

# Some Opportunities for Framing Ontological Engineering for the National Map: Maps and Semantic Maps

Gary Berg-Cross

Principal Semantic Technology (EM&I)

SOCoP Executive Secretary

## Outline of Topics

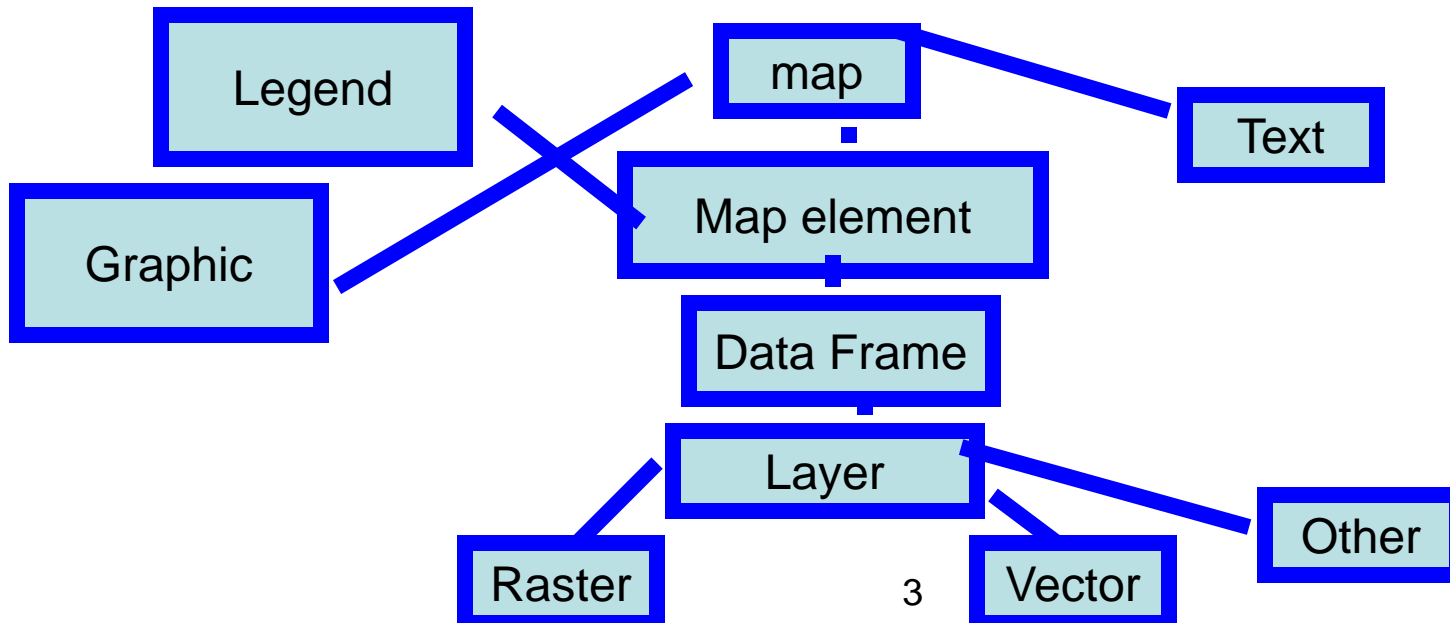
1. About Me (briefly)
2. Ontology is a major feature of V3 of the National Map to specify feature semantics for richer data models which provides an intelligent basis of data access.
3. Reference Models, Frameworks and Ontological Engineering Methods
  1. Early thoughts on SOCoP's ontology reference model initiative – reference models, methods, tools and products
  2. A way of understanding ontology development methods
  3. Obstacles of bad semantics – pseudo-taxonomies, inadequate semantic relations, lack of schemas
4. Why is it hard? And what are the opportunities?

