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Open Geospatial Consortium

Getting Started with GeoSPARQL

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Outline

- Introduction to GeoSPARQL
- GeoSPARQL Vocabulary
- GeoSPARQL Query Relations
- Worked Example:
  - Ontology
  - Instance data
  - Query
- Conclusion

Purpose of GeoSPARQL

- Many problems for which semantic solutions are relevant have an inherent geospatial context
  - Which hospitals within 20 miles have appropriate treatment centers for my patient?
  - What airports within 50 miles of a mission objective can support a C5?
- In order to efficiently perform geospatial reasoning, special indexing is required
  - We cannot take away the ability to do semantic reasoning though

Scope

- GeoSPARQL is a minimal RDF/OWL/SPARQL vocabulary for storage and query of geospatial information
  - Should be able to be easily attached to ontologies with a need for spatial information
  - Represents *only* geometries and the concept of a Feature (a thing with a geometry) and the geospatial relationships between them
- Result: triple store implementations can spatially index information in the vocabulary, and perform spatial reasoning
- GeoSPARQL intends to be:
  - Robust enough to be used for ‘serious’ geospatial data
  - Simple enough for Linked Open Data

SPARQL

- W3C Recommendation for querying RDF/OWL
- Syntax based on RDF/Turtle

```
PREFIX  dc:  <http://purl.org/dc/elements/1.1/>
PREFIX  ns:  <http://example.org/ns#>
SELECT  ?title ?price
WHERE   {
      ?x dc:title ?title .
      OPTIONAL {
            ?x ns:price ?price .
            FILTER (?price < 30)
      }
}
```

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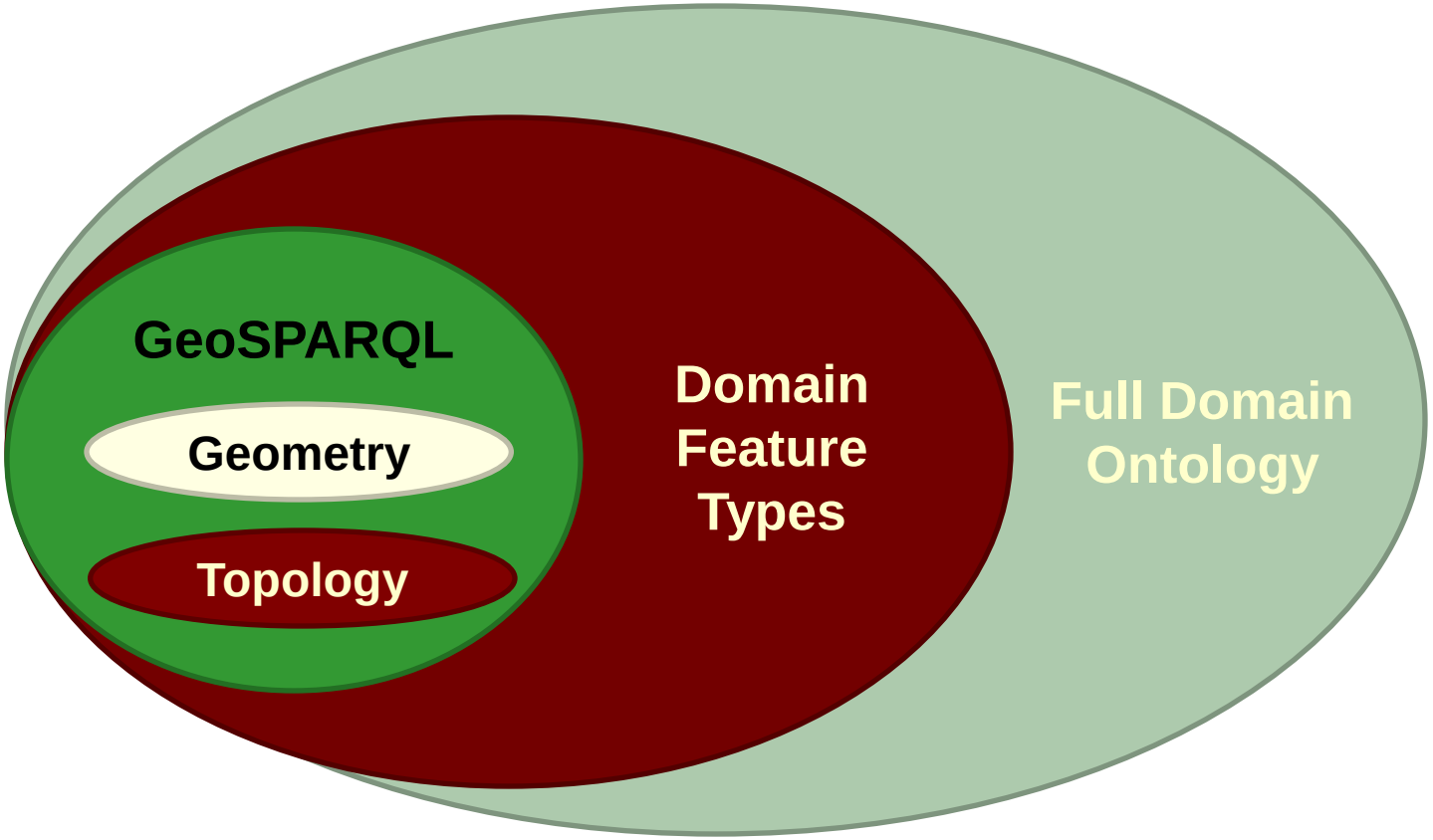
GeoSPARQL

