GeoSPARQL - A geographic query language for RDF data

A proposal for an OGC Draft Candidate Standard

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Objectives

- Spatially-enable SPARQL “endpoints”
  - Enterprise knowledge bases
  - Linked Open Data
    - GeoNames
    - data.gov
    - data.gov.uk
    - Online mapping services
- Build on existing standards
  - W3C Semantic Web (RDF, OWL, SPARQL)
  - OGC (Simple Features, Spatial Relations)
- Leverage $B investments in geospatial data
- Provide foundation for spatial “reasoning”

GeoSPARQL WG Submitters

- Oracle
- US Geological Survey
- UK Ordnance Survey
- BBN Technologies
- Orbis Technologies
- Interactive Instruments

- We Invite others to join as Charter members!

Overview

- Objective: Define minimal RDF schema for geospatial data
  - Based on General Feature Model
  - Provides a standardized vocabulary for representing linked geodata
  - Provides a standardized vocabulary for writing SPARQL queries against geospatial RDF data
- GeoSPARQL reuses common geometry serialization formats
  - Provides FILTER functions that understand GML, KML, WKT strings encoded as RDF Literals.
- Relatively straightforward to implement on top of a spatial database, GIS, file system
- Other possibilities: OWL-based spatial reasoning

Handling Spatial Data in RDF : Objectives

- To develop best practices for managing spatial data in RDF
- To define structured vocabulary and semantics for geographic features (metadata) and relationships.
  - E.g: **ogc:dimension** property on a Spatial Object can capture the dimension of the object
- To manage geographic data as RDF terms using standard serialization formats.
  - E.g: GML captured as text with appropriate RDF literal type.
- To add the ability to answer queries involving geographic features and relationships.
  - E.g: The **ogc:touches** relationship can link two Spatial Objects in a SPARQL triple pattern.

Goal: GeoSPARQL

Find all land parcels with some type of commercial zoning that touch some arterial street

```
SELECT  ?parcel ?hwy
WHERE { ?parcel rdf:type     :Commercial .
        ?parcel rdf:type     ogc:GeometryObject .
        ?hwy    rdf:type     :Arterial_Street .
        ?hwy    rdf:type     ogc:GeometryObject .
        ?parcel ogc:touches  ?hwy }
```

Find all land parcels with some type of residential zoning that are within 10 KM of a boating lake

```
SELECT  ?parcel ?feature
WHERE { ?parcel     rdf:type     :Residential .
        ?parcel     rdf:type     ogc:GeometryObject .
        ?parcel     ogc:hasGML   ?pGML .
        ?feature    rdf:type     :Boating_Lake .
        ?feature    rdf:type     ogc:GeometryObject .
        ?feature    ogc:hasGML   ?fGML .
        FILTER (ogc:within_distance(?pGML, ?fGML, 10, "km"))}
```

Spatial Ontology – Requirements*

- Language should be able to represent
  - Spatial concepts
    - Point, Line, Polygon, …
  - Spatial and non-spatial properties of geographic features
    - geometry and population of a Census block group
  - Metadata for each spatial object
    - dimension, SRID, …
  - Relationships between spatial objects
    - binary: touches, contains, … n-ary: within_distance
  - Specialization/generalization concept hierarchies
    - Point is a specialization of Geometry
  - Simple composition hierarchies – concepts made of sets of other concepts
    - Waterfront_Property is the set of all Land_Parcels that touch some Water_Body

Not asserted: expressed with FILTER functions

* Adapted from: A. I. Abdelmoty, P. D. Smart, C. B. Jones, G. Fu, D. Finch: A critical evaluation of ontology languages for geographic information retrieval on the Internet. J. Vis. Lang. Comput. 16(4): 331-358 (2005)

