Semantic Web and Language Technologies

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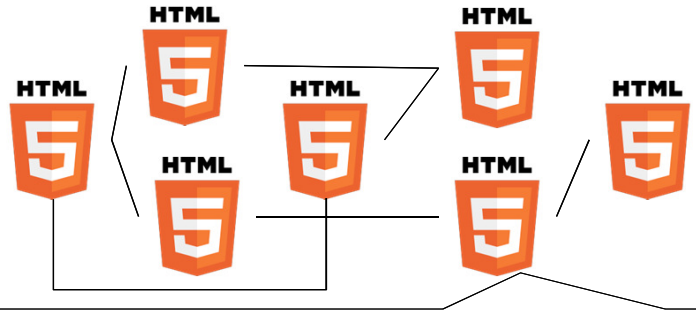
Overview

- What is Semantic Web?
- Technical building blocks
- Vocabularies
- The multilingual Semantic Web?
- LT using or processing Semantic Web
- Semantic Web and language processing workflows
- Linguistic resources and Semantic Web
- Current & future tasks

Building blocks of the Web




```
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```
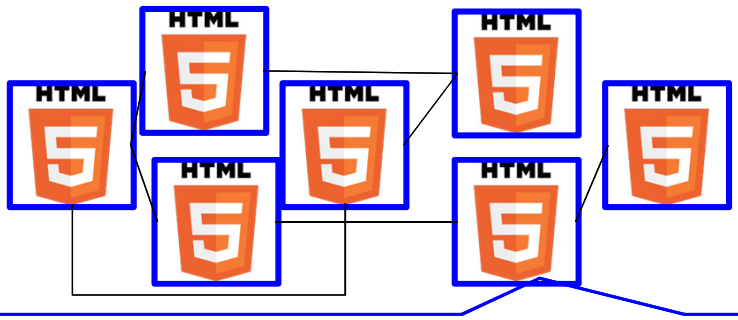


Content

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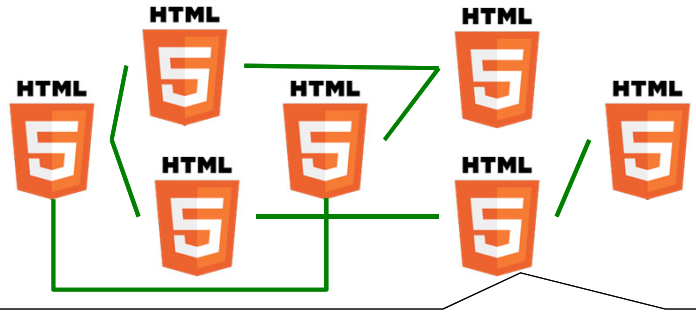
Links (or "identifiers")

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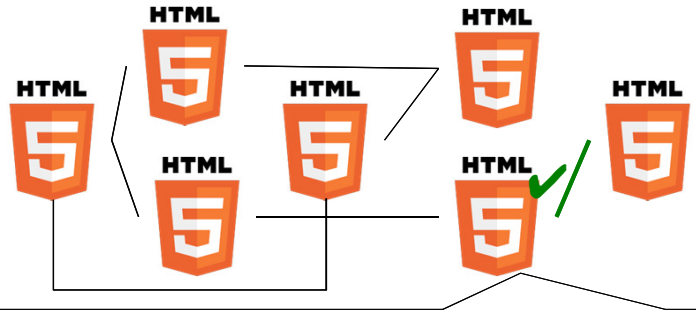
Easy: "Find all content that links to http://creativecommons.org/licenses/by/3.0/"

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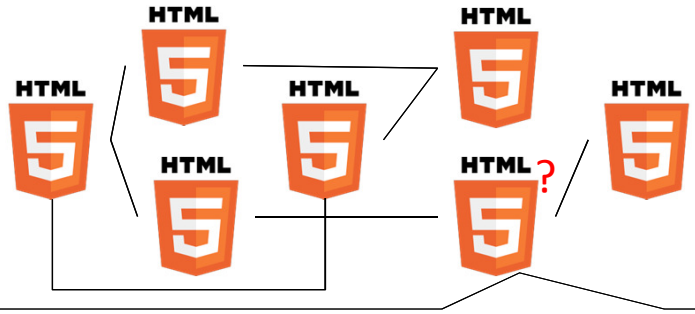
```

Still difficult: “Find all content that links to a creative commons license“

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```
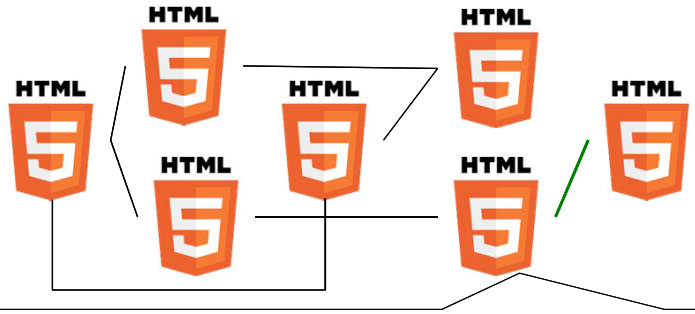


Semantic Web to the rescue = Providing machine readable information on the Web




```
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 href="http://creativecommons.org/licenses/by/3.0/">
   a Creative Commons License</a>. </p>
```
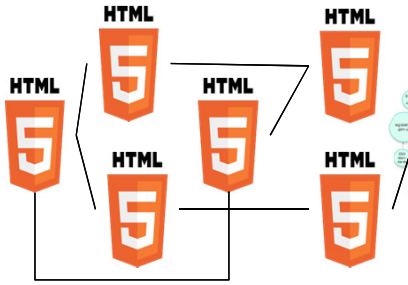
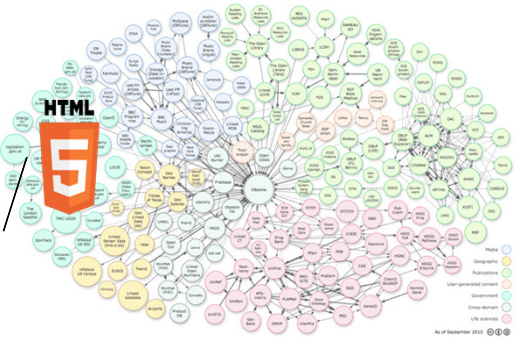

