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Semantic Data for GeoSciences

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Outline

Brief introduction to the Semantic Web

Our research interests

Semantic data in GeoSciences

Use cases

Few words for concluding

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The vision of a **semantic** Web ...

- ... bring structure to the meaningful content of Web pages, creating an environment where software agents roaming from page to page can readily carry out sophisticated tasks for users
- ... is not a separate Web but an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation

[Berners-Lee et al., 2001]

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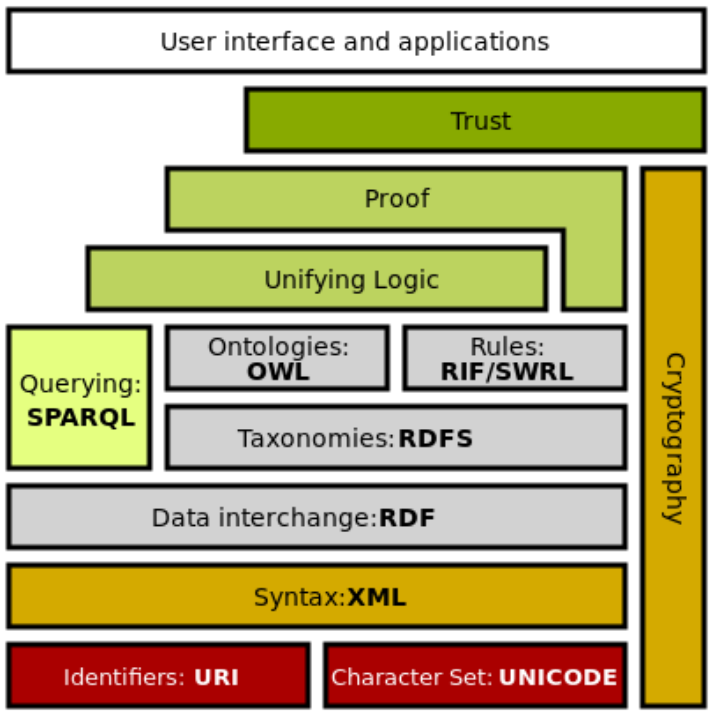
What do we need ?

- Formal languages to describe, explore and reason over the Web content (RDFS, OWL, SWRL)
- Languages for querying the represented knowledge (SPARQL)



[W3C, 2010]

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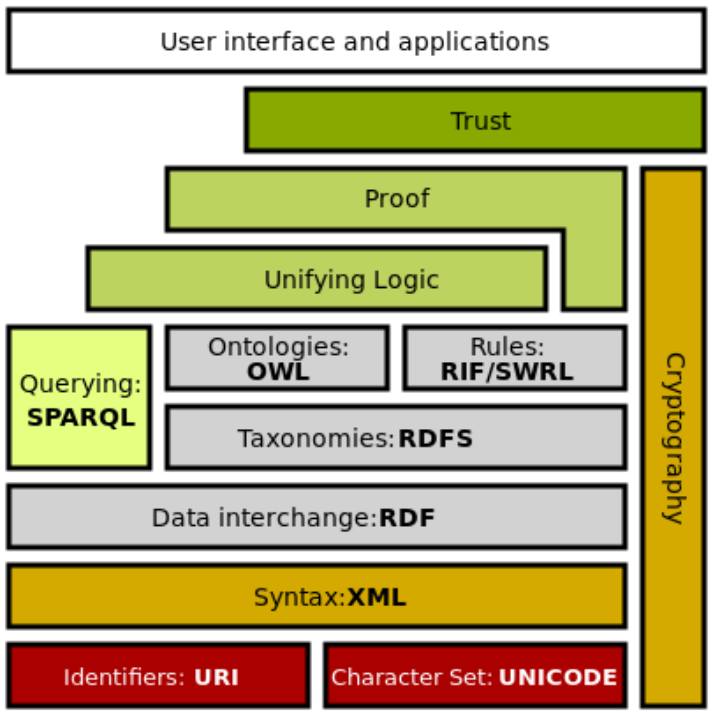

