Leveraging Semantic Web Technologies for Geo-Database Interoperability

The LoBsteR project
There is no Geographic Web!
Case Study: Trip Planning

• Travel by plane, train, rent a car, drive your own?
• Book a hotel near the sights, not too expensive, suitable for kids or a business meeting?
• This should take half an hour
• Right now, it takes half a day
Challenge: lots of unstructured data

- Public transport routes, timetables, prices
- Sights location
- Hotel amenities and vacancies
Decision data is not available

- Difficult for data providers to expose their data in machine-readable form
- Difficult for a single site to aggregate all that data
Standards?

• We have lots of standards for physical and logical structure
• Standardizing semantics is a lot more difficult
Case Study: Cartographic formats

- Cartographic vector data in various formats
- How much work is needed to make data stored in one format available in any other format?
Case Study: Cartographic formats
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Case Study: Cartographic formats

- Feature_123
- LHS
- Area Polygon

- Feature_123
- Solid Structure
- Centroid Point

- type
- s_extent
- position
- type
Case Study: Cartographic formats
Ontologies

• Description of a shared conceptualization
• Logic-based knowledge representation paradigm
• Annotate data with machine-readable knowledge
• Describe concepts (classes of objects) and their relations
Ontology

concept Human
  nonFunctionalProperties
    dc#description hasValue "concept of a human being"
  endNonFunctionalProperties
hasName ofType foaf#name
hasParent inverseOf(hasChild) impliesType Human
hasChild impliesType Human
hasAncestor transitive impliesType Human
hasWeight ofType (1) _decimal
hasWeightInKG ofType (1) _decimal
hasBirthdate ofType (1) _date
hasObit ofType (0 1) _date
hasBirthplace ofType (1) loc#location
isMarriedTo symmetric impliesType (0 1) Human
hasCitizenship ofType oo#country
isAlive ofType (1) _boolean
  nfp
    dc#relation hasValue {IsAlive}
  endnfp
Ontologies

• “Queen-size bed”
  – Meant for one person
  – Fits two
  – Smaller than a “King-size bed”
  – Equivalent to a “double-bed”

• Enables automatic reasoning
Ontologies

- Can serve as repositories of definitions
- Concepts defined in different ontologies can be linked
Cartography revisited

- Solid Structure
- Marine Structure
- LightHouse

- Position
  - Area
  - Centroid
Cartography revisited

Diagram showing relationships and properties of geographic features.
Cartography revisited
Algorithm

- Use concept definition of features, properties and enumerated values to build a transformation between source and destination format
- Implemented using GML, OWL and XSLT
Translation

GML_1 \rightarrow XSLT \rightarrow Instances OWL_1 \rightarrow XSLT \rightarrow Instances OWL_2 \rightarrow XSLT \rightarrow GML_2

WFS \rightarrow GeoData

Reasoner

Domain Ontology

OWL 1

OWL 2

FME

Destination Data
Translating WFS

User

Converter

Contrôleur

Generates

XSLT

Data, GML

WFS

Query, Format B

Schema A, schema B

Schema Catalog

Data, Format B

Data Catalog

Admin

GeoData

GeoWeb 2008
Consequence

- Data providers can make their data interoperable simply by mapping their database schema with the domain ontology.
- Translation looses as little information as possible.
Caveats

- Not very fast – interactive use not yet evaluated
- …because we don’t currently translate queries
- General-purpose reasoners tricky to use
- Spatial reasoning still exploratory
Spatial Reasoning
Spatial Reasoning
GeoWeb 2.0

- Publishing content should be enough for it to reach consumers
- This can’t be done without standards
- Organisation are reluctant to adopt standards
Conclusion

• Interoperating numerous databases is getting easier
• Semantic technologies help
• Still many practical problems
• With further research, exciting applications are just around the corner