Semantic Web = Providing
machine readable information on the Web

Web of documents

Web of data





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Tasks …

Write Semantic Web data

Create Semantic Web vocabularies

Representation and data creation

Query

… and technologies: past and presence

Write Semantic Web data: RDF (Resource Description Framework)

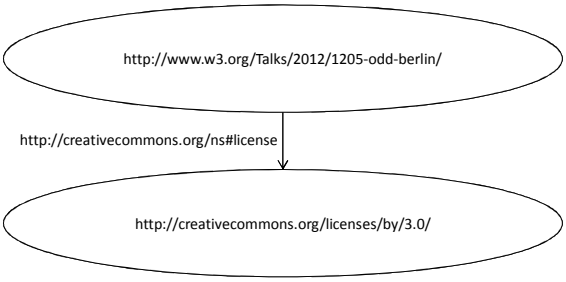
Create Semantic Web vocabularies: RDFS, SKOS, OWL (for complex ontologies)

Representation and data creation: Turtle, RDFa, R2RML, …

Query: SPARQL

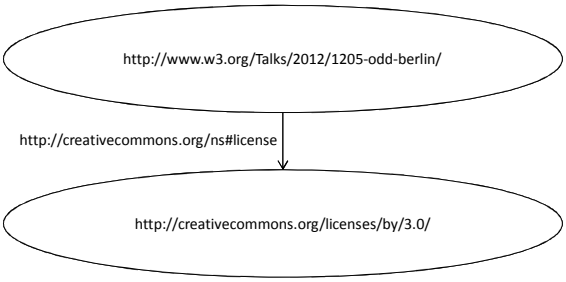
Write Semantic Web Data: RDF "statements"

Reference to license CC BY with an RDF statement (visualization):



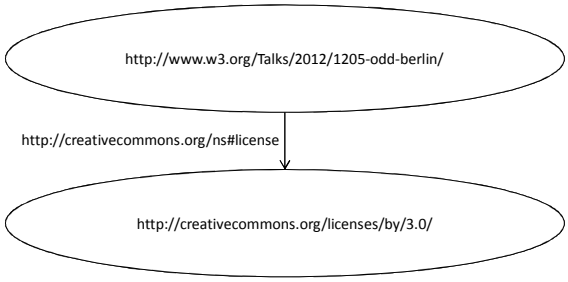
Turtle syntax

Reference to license CC BY with an RDF statement (visualization) + Turtle syntax:

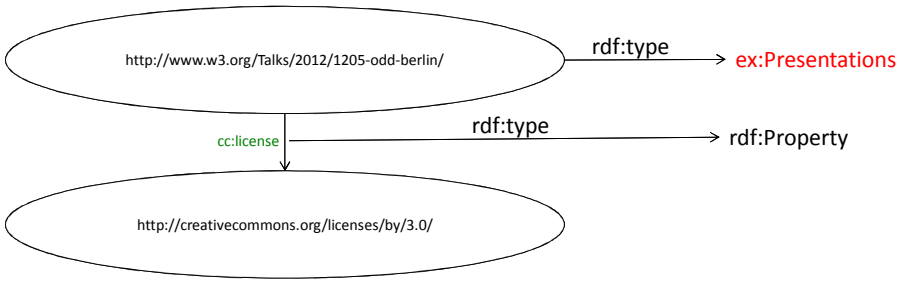



```
@prefix cc: <http://creativecommons.org/ns#>.
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
<http://www.w3.org/Talks/2012/1205-odd-berlin/>
 cc:license
 <http://creativecommons.org/licenses/by/3.0/>.
```

RDF statements …



… can be based on vocabularies



RDF Schema
- For defining Classes (example “Presentations”) and properties (like “cc:license”)

OWL (Web Ontology Language)
- For defining further constraints for vocabularies

SKOS
- For describing e.g. thesauri, taxonomies, classification schemes

Ways to create and store Semantic Web data

```
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:cc="http://creativecommons.org/ns#">
 <rdf:Description
 rdf:about="http://www.w3.org/Talks/2012/1205-odd-berlin/">
```

RDF/XML

```
@prefix cc: <http://creativecommons.org/ns#>.
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>.
<http://www.w3.org/Talks/2012/1205-odd-berlin/>
  cc:license
  <http://creativecommons.org/licenses/by/3.0/>.
```

Turtle

```
<p>All content on this site is licensed under
<a property="http://creativecommons.org/ns#license"
 href="http://creativecommons.org/licenses/by/3.0/">
   a Creative Commons License</a>. </p>
```

RDFa (embedding in HTML)

- RDFa Lite 1.1 http://www.w3.org/TR/rdfa-lite/: one-to-one mapping to microdata
- Microdata to RDF http://www.w3.org/TR/microdata-rdf/: extracting RDF from microdata
- HTML Data Guide http://www.w3.org/TR/html-data-guide/: guidance about RDFa vs. microdata vs. microformats
- R2ML http://www.w3.org/TR/r2rml/: Mapping relational data bases to RDF

Query - SPARQL

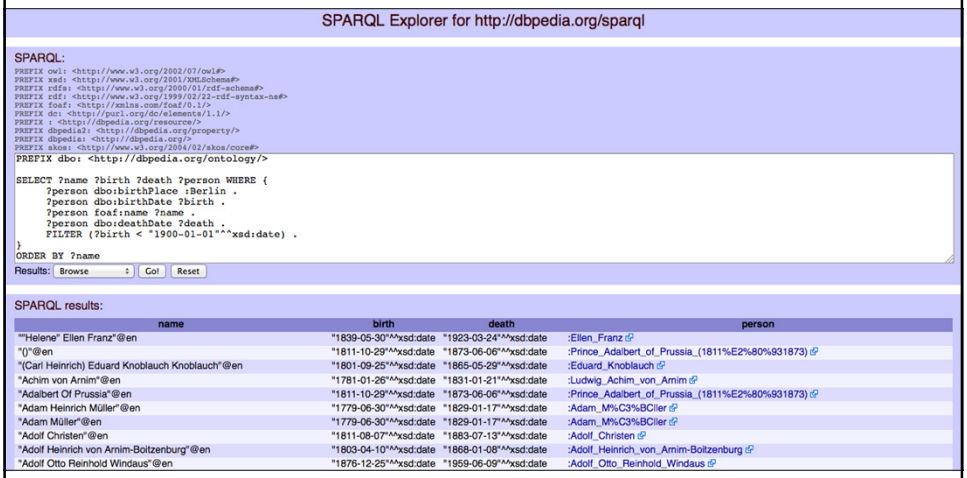
- Query language for RDF
- Patterns in link (=graph) structures
- E.g. “find all presentations with CC BY license”