- Uses W3C's SPARQL's extensibility framework
- Contains a shared vocabulary
  - Feature Model and Geometry Model
  - Minimal set of classes and properties supporting triple patterns
- Contains datatypes based on text-based geometry serializations : WKT (augmented for CRS); GML
  - geo:wktLiteral, geo:gmlLiteral, …
  - Different conformance class for each serialization
- Contains shared set of FILTER functions
  - For each Simple Features function
- Contains Query Rewrite Rules for spatial relations between Features — both explicit (triples) and implicit (geometry)

GeoSPARQL vs W3C Geo

- Unlike GeoSPARQL, W3C Geo:
  - Only supports point geometries
  - Only supports one coordinate reference system
  - Has no spatial relationships
- Have data in W3C Geo format?
  - No problem. One query converts W3C Geo into GeoSPARQL information (see paper “Enabling the Geospatial Semantic Web with Parliament and GeoSPARQL”)
- W3C Geo is very simple and useful, but GeoSPARQL offers significantly more functionality

GeoSPARQL in Use



GeoSPARQL is a foundation for spatial domain ontologies.

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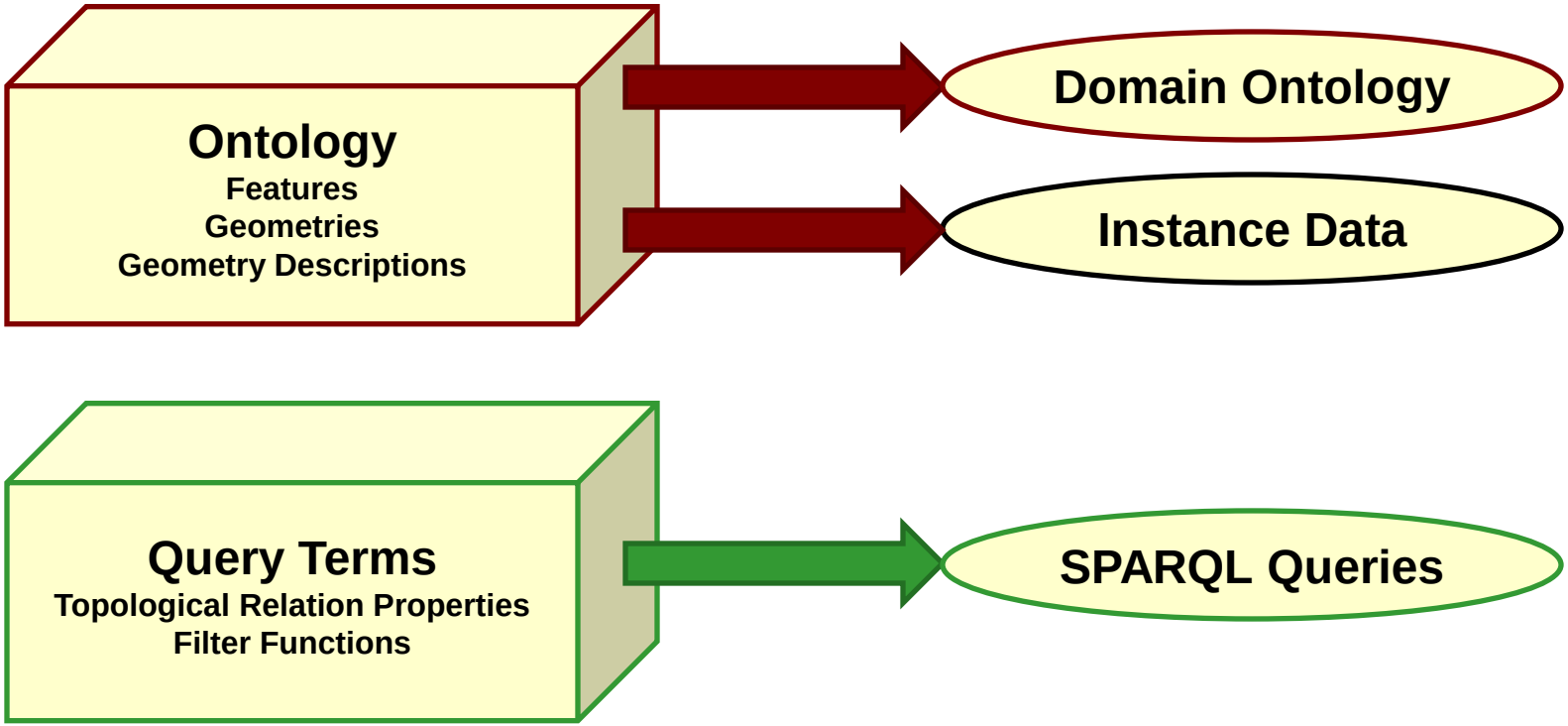
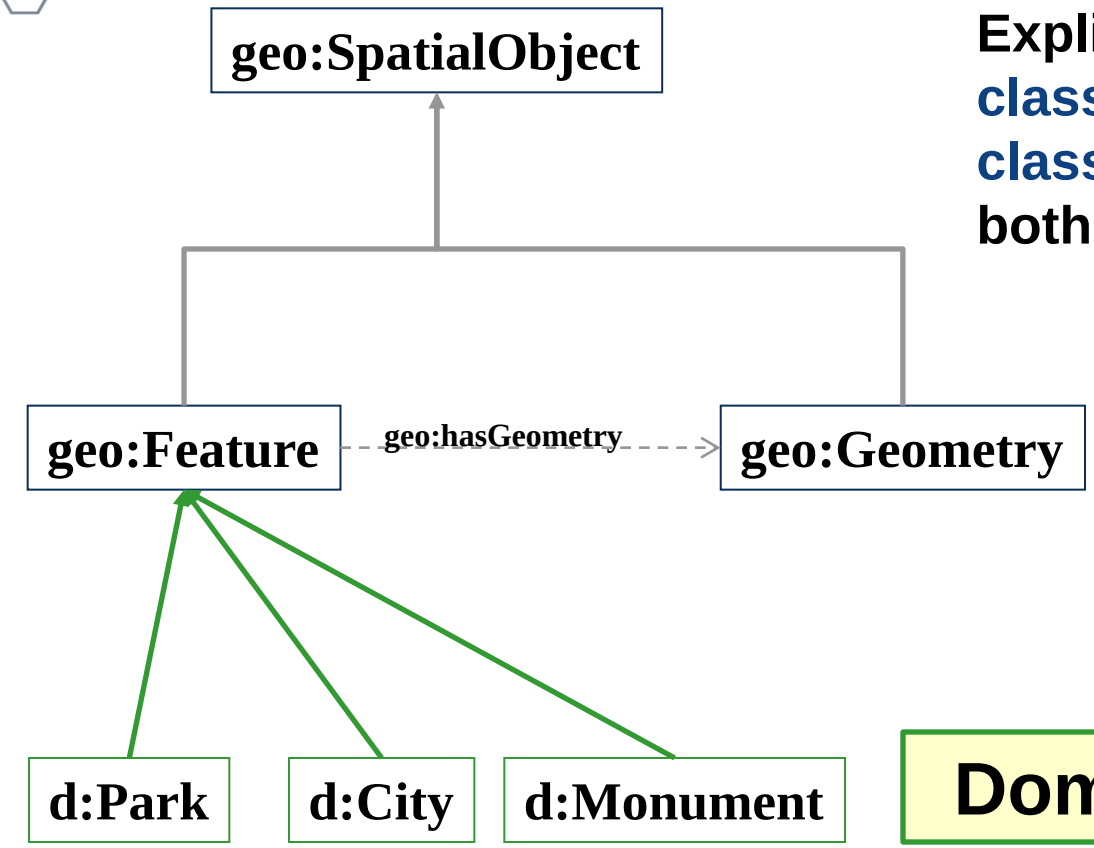
Parts of GeoSPARQL



