Web Services in the Geospatial Semantic Web

Patrick Maué
pajoma@uni-muenster.de

Institute for Geoinformatics (IFG)
University of Münster

Semantic Web Services Winter Retreat
March 6th, 2009
The world is not a toy example.
Topics

- Geospatial Semantic Web
- Spatial Data Infrastructures
- Semantic Annotations
What is geospatial data?
Geospatial Semantic Web

- Geographic Information / Geospatial Data
- Three Dimensions
  - Space
  - Time
  - Theme
- Represents the real (changing) world.
Semantics can't cover every detail.
Geospatial Semantic Web

What is geospatial data / geographic information?

OpenStreetMap is a free editable map of the whole world. It is made by people like you.

OpenStreetMap allows you to view, edit, and use geographical data in a collaborative way from anywhere on Earth.

OpenStreetMap's hosting is kindly supported by the UCL VR Centre and byteamark.

Help & Wiki
News blog
Shop
Map key

Search
Where am I?
examples: Alaska, Regents Street, Cambridge, CB2 5AP
or post-office, near Linnen, more examples...

Make a Donation

Done
What is geospatial data / geographic information?
Geospatial Semantic Web

Get a 3D file and program you can view this map data with.

Get any data in the ftp area.

**NETCDF GMT files of different sizes:**

- **Get the large GMT NETCDF file**  surface_17.1_all_topo30.surface  New November
  This file is gridded at 6 seconds in Longitude and 2 seconds in Latitude spacing. It is space saving to be gained in compressing it.

- **Get the GMT NETCDF file**  surface_17.1_all_topo30_10c.grd  Updated January
  This file is gridded at 10 seconds spacing. It is smaller (44.6 megabytes) that the above file.

- **Get the GMT NETCDF file**  surface_17.1_all_topo30_15c.grd  Updated January
  This file is gridded at 15 seconds spacing. It is smaller (19.83 megabytes) that then above file.

- **Get the GMT NETCDF file**  surface_17.1_all_topo30_1min.grd  Updated January
  This file is gridded at 1 minute spacing. It is smaller (1.25 megs) that then above file.

  *surface_17.1_all_topo30.xyz.gz  NOT Available*
  This file is compressed and is gridded at 6 seconds in Longitude and 2 seconds in Latitude spacing. It is uncompressed from the file: surface_17.1_all_topo30.surface . I am have not provided GMT tools and using the program grd2xyz to get the file surface_17.1_all_topo30.surface

**ASCII XYZ files from the NETCDF GMT files above:**

- **Get the ASCII XYZ file**  surface_17.1_10c.xyz.gz  Updated January 11, 2009
  This file is compressed and is gridded at 10 seconds spacing. It is a simple ASCII XYZ file: surface_17.1_all_topo30_10sec.grd.

- **Get the ASCII XYZ file**  surface_17.1_15c.xyz.gz  Updated January 11, 2009
  This file is compressed and is gridded at 10 seconds spacing. It is a simple ASCII XYZ file: surface_17.1_all_topo30_15sec.grd.

- **Get the ASCII XYZ file**  surface_17.1_1min.xyz.gz  Updated January 11, 2009
  This file is compressed and is gridded at 1 minute spacing. It is a simple ASCII XYZ file: surface_17.1_all_topo30_1min.grd.

"ASCII" files for ArcView from the NETCDF GMT files above:

http://www.whoi.edu/science/PO/so_globec/SO_GLOBEC_bathy.html
Geospatial Semantic Web

Interactive Maps
Scenarios
Semantic Web Services Interoperability for Geospatial Decision Making
SWING Use Case

- Setting: Geospatial Decision-Making
  - Domain: Mineral Resources (BRGM)
  - Task: Finding potential Quarry Locations
Aggregate relevant information to find an appropriate source for needed materials.
SDI-Grid – Spatial Data Infrastructures and Grids
Setting: Semantic Validation of Workflows

- **Domains:**
  - Hydrodynamic Models (flood modeling)
  - Noise Dispersion Models

- **Task:**
  - Create, prepare, and run in Grid
GDI-Grid Use Case
Geospatial Web Services
• Spatial Data Infrastructures

the technology, policies, standards, human resources, and related activities necessary to acquire, process, distribute, use, maintain, and preserve spatial data

• Keeping data up-to-date
• Sophisticated Query Capabilities
• Evaluation
• Billing and Security
- Open Geospatial Consortium (1994)
- Implementation guidelines for SDI components
  - Geospatial Web Services
  - Geospatial Data (GML, KML)
OGC

- Web Feature Service (WFS)
How to access a WFS

- GetCapabilities()
- DescribeFeatureType()
- GetFeature(id)
OGC

- Web Coverage Service (WCS)
OGC

- Web Processing Services (WPS)
From Standards to Ontologies.
Workflows for OGC Services

WCS → WPS
WFS → WPS
WPS → WMS
How can the ontologies help?

