

# Rules for Geospatial Semantic Web Applications

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# Objectives

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- Describe the use of rules in Geospatial Semantic Web application
  - Discuss language requirements for expressing geospatial inference rules
  - Discuss tools requirements for processing geospatial inference rules
  - Highlight open questions associated with the use of rules in geospatial applications
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# Geospatial Semantic Web

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- Geospatial Semantic Web is a natural extension of the current geospatial systems and applications
- Key focuses
  - Enable data interoperability by exploiting semantic web languages and ontologies
  - Automate the production of geospatial knowledge by using rules and OWL inferences

# An Intelligence Analyst Application

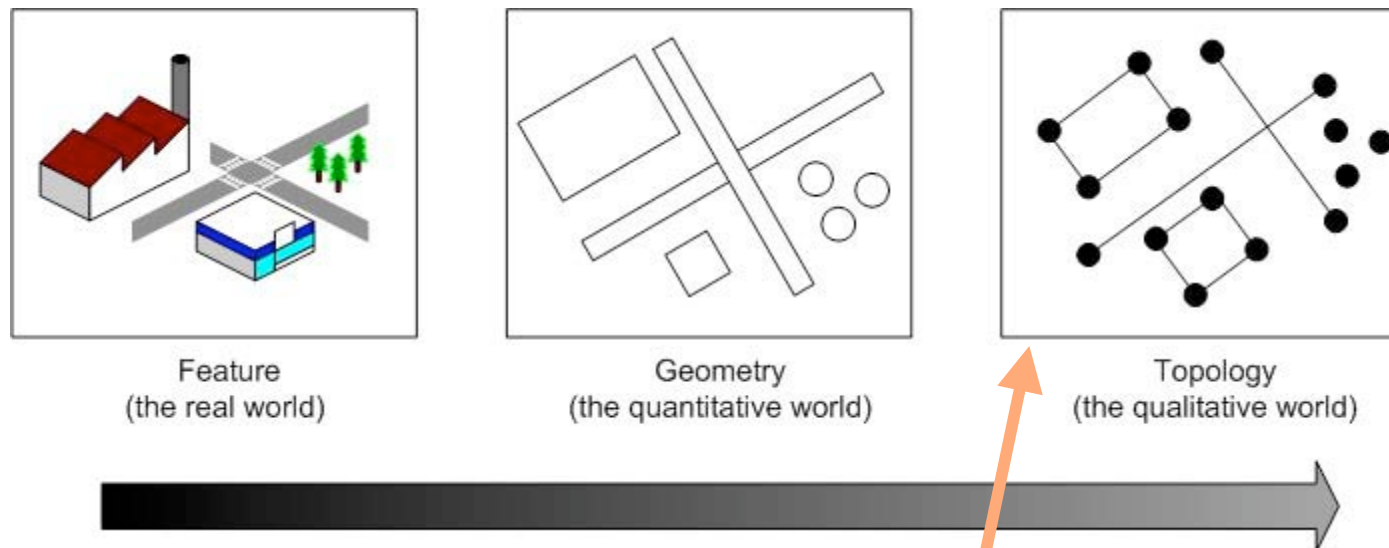
The screenshot displays the NGA GIAS application interface. The main window shows a world map with various regions highlighted in different colors (yellow, orange, red, purple, blue). The interface includes several panes:

- Problem Profile:** A tree view showing the structure of the WMD Capability Profile 01, including Support Evidence, Assertions, Inferred Knowledge, and Threat Score.
- Task View:** A list of tasks such as "For discovering helicopter landing zone" and "For discovering potential WMD Capability".
- Analyst Asset:** A list of features including "Feature", "IntersectionGuardedByMilitary", "IsotopeProductionFactory", "MilitaryPost", "MissileFactory", "NuclearMissileFactory", "Road", "RoadIntersection", "RoadToIsotopeProductionFactory", "RoadWithControlledTraffic", "r3312", "r3313", and "r3314".
- Property View:** A table showing the properties of a selected feature.

Property Name	Value
gfi:hasIntersection	r3312
r3fi:type	gfi:Road
gfi:connectsFeature	r3298
gfi:connectsFeature	g7326

- Help intelligence analysts to solve problems using different types of geospatial knowledge
- E.g. Discover WMD capabilities of a country by comparing the collected data with the known WMD signature information

# Geospatial Models



Typically, we do reasoning in this world with rules!

# Rules Usage Examples

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- Assumption: all geospatial data are expressed in OWL/RDF based on some shared ontology
  - Enable data interoperability
    - Using rules to convert data from one geometry representation to another geometry representation
    - Using rules to unify Unit of Measurements
  - Automate geospatial knowledge production
    - Define rules for topological reasoning (e.g. Region Connection Calculus, Allen's Interval Calculus)
    - Define rules for bridging geometry reasoning and topological reasoning
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# Rule Language Requirement

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- Support for N-ary representation
  - Not all geospatial relations are binary.
    - distanceFrom (?locA, ?locB, 200m)
- Support for mapping data from the RDF representation to other rule engine specific representation
  - Classical rule engines may be needed to support default reasoning, fuzzy reasoning
  - It's inconvenient to write rules that involve a large number of N-Triples

# Rule Processing Requirement

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- When processing certain geospatial inference rules, a rule engine may be required to preprocess the associated `rdf:Resource`.
  - IF `distanceFrom(?locA, ?locB, 200m)`  
THEN `do_some_work()`
  - Must extract geometry information of the `rdf:Resource` that are bound to `?locA` and `?locB`
- Integrate the representation of “functors” (built-ins) as RDF properties
  - `(?geoA geo:within ?geoB)`
  - `(?a geo:within ?c) <- (?a geo:within ?b), (?b geo:within ?c)`
  - If “`geo:within`” is a functor, what should be the caching policy, and when should the engine do triple evaluations rather than calling the functor?



# Open Question: Contexts

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- Geospatial inference often involves context (location, time etc).
    - Rules for determining WMD facilities within a forest area might be different from those for determining WMD facilities within a desert area
    - Rules for determining WMD facilities during a winter season might be different from those for determining WMD facilities during a summer season
  - Should rule representation include constructs for context representation?
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# Open Question: Constraint Rules

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- Constraint rules are essential for geospatial representation and inference
    - E.g. The Helipad should be within the Security Fences of a potential WMD facility, and it should be at least 200 meters away from the fence
    - E.g. a potential WMD facility should not be within or partially within a flood plain.
  - Should there be special constructs for representing constraint rules?
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# Open Question: Working with Imprecise Data

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- An intelligence analyst rule:
  - Most WMD facilities are within 50Km of cities with populations equal to or greater than 10,000 population.
- How to define rules that can tolerate imprecise data that is measured from the real world?
  - What if facility(X) is within 50.05 Km of a city with population 9,999?
- How to define rules to deal with subjective concepts?
  - Nearby, far away, cold/warm, soon, later etc.

Questions?