Query will return

http://www.w3.org/Talks/2012/1205-odd-berlin/

```
PREFIX cc: <http://creativecommons.org/ns#>
SELECT ?presentation WHERE {
?presentation cc:license <http://creativecommons.org/licenses/by/3.0/>.
}
```

SPARQL Query with dbpedia data set: “People who where born in Berlin before 1900”: http://tinyurl.com/born-in-berlin



SPARQL Explorer for http://dbpedia.org/sparql

SPARQL:

```
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
PREFIX dc: <http://purl.org/dc/elements/1.1/>
PREFIX : <http://dbpedia.org/resource/>
PREFIX dbpedia2: <http://dbpedia.org/property/>
PREFIX dbpedia: <http://dbpedia.org/>
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
PREFIX dbo: <http://dbpedia.org/ontology/>

SELECT ?name ?birth ?death ?person WHERE {
      ?person dbo:birthPlace :Berlin .
      ?person dbo:birthDate ?birth .
      ?person foaf:name ?name .
      ?person dbo:deathDate ?death .
      FILTER (?birth < "1900-01-01"^^xsd:date) .
}
ORDER BY ?name
```

Results: Browse Go! Reset

SPARQL results:

name	birth	death	person
""Helene" Ellen Franz"@en	"1839-05-30"^^xsd:date	"1923-03-24"^^xsd:date	:Ellen_Franz
"()"@en	"1811-10-29"^^xsd:date	"1873-06-06"^^xsd:date	:Prince_Adalbert_of_Prussia_(1811%E2%80%931873)
"(Carl Heinrich) Eduard Knoblauch Knoblauch"@en	"1801-09-25"^^xsd:date	"1865-05-29"^^xsd:date	:Eduard_Knoblauch
"Achim von Arnim"@en	"1781-01-26"^^xsd:date	"1831-01-21"^^xsd:date	:Ludwig_Achim_von_Arnim
"Adalbert Of Prussia"@en	"1811-10-29"^^xsd:date	"1873-06-06"^^xsd:date	:Prince_Adalbert_of_Prussia_(1811%E2%80%931873)
"Adam Heinrich Müller"@en	"1779-06-30"^^xsd:date	"1829-01-17"^^xsd:date	:Adam_M%C3%BCller
"Adam Müller"@en	"1779-06-30"^^xsd:date	"1829-01-17"^^xsd:date	:Adam_M%C3%BCller
"Adolf Christen"@en	"1811-08-07"^^xsd:date	"1883-07-13"^^xsd:date	:Adolf_Christen
"Adolf Heinrich von Arnim-Boitzenburg"@en	"1803-04-10"^^xsd:date	"1868-01-08"^^xsd:date	:Adolf_Heinrich_von_Arnim-Boitzenburg
"Adolf Otto Reinhold Windaus"@en	"1876-12-25"^^xsd:date	"1959-06-09"^^xsd:date	:Adolf_Otto_Reinhold_Windaus

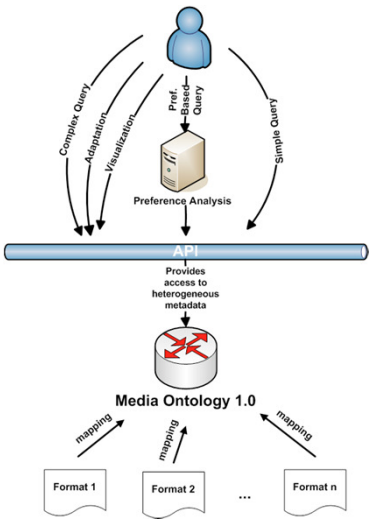
SOME ADDITIONAL BUILDING BLOCKS

Media Fragments URI 1.0 (basic)

- See http://www.w3.org/TR/media-frags/
- Fragments for identifying spatial and temporal dimensions of various medias
- Using these other HTTP

Base URI: http://www.example.com/example.ogv . Example fragments:
#t=10,20
#track=audio&t=10,20
#id=Cap%C3%ADtulo%202
xywh=160,120,320,240

Ontology for Media Resources 1.0



MAWG	Relation	EXIF 2.2
Descriptive Properties (Core Set)		
Identification		
identifier	exact	ImageUniqueID
title	more specific	ImageDescription, INAM
language	N/A	
locator	N/A	
Creation		
contributor	exact	IART, IENG, ISRC, ITCH
creator	more specific	IART, ISRC

From Semantic Web to the Web of Data

- Since end of 2013: W3C Data activity

http://www.w3.org/2013/data/ encompasses

  - Semantic Web (previous slides)
  - eGov (following slides)
- Semantic Web is just one technology stack
  - Work on mapping to other formats, e.g. CSV
  - Best Practices for Data on the Web
  - Semantic Web = one form of Big Data

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Vocabularies

- A growing set
- Various choices, e.g. syntax
- Application scenarios
  - eGovernment
  - Search Engine Optimization
  - …
  - LT

Not W3C, but related: Schema.org

- See http://www.schema.org/
- Collection of schemas
  - Creative works, person, place, product, ..
- Markup approach(es)
  - Microdata, RDFa Lite 1.1
- Recognized by major search engine providers

"Two syntax" approach

RDFa Lite 1.1

```
<p vocab="http://schema.org/" typeof="Person">
  My name is <span property="name">Felix Sasaki</span>.
</p>
```

Microdata

```
<p itemscope itemtype="http://schema.org/Person">
 My name is <span itemprop="name">Felix Sasaki</span>.
</p>
```