How to discover the relevant data?

Can the WPS process the served coverage?
SWING workflows
Performance is crucial.
Zonage WFS
Metadata: describing geospatial data.

```xml
<element name="Zico_region"
  type="con:Zico_regionType"
  substitutionGroup="gml:_Feature" />

<complexType name="Zico_regionType">
  <complexContent>
    <extension base="gml:AbstractFeatureType">
      <sequence>
        <element name="msGeometry"
          type="gml:GeometryPropertyType"/>
        <element name="REGIONAL" type="string"/>
        <element name="LIBELLE" type="string"/>
        <element name="TYPE" type="string"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
```
Ontologies: describing the reality.

Geographical Region

is a

Habitat

inhabited in

Animal

is a

Regulations

is a

Conservation Laws

Bird

protect

Domain Ontology

conceptualizes

Reality
Resource Metadata describes Reality via Model Reference to Domain Ontology, which conceptualizes Semantic Annotations.
Model Reference won't suffice.

```
<complexType name="Zico_regionType">
  <element name="REGIONAL" type="string" reference="dom:Identifier"/>
  <element name="LIBELLE" type="string" reference="dom:Identifier"/>
</complexType>
```

→ too generic (loose reasoning benefits)

```
<complexType name="Zico_regionType">
  <element name="REGIONAL" type="string" reference="dom:GeographicalRegionName"/>
  <element name="LIBELLE" type="string" reference="dom:ProtectedBirdRegionName"/>
</complexType>
```

→ too specific (results in unusable ontologies)
Introducing Rule-based Annotations.

Resource Metadata

Resource Ontology

Model Reference

Domain Reference

Domain Ontology

Resource Metadata describes Resource

Resource represents Reality

Domain Ontology conceptualizes Reality
<element name="Zico_region"
    type="con:Zico_regionType"
    substitutionGroup="gml:_Feature"
    sawsdl:modelReference="http://.../ZonageWFS/Onto#ZICO" />

<complexType name="Zico_regionType">
    <complexContent>
        <extension base="gml:AbstractFeatureType">
            <sequence>
                <element name="msGeometry" type="gml:GeometryPropertyType"/>
                <element name="REGIONAL" type="string"/>
                <element name="NATIONAL" type="string"/>
                <element name="LIBELLE" type="string"/>
                <element name="TYPE" type="string"/>
                <element name="LA_MESURE" type="string"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>

Check: http://swing.brgm.fr/dataaccess
Resource Ontology

namespace { _"http://.../ZonageWFS" ...}
ontology onto

custom Zico_region subConceptOf dom_gml#FeatureType
nonFunctionalProperties
  dc#Title hasValue "Zones d'importance pour la conservation des .."
  ogc#LatLongBoundingBox hasValue "-4.07711 45.0472,-0.987434 .."
  ogc#SRS hasValue "EPSG:27582"
EndNonFunctionalProperties

msGeometry impliesType (0 1) dom_gml#GeometryPropertyType
REGIONAL impliesType _string
NATIONAL impliesType _string
LIBELLE impliesType _string
TYPE impliesType _string
LA_MESURE impliesType _string
Domain Reference
(Link: Resource Ontology – Domain Ontology)

namespace { _"http://.../ZonageWFS" ...}
WebService ws

postcondition wfsOut
definedBy
?f[LIBELLE ofType ?a] memberOf Zico_region and
?d1 memberOf dom#ImportantBirdArea and
?d2 memberOf dom#Identifier and
dom#domainReference(?f, ?d1) and
dom#domainReference(?a, ?d2) and
dom#names(?a, ?f).

→ Rebuilds the inner relationships of the data model
Looking for the name of important Bird Areas

Goal myGoal
Postcondition
?feature[?attr ofType ?attrType]
    memberOf gml#FeatureType and
?domBirdArea memberOf dom#ImportantBirdArea and
?domIdentifier memberOf dom#Identifier and
dom#domainReference(?feature, ?domBirdArea) and
dom#domainReference(?attrlibelle, ?domIdentifier) and
dom#names(?attrlibelle, ?feature).

Looking for protected areas in general

Goal myGoal
postcondition
?domBirdArea memberOf dom#ProtectedRegion
Try it out: http://swing.brgm.fr/mimsalpha/download
Visualizing Ontologies
How it should be modelled (as role).

How it should be visualized (and queried).
Communicate what's happening.
Wrapping up.

- Geospatial Data
- Geospatial Web Service Standards
- Semantic Annotations