Ontology - Basic Classes



Explicitly typed as OWL classes and RDFS classes to accommodate both types of systems

Domain Classes

Datatype Properties for geo:Geometry

- Explicitly typed as owl:DatatypeProperty and rdf:Property
  - geo:dimension
  - geo:coordinateDimension
  - geo:spatialDimension
  - geo:isEmpty
  - geo:isSimple
  - geo:is3D
  - geo:asWKT
  - geo:asGML

Only one of these -- based on the conformance class

- Implementations may do both.

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Datatype for Geometry Serialization

- Serialization defines the conformance class
- Initially conformance classes for WKT and GML
  - GML is used as-is for geo:gmlLiteral
  - Spatial Reference System Identifier (**SRID**) URI is added for geo:wktLiteral

```
"<http://www.opengis.net/def/crs/EPSG/0/4326>
                              Point(-83.38 33.95)"^^geo:wktLiteral
```

```
"Point(33.95 -83.38)"^^geo:wktLiteral
```

```
(Default CRS is http://www.opengis.net/def/crs/OGC/1.3/CRS84)
```

Topological Spatial Relations

Simple Features
geo:sfEquals
geo:sfDisjoint
geo:sfIntersects
geo:sfTouches
geo:sfWithin
geo:sfContains
geo:sfOverlaps

9-IM
geo:ehEquals
geo:ehDisjoint
geo:ehMeet
geo:ehOverlap
geo:ehCovers
geo:ehCoveredBy
geo:ehInside
geo:ehContains

RCC8
geo:rcc8Eq
geo:rcc8dc
geo:rcc8po
geo:rcc8tppi
geo:rcc8tpp
geo:rcc8ntpp
geo:rcc8ntppi

Can be used in two ways:
- **A property in the triple pattern**
- **A filter function**

Transformational FILTER Functions

```
geof:relate
geof:distance
geof:buffer
geof:convexHull
geof:intersection
geof:union
geof:difference
geof:symDifference
geof:envelope
geof:boundary
```

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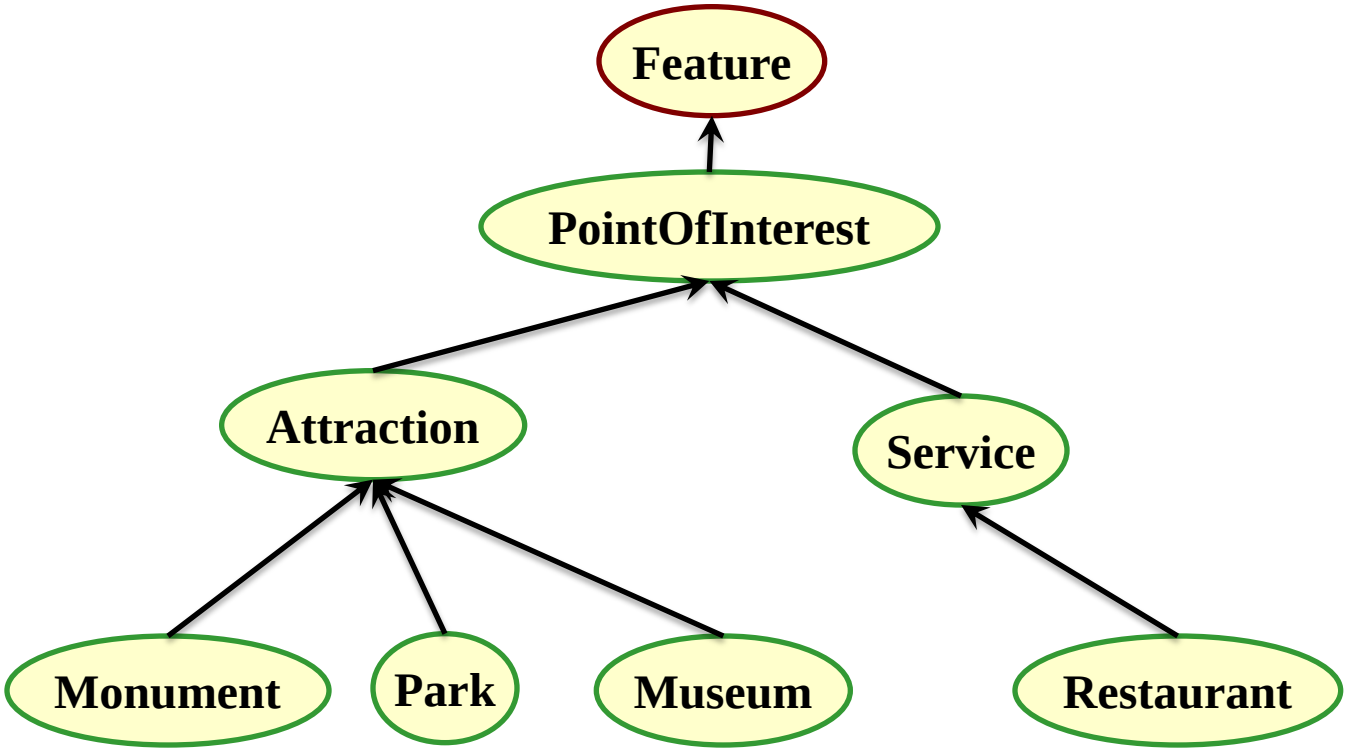
Implementations