[W3C, 2010]

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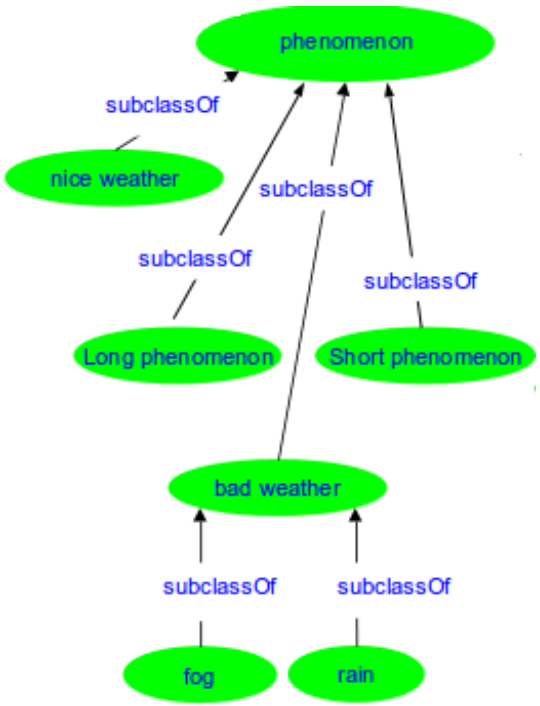
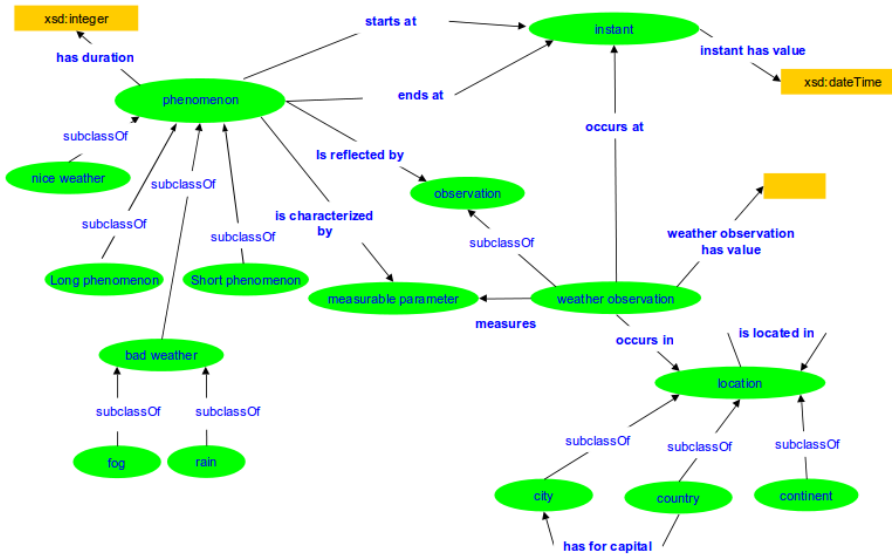
The role of ontologies : one of the pillars of the SW

- An ontology is a conceptual specification that describes knowledge about a domain (concepts and relationships between them)





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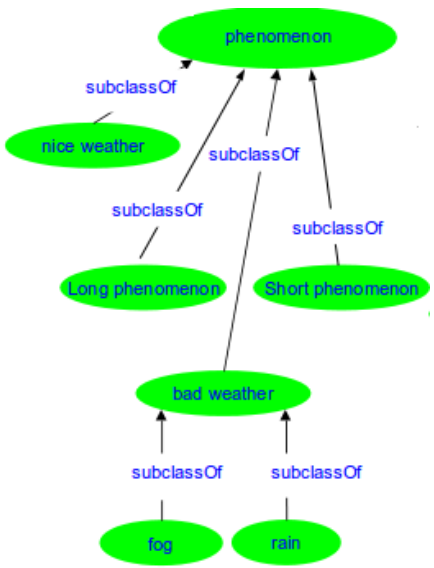
The role of ontologies : one of the pillars of the SW

