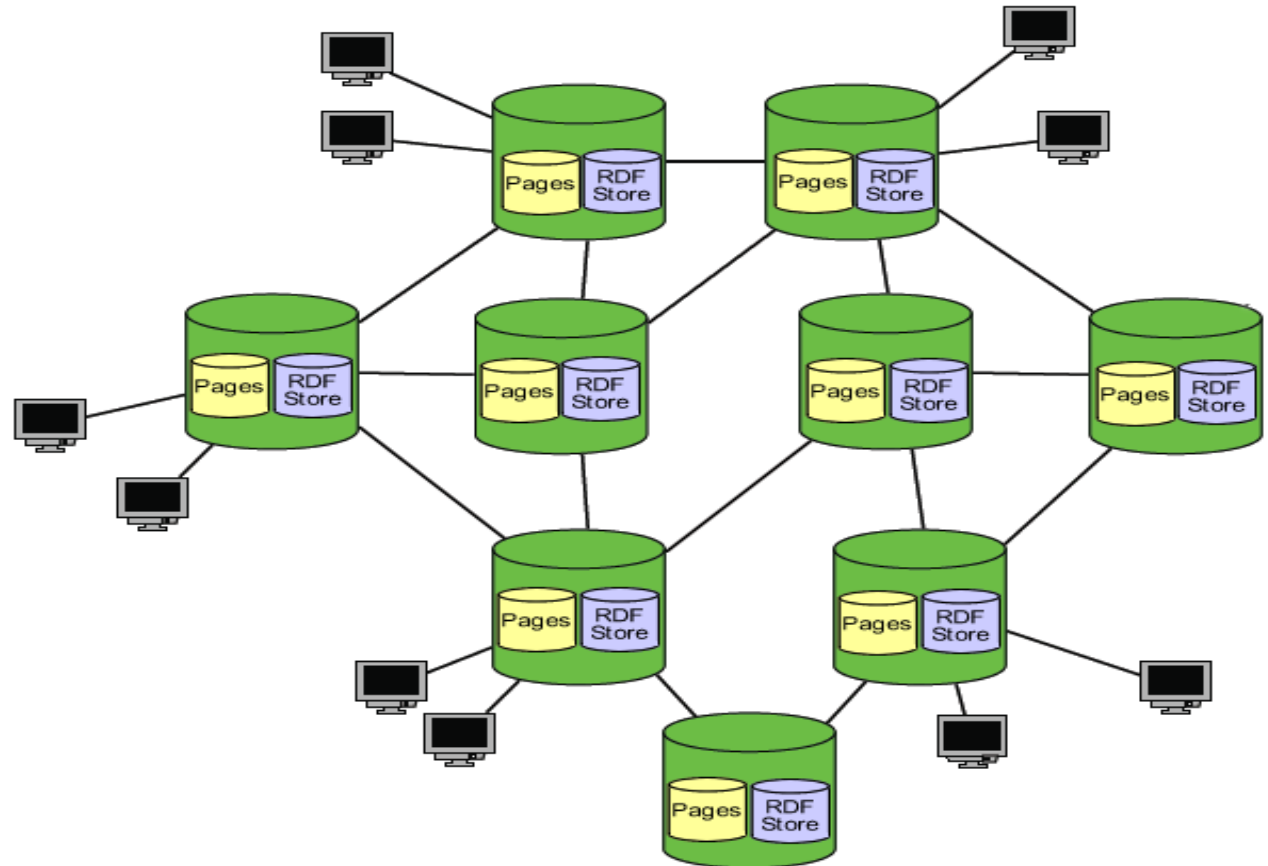- Partially solved through the use of templates

WIKIS EVOLUTIONS

Wikis
eg: Mediawiki

+Collaborative editing
+Social Software

Semantic Wikis

+Wiki page + RDF annotation
+Semantic request
+Better Navigation

P2P Wikis

+Replicated Wiki pages
+Fault tolerance
+high performance
+Optimistic replication

wiki
Server

RESEARCH TOPICS: P2P SEMANTIC WIKIS

- SWOOKI

DSMW

- Distributed Semantic Wiki
- SMW Extension
  - http://www.mediawiki.org/wiki/Extension:DSMW
  - Cooperation over social network
  - Social publish and subscribe
- Allows processes

Multi-synchronous Collaborative Semantic Wikis. Charbel Rahhal, Hala Skaf-Molli, Pascal Molli and Stéphane Weiss. In Wise'09: International Conference on Web Information Systems, 2009