Schema.org: *not* W3C work, but also discussed in W3C Web Schemas task force

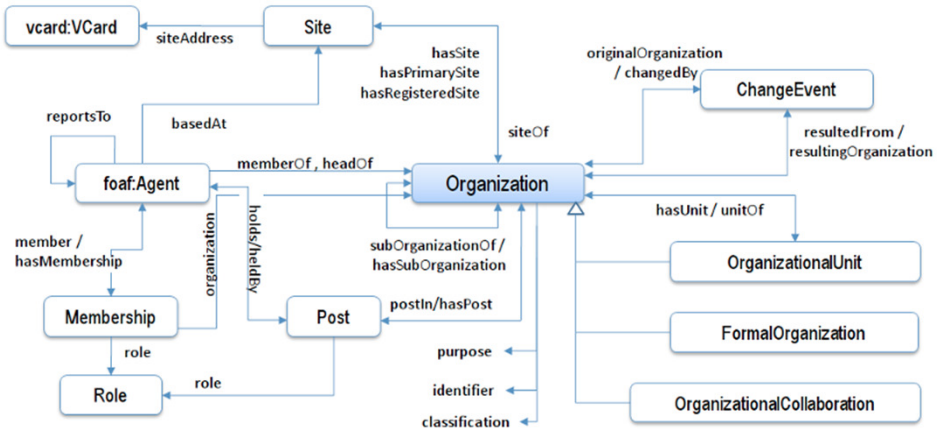
- See http://www.w3.org/wiki/WebSchemas
- Discussing extension proposals and mappings
- Example extension (partially still proposals)
  - rNews (collab. with IPTC)
  - Health and Medical (collab. with W3C health care and life sciences Interest Group)
  - GoodRelations (collab. with GoodRelations)
- Public discussion list at http://lists.w3.org/Archives/Public/public-vocabs/

eGov @ W3C

- See http://www.w3.org/egov/
- Work on actual vocabularies, e.g. in the area of eGovernment
  - "An Organization Ontology"
    - http://www.w3.org/TR/vocab-org/
  - "RDF Data Cube Vocabulary"
    - http://www.w3.org/TR/vocab-data-cube/
  - "Data Catalog Vocabulary (DCAT)"
    - http://www.w3.org/TR/vocab-dcat/
- Discussing how to actually use open data
  - "Using Open Data" workshop June 2012 http://www.w3.org/2012/06/pmod/
- Actual standardization work (Working Group) and discussion form (Interest Group – please join ☺)