- An ontology intends to constrain the possible interpretations of a language's vocabulary so that its logical models approximate as well as possible the set of intended world structures of a conceptualization

[Guizzardi, 2005]



TBox :

(1) $Phenomenon \sqsubseteq hasDuration$

(2) $ShortPhenomenon \equiv Phenomenon \sqcap \exists hasDuration.\leq 15$

ABox :

```
What we assert :
     P1 hasDuration 15 min

What we infer :
     P1 is a Phenomenon (1)
     P1 is a ShortPhenomenon (2)
```

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Our research interests

- Automatic ontology construction, enrichment and population
  - from text, from structured resources (thesaurus, relational data bases, ...)
  - applying NLP methods, machine learning, distributional models

[Aussenac-Gilles et al., 2013]

- Validation of extracted/reused knowledge
  - from automatic extraction, data conversion, sensors
  - taking into account confidence, quality and pertinence of sources

[Kamel and Trojahn, 2016]

- Semantic annotation of data and documents using ontologies
  - annotation of text or semi-structured documents
  - evolution of annotations

[Tissaoui et al., 2011]

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Our research interests

- Ontology matching
  - finding corresponding entities in two overlapping ontologies
  - (semi)-automatic generation of alignments (mono/multilingual)

[Severo et al., 2015]

- Facilitating the access to the semantic data via intuitive user interfaces
  - translating NL-based queries into SPARQL queries

[Pradel et al., 2014]

- Semantic integration and search of Earth Observation data
  - federating various sources of data so that a rich ecosystem of new services and uses could emerge
  - giving access to EO data coming from satellites and sensors and to a catalogue of services (agriculture, urban planning, security, oceanography and climate studies)

http://atos.net/en-us/home/we-are/news/press-release/2015/pr-2015_03_02_01.html

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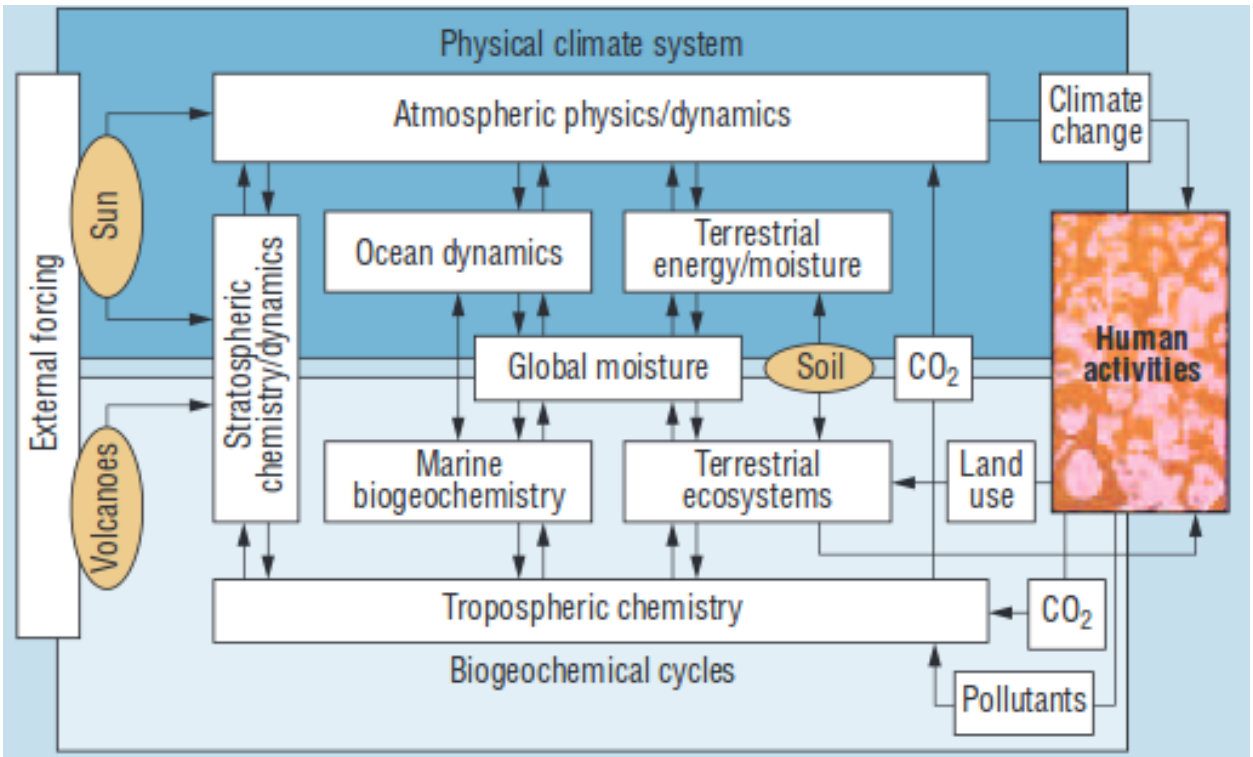
Semantic Data in GeoSciences