# Briefly About Me

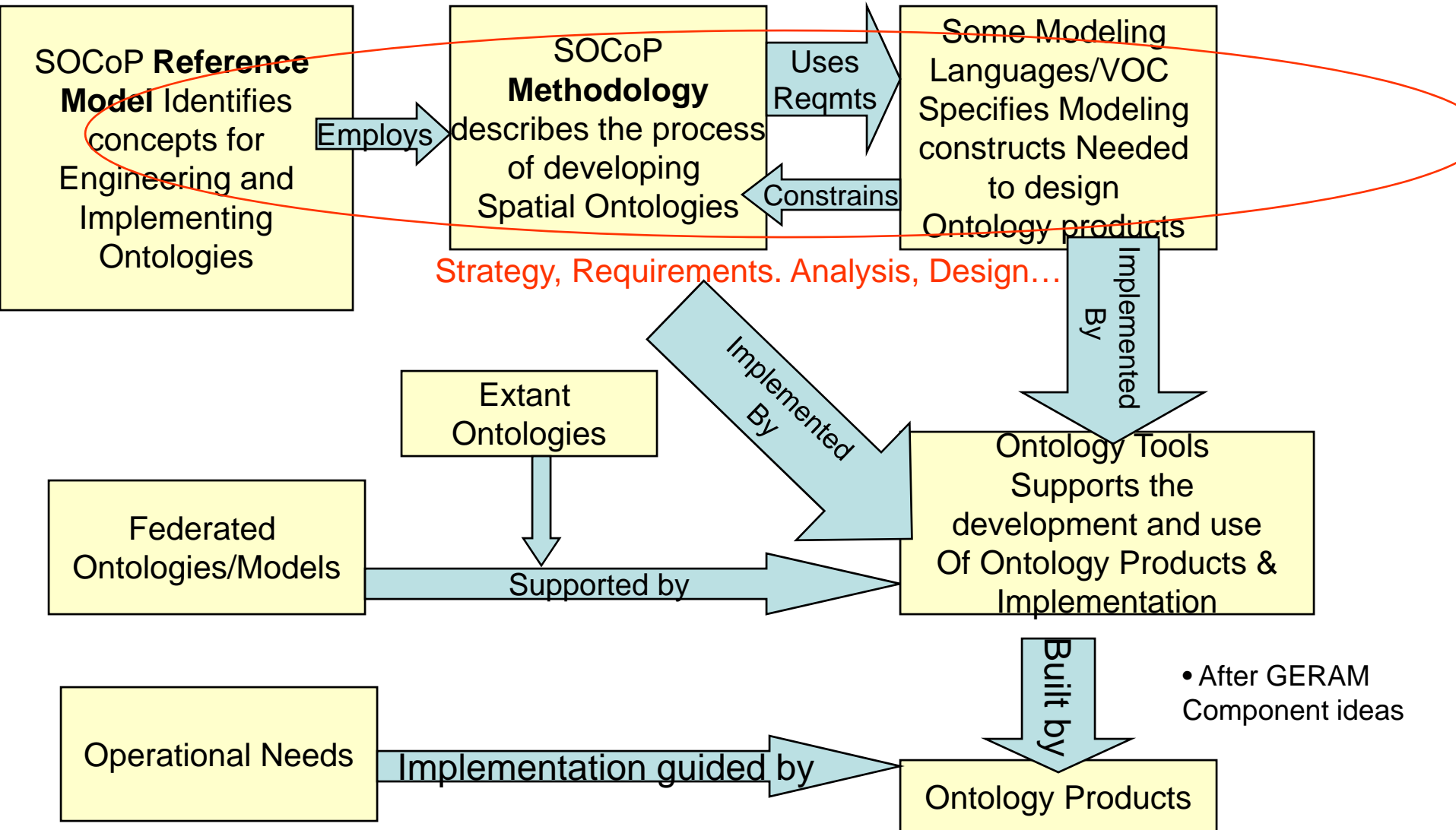
- PhD in Cognitive Psychology – studied the representation and memory for narratives
- First work on “ontologies” in 84-86 published as part of 1<sup>st</sup> Conceptual Graph Conference (86)
- Various work consulting on better semantics for enterprise data from data warehousing, enterprise architecture and data services (e.g. Military Health System, DHS, NIH etc.)
- SOCoP Executive Secretary, on Program Committee for in Terra Cognita etc.
  - Interested in semantic methods not just products and will touch on our effort to create a reference model for GS ontologies
- Member of W3C Emergency Information Interoperability XG