Ontology for Spatial Modeling

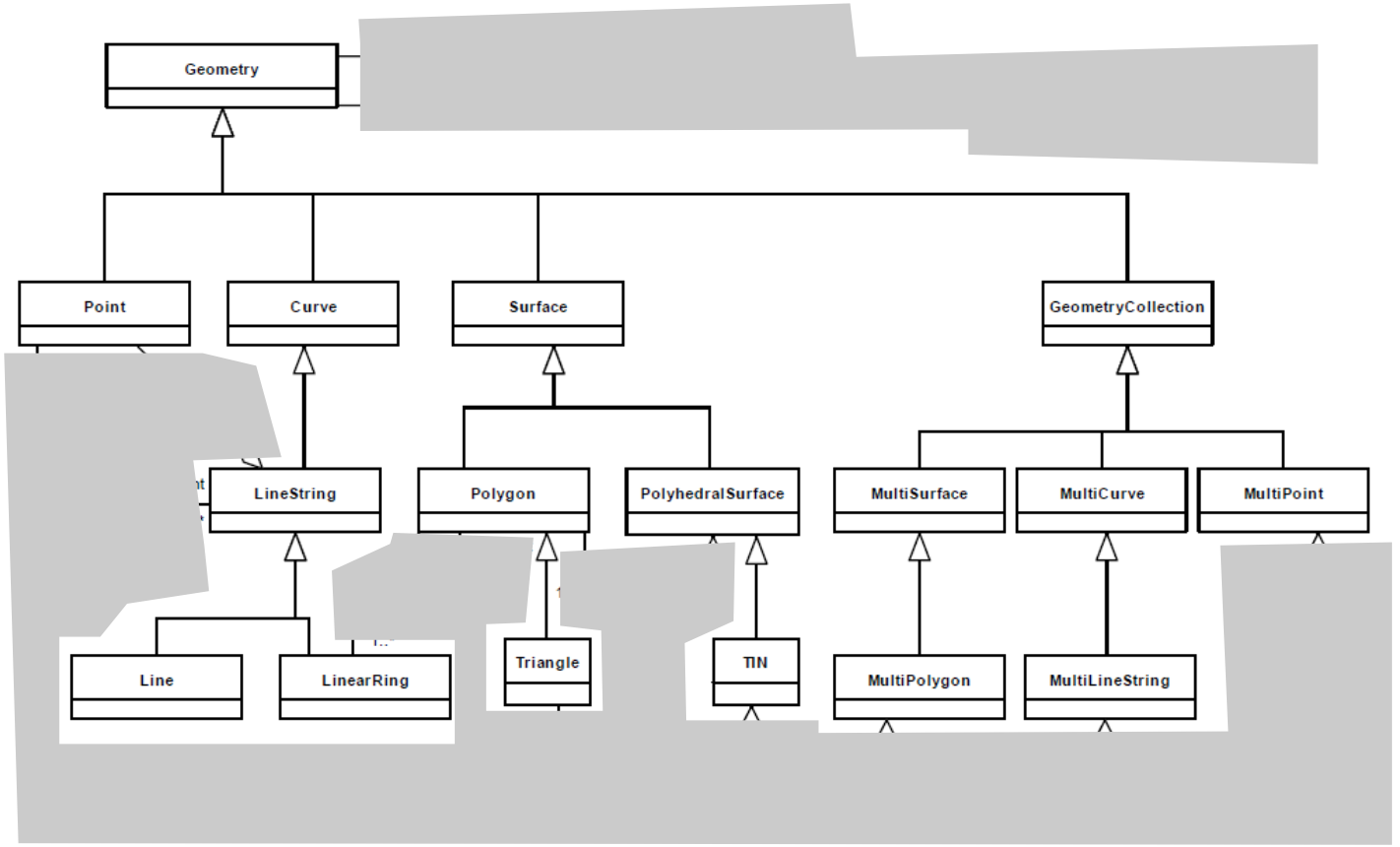
- An agreement on the vocabulary used to represent spatial concepts
- An agreement on the encoding of (some) spatial semantics using OWL/RDFS vocabulary

Building Blocks:

OGC Simple Features Specification

WKT KML GML

Geometry Class Hierarchy *



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* OpenGIS® Implementation Specification for Geographic information – Simple feature access - Part 1: Common Architecture

Properties for OGC:GeometryObject

Listed properties all have rdfs:domain ogc:GeometryObject

- Datatype Properties
  - ogc:dimension :range xsd:integer
  - ogc:srid :range xsd:integer
  - ogc:isEmpty :range xsd:boolean
  - ogc:isSimple :range xsd:boolean
  - ogc:envelope :range **ogc:GMLType**
  - ogc:boundary :range **ogc:GMLType**
  - **ogc:hasGML** :range **ogc:GMLType**

- Object Properties
  - ogc:equals :range ogc:GeometryObject
  - ogc:disjoint :range ogc:GeometryObject
  - ogc:intersects :range ogc:GeometryObject
  - ogc:touches :range ogc:GeometryObject
  - ogc:crosses :range ogc:GeometryObject
  - ogc:within :range ogc:GeometryObject
  - ogc:contains :range ogc:GeometryObject
  - ogc:overlaps :range ogc:GeometryObject

Detailed geometry information encoded as RDF XML Literal (GML in this case)

Properties taken from Simple Features Specification

An Example Query

Design Decision: Encoding Spatial Data as XML Literal (GML)

Advantage: single self-contained unit

Consistent way to select geometry information

Find all water bodies that are within 1 km of Route 3

```
SELECT   ?water ?wGML
WHERE { ?water    rdf:type     :WaterBody .
        ?water    ogc:hasGML   ?wGML .
        :Route_3 ogc:hasGML   ?r3GML .
        FILTER(ogc:within_distance(?r3GML, ?wGML,
                                   1, "km"^^xsd:string)) }
```

Consistent way to pass geometry information around

Expressing Spatial Queries with SPARQL

- Types of spatial properties, operations and relationships
  - Descriptive datatype properties (e.g., dimension)
  - Binary relations (e.g., touches, intersects, contains)
  - Parameterized relations (e.g., within distance)
  - Operations that produce new objects (e.g., buffer, union, intersect)
- SPARQL features to use (rely on *standard* SPARQL syntax)
  - Triple patterns
  - Extensible FILTER functions
- Issues
  - What should be in a FILTER clause and what should be in a graph pattern?
  - How do we test relationships with transient spatial objects?
  - What should the arguments be to Spatial FILTER functions?

Next Steps

- Draft Candidate OGC Specification
  - Spatial Query for SPARQL
  - Spatial Ontology
- Inaugural GeoSPARQL WG Meeting
  - Silver Springs, Thursday, June 17, 2010
  - Finalize WG charter, WG members
- Open Review
  - Late 2010
- Interoperability Tests (2010-11)
  - USGS, UK OS, others?
- Future OGC Working Groups?
  - Catalog Services
  - Feature Services