Where/What/How is the semantics ?



[Reitsma and Albrecht, 2005]

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Semantic Data in GeoSciences : general ideas

- Ontologies for modelling (complex) earth system processes
  - support to conceptually sound models (types, properties, behavior, spatial and temporal characteristics, and relations with other processes)
  - provide the opportunity for model components' reuse and sharing
  - enhance interoperability between models developed in adjacent domains

- Semantic-based discovery and retrieval of geographical information
  - expression of data and metadata semantics for enhancing data discovery
  - semantics of the temporal and spatial data for reasoning and automated discovery

[Reitsma and Albrecht, 2005]

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Semantic Data in GeoSciences : GeoSpatial knowledge

- Conceptual modeling and formal representation of geospatial knowledge
- Different vocabularies (different levels of expressiveness) :
  - GeoRDF : latitude, longitude, and altitude as properties of points (WGS84 as reference datum)
  - GeoRSS and GeoOWL : more spatial objects (lines, rectangles, polygons)
  - GeoSPARQL : promising W3C standard for geospatial RDF
    - reasoning capabilities (quantitative reasoning) between geometries
    - follows standards from OGC for facilitating spatial indexing
- Further developments : representing spatial and temporal theories, relationships, mediations and transformations, reason qualitatively with spatial entities of higher dimension

[Reitsma et al., 2009, Garcia-Rojas et al., 2013]

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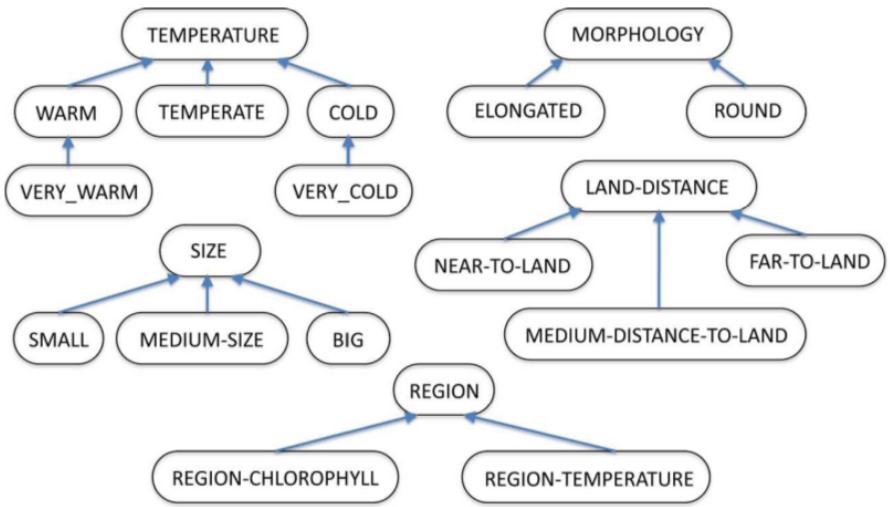
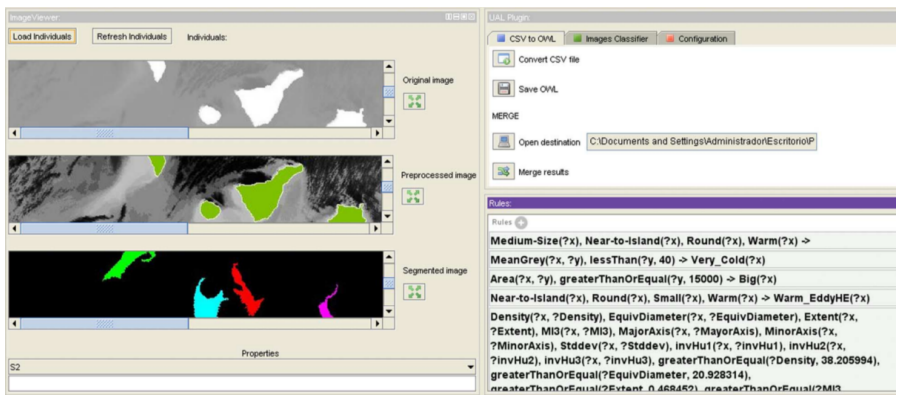
Semantic Data in GeoSciences : semantic image classification