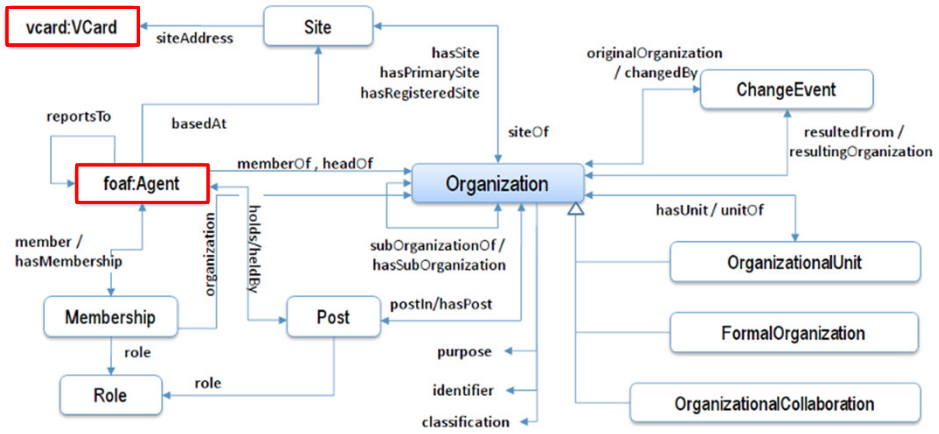
An Organization Ontology

- Organizational information across domains



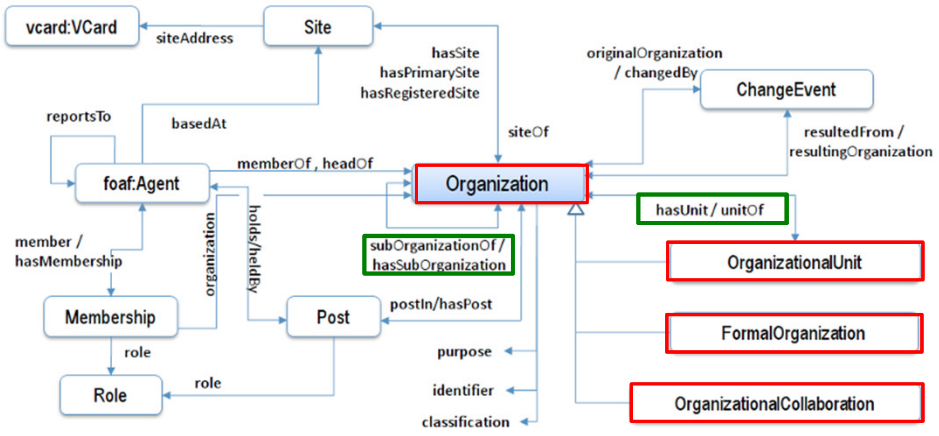
An Organization Ontology

- Re-use of vocabularies



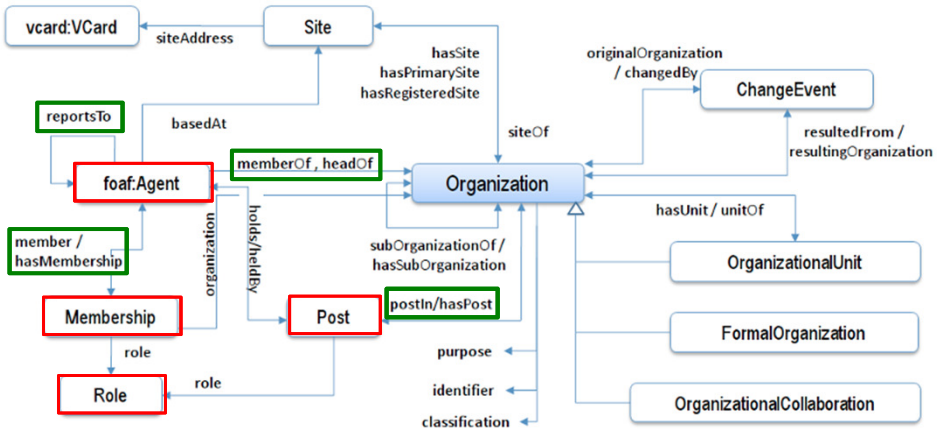
An Organization Ontology

- Organisational structure



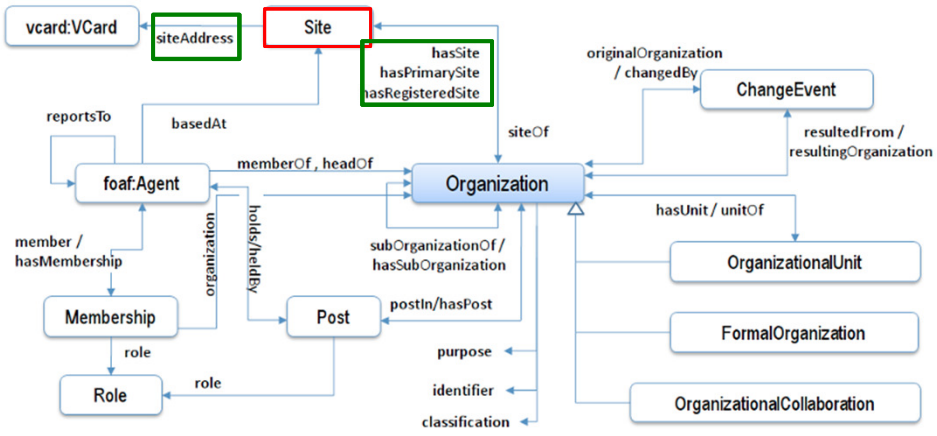
An Organization Ontology

- Membership and reporting structure



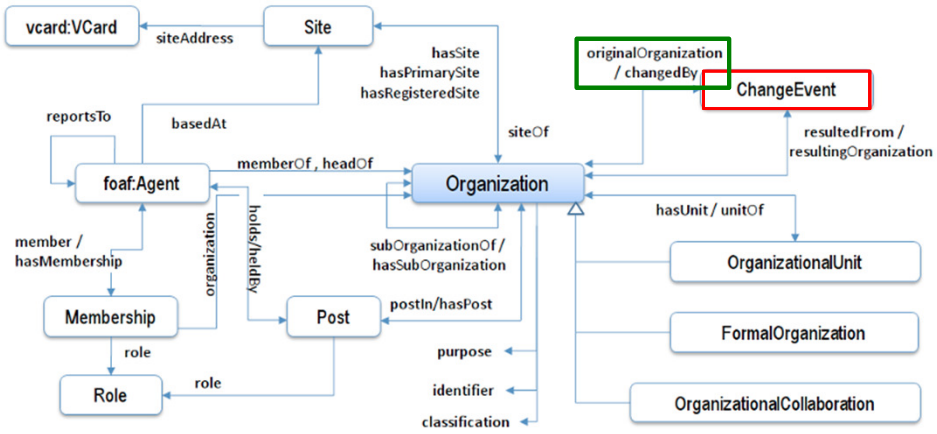
An Organization Ontology

- Location information



An Organization Ontology

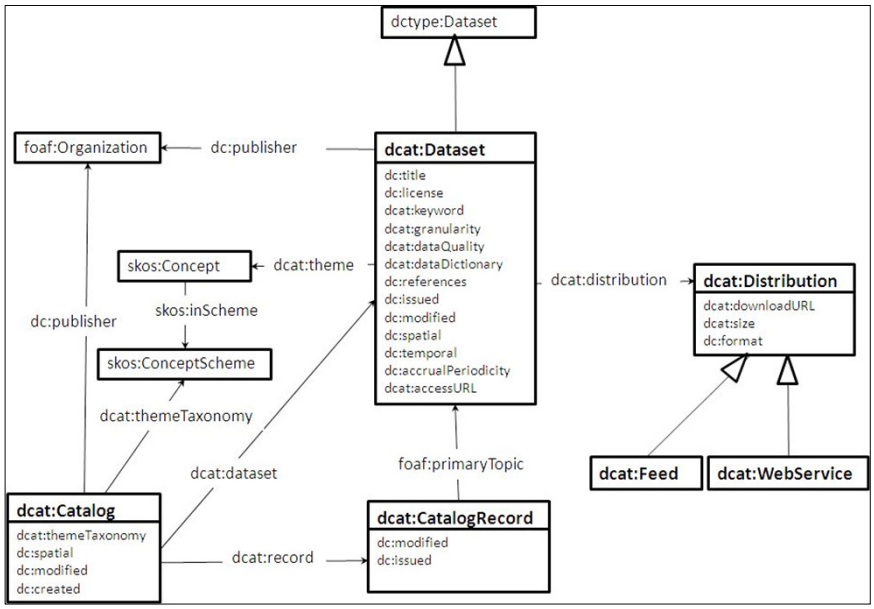
- Organizational History



Data Catalog Vocabulary (DCAT)

- Facilitate interoperability between data catalogs on the Web
- Uses existing vocabularies
  - FOAF
  - Dublin Core
  - SKOS

DCAT overview



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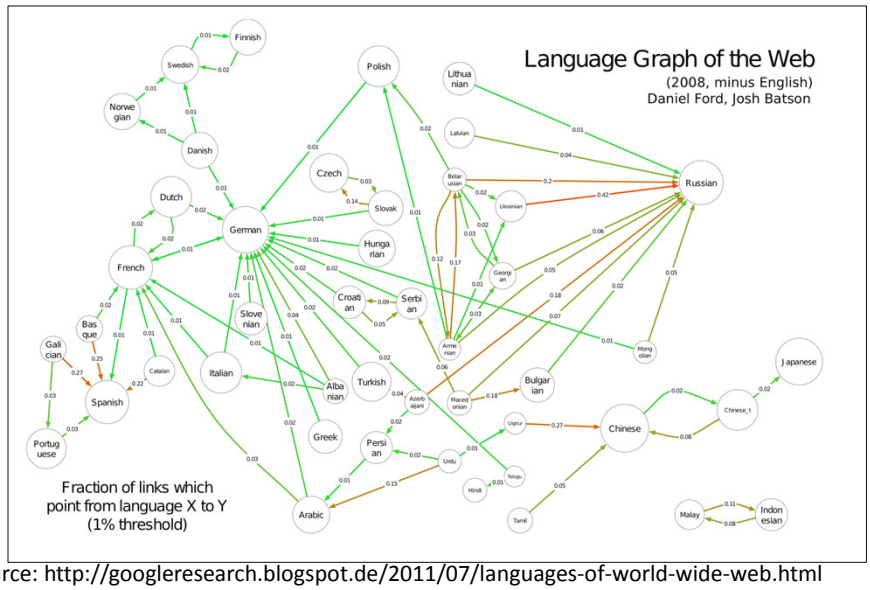
Multilinguality?