- BBN Parliament
  - http://parliament.semwebcentral.org/
  - Open Source triplestore
  - Jena/Joseki front end
- Oracle Database
  - http://www.oracle.com/technetwork/database/index.html
- Strabon
  - http://www.strabon.di.uoa.gr/about

Example Ontology

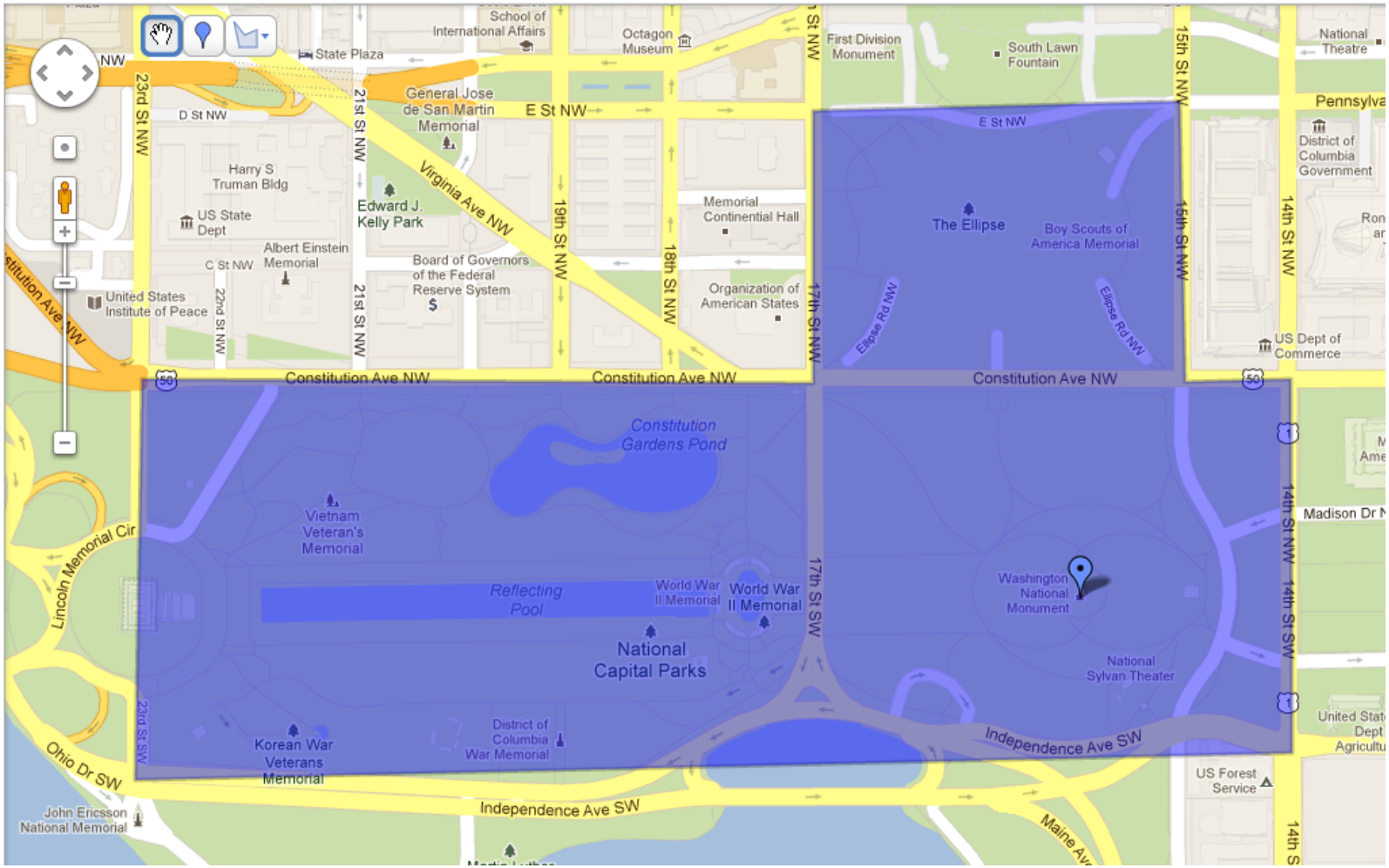


Example Ontology

```
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix geo: <http://www.opengis.net/ont/geosparql#> .
@prefix ex: <http://www.example.org/POI#> .

ex:Restaurant a owl:Class;
   rdfs:subClassOf ex:Service .
ex:Park a owl:Class;
   rdfs:subClassOf ex:Attraction .
ex:Museum a owl:Class;
   rdfs:subClassOf ex:Attraction .
ex:Monument a owl:Class;
   rdfs:subClassOf ex:Attraction .
ex:Service a owl:Class;
   rdfs:subClassOf ex:PointOfInterest .
ex:Attraction a owl:Class;
   rdfs:subClassOf ex:PointOfInterest .
ex:PointOfInterest a owl:Class;
   rdfs:subClassOf geo:Feature .
```

Example Instance Data



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Example Instance Data

```
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix geo: <http://www.opengis.net/ont/geosparql#> .
@prefix ex: <http://www.example.org/POI#> .
@prefix sf: <http://www.opengis.net/ont/sf#> .

ex:WashingtonMonument a ex:Monument;
   rdfs:label "Washington Monument";
   geo:hasGeometry ex:WMPoint .
ex:WMPoint a sf:Point;
  geo:asWKT "POINT(-77.03524 38.889468)"^^geo:wktLiteral.