- Ocean image classification based on ontologies
  - Low and high level content of images modeled with an ontology
  - Rules for classification expressed in SWRL




```
ContinentDist(?Reg,?ContDist)
^ lessThan(?ContDist, 10) ^
associated_to(?Reg,?Image)
^ is_from(?Image,Tenerife)
^ from_band(?Image,?Band) ^
has_Spatial-Resolution(?Band,SP_1km)

- > Near-to-Land(?Reg)
```



[Almendros-Jiménez et al., 2013]

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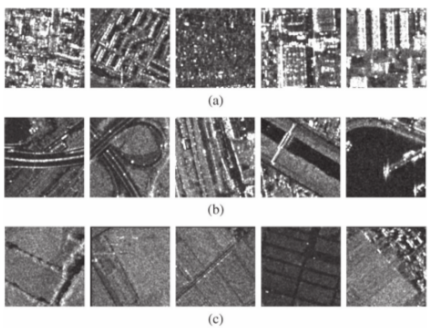
Semantic Data in GeoSciences : semantic image retrieval

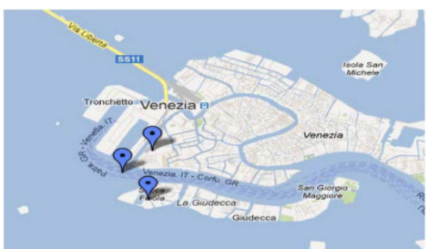
- Earth-observation IR based on enriched metadata and semantic annotation
  - semantic annotation based on machine learning
  - search strategies : by image metadata, by semantics, by spatial content (location of features on an image)

EO Taxonomy

- Built-up
  - Urban area
    - Not specified further
    - High-density residential area
    - Medium-density residential area
    - Low-density residential area
    - Informal settlements
    - Mixed urban area
    - Commercial area
    - Industrial area
    - Industrial and commercial complexes
  - Transportation
    - Not specified further
    - Roads
    - Railways
    - Bridges
    - Ports
    - Airports
- Natural scenes
  - Agriculture
    - Not specified further
    - Cropland
    - Pasture
    - Stubble/bare agriculture land

Semantic classes : (a) Urban area ; (b) normal and curved roads, railways, bridge, and port ; (c) agriculture comprising examples of cropland, pasture, and mixed areas.