Source: http://googleresearch.blogspot.de/2011/07/languages-of-world-wide-web.html

Multilinguality and the Semantic Web?

"4.78% human readable descriptions have one language tag"

"Only 0.7% datasets contain several language tags"

"Most commonly language used:

44.72% (en), 5.22% (de), 5.11% (fr), 3.96% (it),..."

Source: Ell et al, 2011 Labels in the Web of Data, ISWC 2011

Internationalization Tag Set 2.0

- See http://www.w3.org/TR/its20/
- Defining metadata for multilingual processing of Web or other content, e.g. via
  - Machine translation
  - Localization workflows
- Where is the metadata needed – *for example*:
  - In Web content, e.g. HTML5
  - In XML-based and localization related formats
  - In the Semantic Web

Metadata example: "Translate" in HTML5 and XLIFF

```
<!DOCTYPE html>
<html> ...
<p>The <span translate=no>World Wide Web Consortium</span> is making the World Web Web worldwide!</p>...</html>
```

```
<xliff ...> ...
 <trans-unit id="1">
  <source xml:lang="en">The <mrk mtype="protected">World Wide Web Consortium</mrk> ...!</source>
  <target> ...
</xliff>
```

Metadata example: “Terminology” in HTML5 and XLIFF

```
<!DOCTYPE html>
<html> ...
<p>We need a new <span its-term=yes>motherboard</span>
...</html>
```

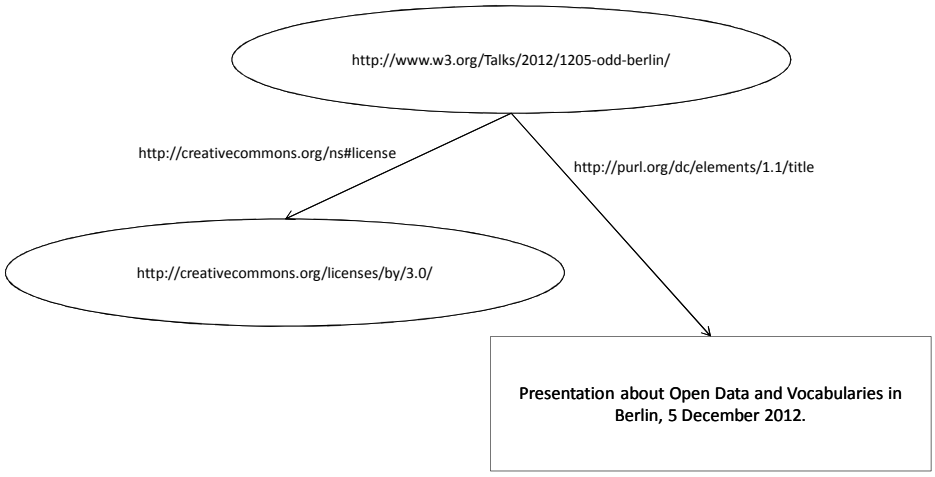
```
<xliff ...> ...
 <trans-unit id="1">
  <source xml:lang="en“>We need a new
    <mrk mtype="term">motherboard</mrk></source>
  <target> ...
</xliff>
```


Metadata example: “Text Analysis” in HTML5

- Identify special conceptual patterns (e.g. named entities, lexical concepts)
- Add further information (e.g. class of entity, unique identifier)

```
<html> .... <p><span ...
    its-ta-class-ref="http://nerd.eurecom.fr/ontology#Place"
    its-ta-ident-ref="http://dbpedia.org/resource/Dublin"
    >Dublin</span> is the <span
      its-ta-source="Wordnet3.0"
      its-ta-ident="301467919“ ... >capital</span> of Ireland.</p>
</body></html>
```

ITS 2.0: Metadata for localizing the Semantic Web



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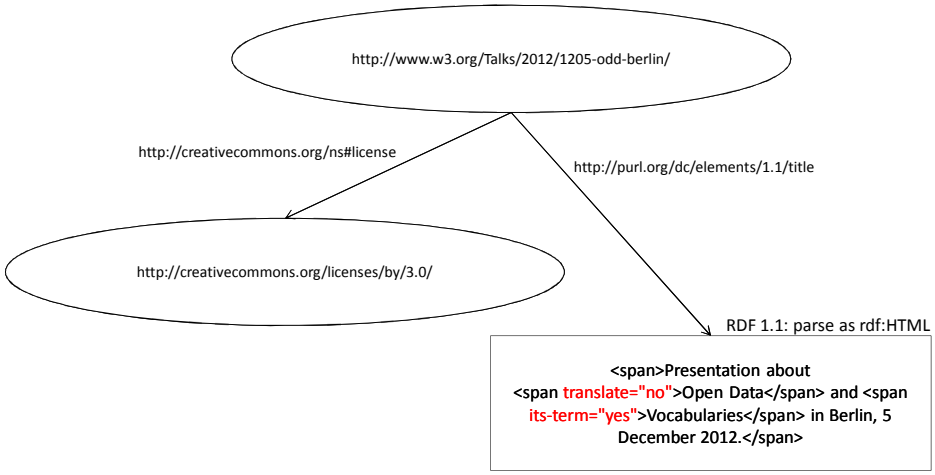
ITS 2.0: Metadata for localizing the Semantic Web



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LT using Semantic Web

- Question Answering over the Semantic Web
  - Example: IBM Watson
  - Using e.g. connection between linked data and natural language text in Wikipedia
  - Tasks: entity recognition & relation detection
- Generation of Natural Language from Linked Data
  - SW as an interlingua
  - RDF/OWL as a knowledge representation formalism
  - NLG from distributed ontologies

LT using Semantic Web

- Named Entity Disambiguation by exploiting domain knowledge
  - E.g. Wikipedia as semantic knowledge source
  - Example (demo): dbpedia spotlight http://dbpedia-spotlight.github.com/demo/
  - Potential: schema.org annotations for domain specific LT tasks, e.g.
    - rNews for news domain
    - Health and Medical for life sciences
    - GoodRelations for E-Commerce