ex:NationalMall a ex:Park;
   rdfs:label "National Mall";
   geo:hasGeometry ex:NMPoly .
ex:NMPoly a sf:Polygon;
   geo:asWKT "POLYGON((-77.050125 38.892086, -77.039482 38.892036, -77.039482 38.895393,
-77.033669 38.895508, -77.033585 38.892052, -77.031906 38.892086, -77.031883 38.887474, -
77.050232 38.887142, -77.050125 38.892086 ))"^^geo:wktLiteral.
```

Example Query

- Which monuments are spatially within which parks?

```
PREFIX geo: <http://www.opengis.net/ont/geosparql#>
PREFIX ex: <http://www.example.org/POI#>

SELECT ?m ?p
WHERE {
    ?m a ex:Monument ;
          geo:hasGeometry ?mgeo .
    ?p a ex:Park ;
          geo:hasGeometry ?pgeo .
    ?mgeo geo:sfWithin ?pgeo .
}
```

Tip of the Iceberg

- This is the simplest of simple examples
- GeoSPARQL is about adding geospatial reasoning to Semantic Web applications
  - Most domain ontologies are much richer than this example, enabling interesting reasoning
  - Data integration applications can have a geospatial component
- Some potential queries:
  - Which hospitals within 20 miles have appropriate treatment centers for my patient? (reasoning)
  - What hotels with 3 star ratings are within 10km of at least 3 attractions with 4 star ratings? (data integration)

Conclusion

- Do you need to use geospatial locations in your ontology?
  - Don’t reinvent, use GeoSPARQL.

Questions?