DSMW
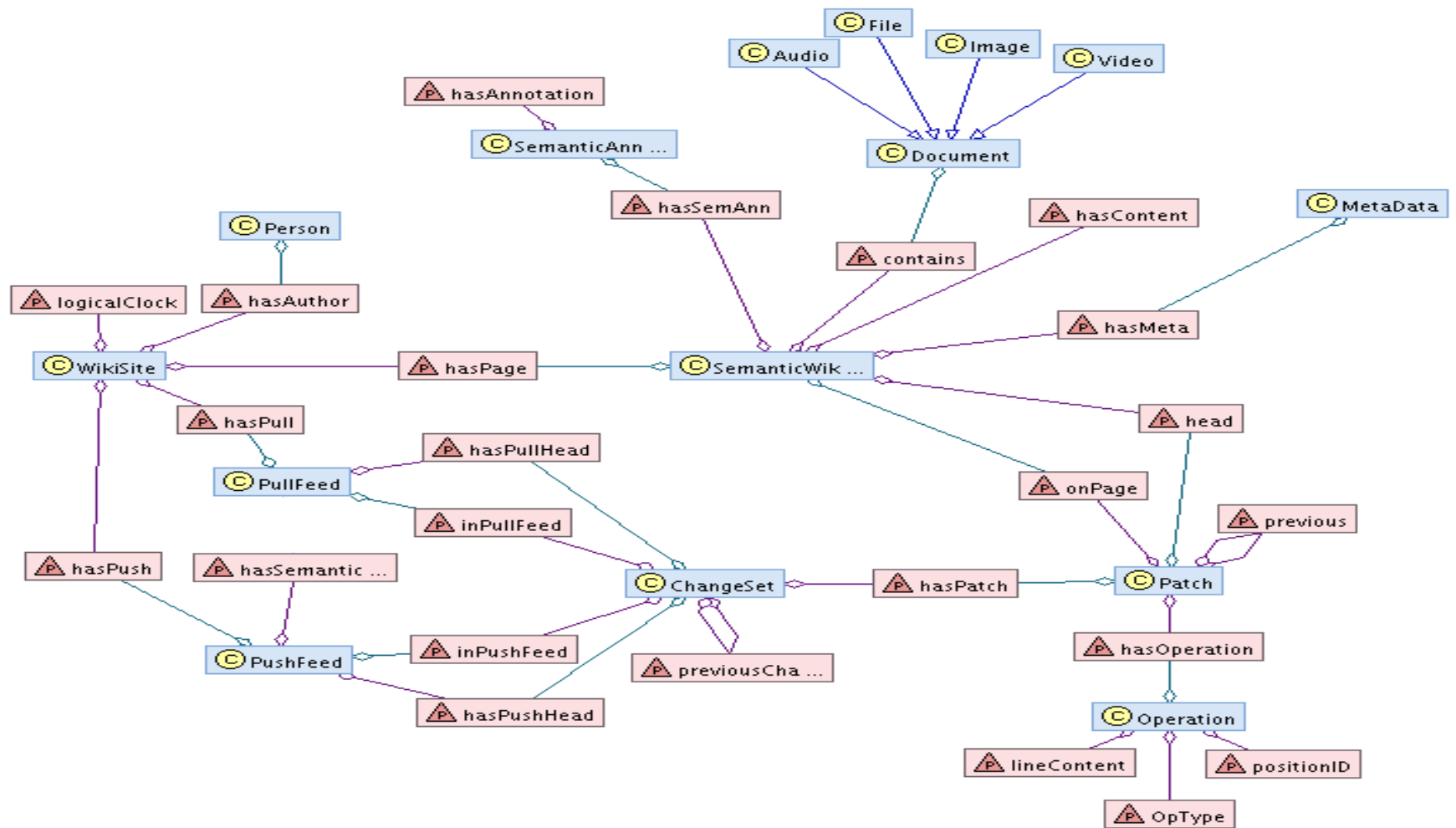
CONCLUSION

- Combine advantage of Wikis and Web Semantic
  - Semantic search
- Semantic wikis enable Social Semantic Web

- *"Experiences gathered in semantic wikis are highly relevant to many other applications of expressive semantics, since they provide typical situations for a number of problems that still need to be overcome by the Semantic Web community.*
- *As semantic wikis have many characteristics of "small semantic webs", many of these issues are equally relevant for the Semantic Web as a whole"*

Reasoning in Semantic Wikis Markus Krötzsch1, Sebastian Schaffert, and Denny Vrandecic1, Reasoning Web 2007, LNCS 4636