LT using Semantic Web

- Reasoning upon facts extracted from text
- Temporal interpretation and reasoning for text analytic tasks
  - "Obama = president" not eternally true
  - Normalization of dates
  - Integration with existing facts

Semantic Web using LT

- Still rather a desire
- (Potential) Tasks
  - (schema.org) annotation quality checking
  - eGov (organization ontology, dcat) linking "ontologies to text"
  - Creating multilingual Semantic Web resources via LT (e.g. MT, see BabelNet http://lcl.uniroma1.it/babelnet/)
  - Creating annotations (e.g. ITS "Text Analysis") for further NLP processing, see upcoming slides

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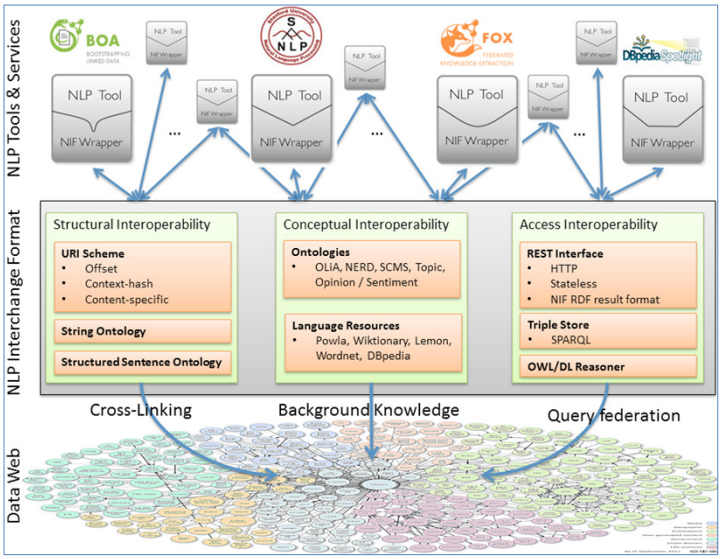
- LT using or processing Semantic Web
- Semantic Web and language processing workflows
- Linguistic resources and Semantic Web
- Current & future tasks

LT processing

- Organized in workflows, relying on frameworks
  - UIMA
  - GATE
  - …
- Re-use of workflows hindered by data integration challenge
- RDF to the rescue: NLP Interchange Format (NIF) http://nlp2rdf.org/nif-1-0

NIF overview



NIF example: converting HTML5 with ITS 2.0 metadata to NIF

```
<html>...<body><h2 translate="yes">Welcome to <span
  its-ta-ident-ref="http://dbpedia.org/resource/Dublin"
  translate="no">Dublin</span> in <b
translate="no">Ireland</b>!</h2></body></html>
```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```

```
@prefix itsrdf: <http://www.w3.org/2005/11/its/rdf#> .
# "Welcome to "
<http://example.com/exampledoc.html#xpath(/html/body[1]/h2[1]
/text()[1])>
   itsrdf:nif <http://example.com/exampledoc.html#offset_0_11> .
```

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```

```
@prefix itsrdf: <http://www.w3.org/2005/11/its/rdf#> .
# "Welcome to " ...
<http://example.com/exampledoc.html#offset_0_11>
 rdf:type str:String ; rdf:type str:OffsetBasedString ;
 itsrdf:translate "yes";
   str:referenceContext
<http://example.com/exampledoc.html#offset_0_29> .
```


NIF processing: generating ITS 2.0 "text analysis" metadata

```
# Input: <html>
  <body>
    <h2>Welcome to Dublin in Ireland!</h2>
  </body>
</html>
# ITS2NIF:
<http://example.com/exampledoc.html#xpath(/html/body[1]/h2[1]
/text()[1])>
   itsrdf:nif <http://example.com/exampledoc.html#offset_0_29>
# DBpedia Spotlight returns:
 <http://example.com/exampledoc.html#offset_21_28>
   itsrdf:taIdentRef  <http://dbpedia.org/resource/Ireland> .
# final step: NIF2ITS (generation of annotated HTML document)
```

Overview

- What is Semantic Web?
- Technical building blocks
- Vocabularies
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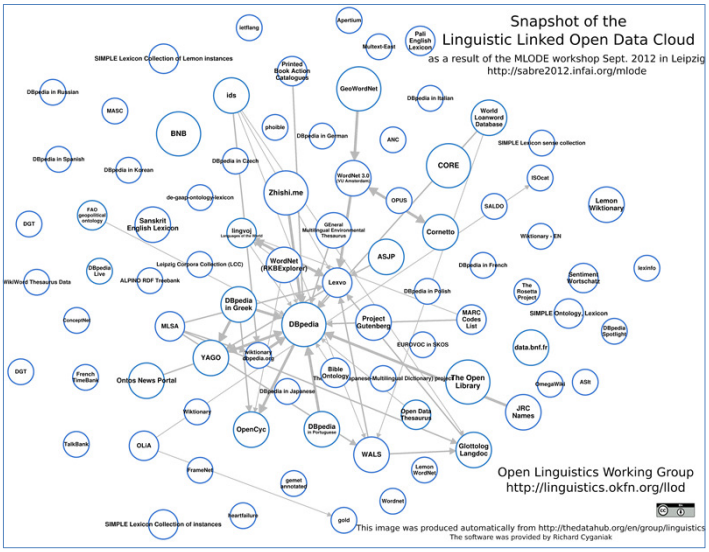
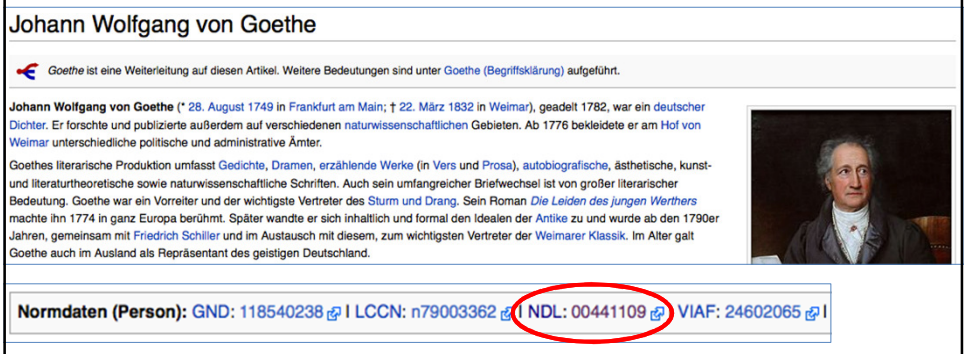
Linguistic open data cloud