Semantic query : finding all the patches in Venice that contain forest within 2 km of St. Mark's Square

[Espinoza-Molina and Datcu, 2013]

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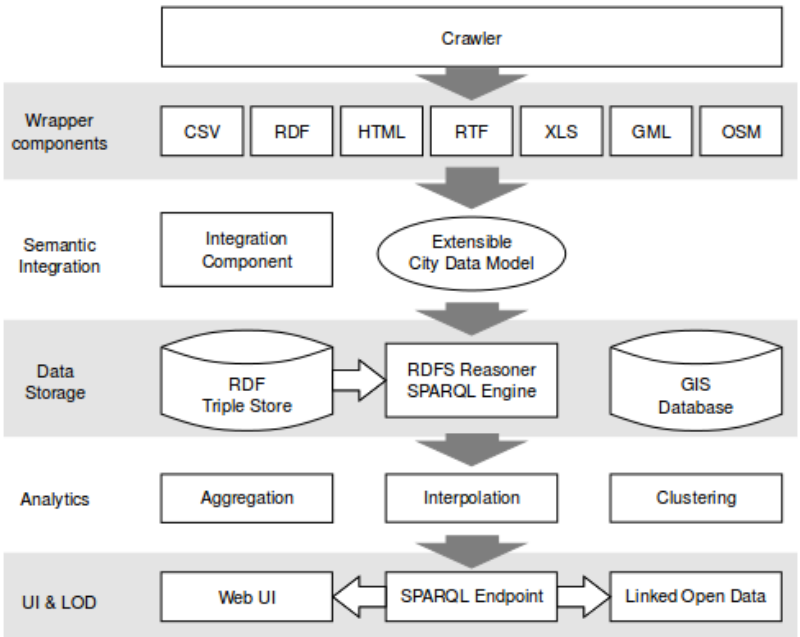
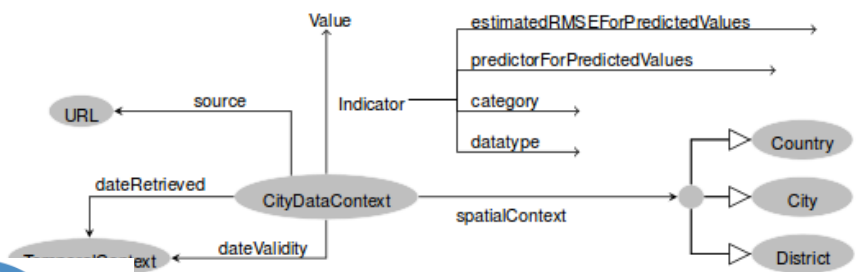
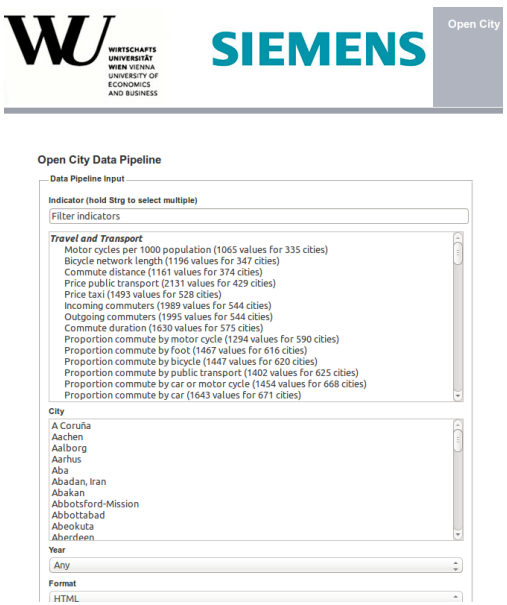
Semantic Data in GeoSciences : semantic data integration

- Platform for collecting, integrating, and enriching open data
  - predicting (and mapping) indicator values across data sets
  - republish the integrated and predicted values as linked open data







http://citydata.ai.wu.ac.at/KPIDataPipeline/

[Bischof et al., 2015]

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Concluding

- We presented (very) general ideas on adding semantics in GeoSciences ...
- ... we will see more later ;-)
- We are working on semantic annotation and search of images ...
- ... but our interests are not limited to that ;-)
- We will be glad to hear about how to add semantics in your work !

Thanks for your attention !

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