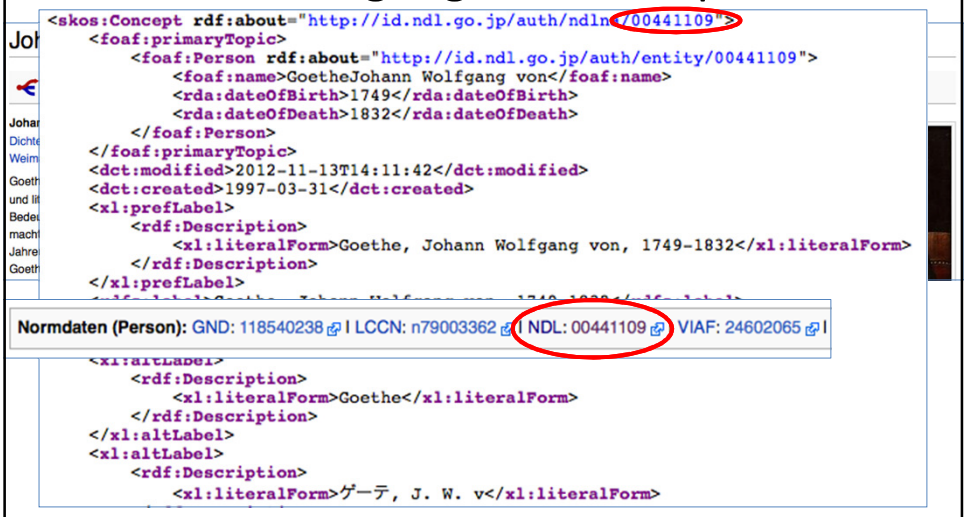
Linguistic open data cloud

- Goal: represent linguistic resources as linked open data
- Potential input: see http://tinyurl.com/llod-input
- Issues
  - Data quality
  - Maintenance / persistence
  - Licensing
  - "What's a linguistic data set?" See http://tinyurl.com/llod-what

Potential for LT: authority files linked across languages via Wikipedia



Potential for LT: authority files linked across languages via Wikipedia

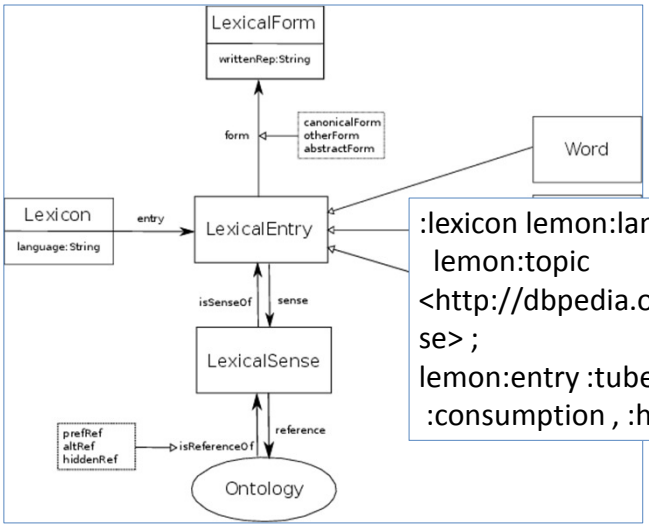


Lexicon Model for Ontologies (LEMON)

- Representing lexical information in RDF, relative to ontologies
- Intro at http://www.lemon-model.net/5mins.html

```
:tuberculosis lemon:canonicalForm [
  lemon:writtenRep "tuberculosis"@en ] ;
 lemon:sense [
  lemon:reference <http://dbpedia.org/resource/Tuberculosis> ] .
```

Lexicon Model for Ontologies (LEMON)




```
:lexicon lemon:language "en" ;
  lemon:topic
<http://dbpedia.org/resource/Disea
se> ;
lemon:entry :tuberculosis ,
 :consumption , :hepatitis .
```


Terminological resources

- Many formats used in localization
  - TBX
  - OLIF
  - …
- TBX/RDF: approach to bring terminological resources to the Semantic Web

http://www.w3.org/International/multilingualweb/dublin/slides/09-melby.pdf

- Still in early stage

META-SHARE

- See http://www.meta-share.org/
- Network of repositories of language data, tools and related web services
- Not (yet) based on Semantic Web representation of resources
- But: holds the "missing block" of llod: curated, high-quality resources with clear licensing information

Linked Data and Content Analytics

- Content analytics
  - Analysis of (textual) content, based on (named) entities
- Going far beyond entities: sentiment analysis, opinion detection
- Relation to linked data / SW
  - Content analytics generates structural data
  - Facilitates search & semantic data integration
  - Content analytics can benefit from controlled vocabularies, taxonomies, ontologies

Linked Data and Content Analytics

- LIDER project – started November 2013
- Aim: explore chances & challenges for Semantic Web & content analytics
- Develop a roadmap around "content analytics & linked data" research topics
- Engage various industries
  - Localization, media industries, Web technology in general

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Current and future tasks

- Semantic Web data cleansing
- Creation of multilingual Semantic Web data
- Definition of a lexico-linguistic layer in the LOD cloud
- Integration with industry workflows (e.g. in localization / web technologies)
- Development of research & industry usage scenarios

Semantic Web and Language Technologies

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Assignment

ITS 2.0 "Text Analysis" and (Semantic Web sensitive) LT tools

- "Text Analysis" defines various pieces of metadata, see http://www.w3.org/TR/its20/#EX-text-analysis-html5-local-1
  - its-ta-confidence, its-ta-class-ref, its-ta-ident-ref, its-ta-source, its-ta-ident
- Look for LT tools that produce text analysis information
- Create a table comparing output of these tools to the ITS 2.0 metadata pieces
- Take usage of Semantic Web resources (e.g. dbpedia) into account
- Be prepared to state your view about the usefulness of the ITS 2.0 "text analysis" information