# SOCoP's Geospatial Ontology Reference Model

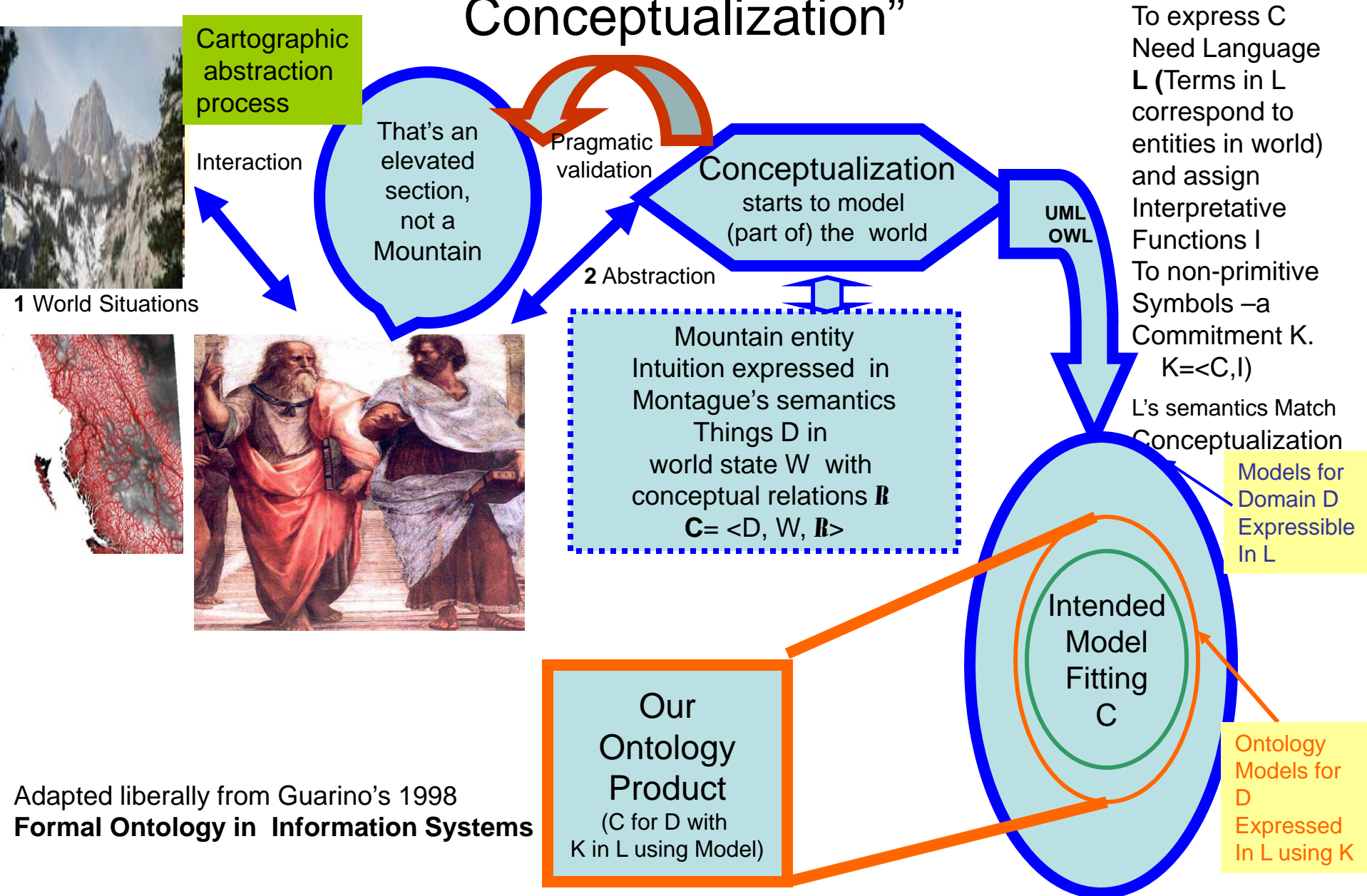
- As John Moeller discussed SOCoP has started on development of a Geospatial Ontology *Reference Model* to acquaint people with this subject and socialize concepts, describe/define semantics and ontologies, their components (e.g. vocabularies, spatial elements/concepts, spatial relations, axioms etc.)
- The idea is that a RM will provide the **appropriate conceptual model** for developing and describing geospatial ontologies their composition and how they fit together and how they provide benefits beyond existing standards.
- Envisioned as part of the RM would be some **suggested process/approach for developing an ontology** and particular requirements for geospatial ontologies to facilitate key functions such as interoperability (a primary concern in geographic information science), and support for geospatial reasoning.



# One Way to “Frame” Ontologies



# One View of How Ontologies Arise from “Analysis and Conceptualization”



Adapted liberally from Guarino's 1998  
**Formal Ontology in Information Systems**

# There are Obstacles – Pseudo-Taxonomies & Ontologies have many more semantic relations such as Part-Relations

Composition is important to GeoSpatial Concepts so part-whole relations need to be well founded

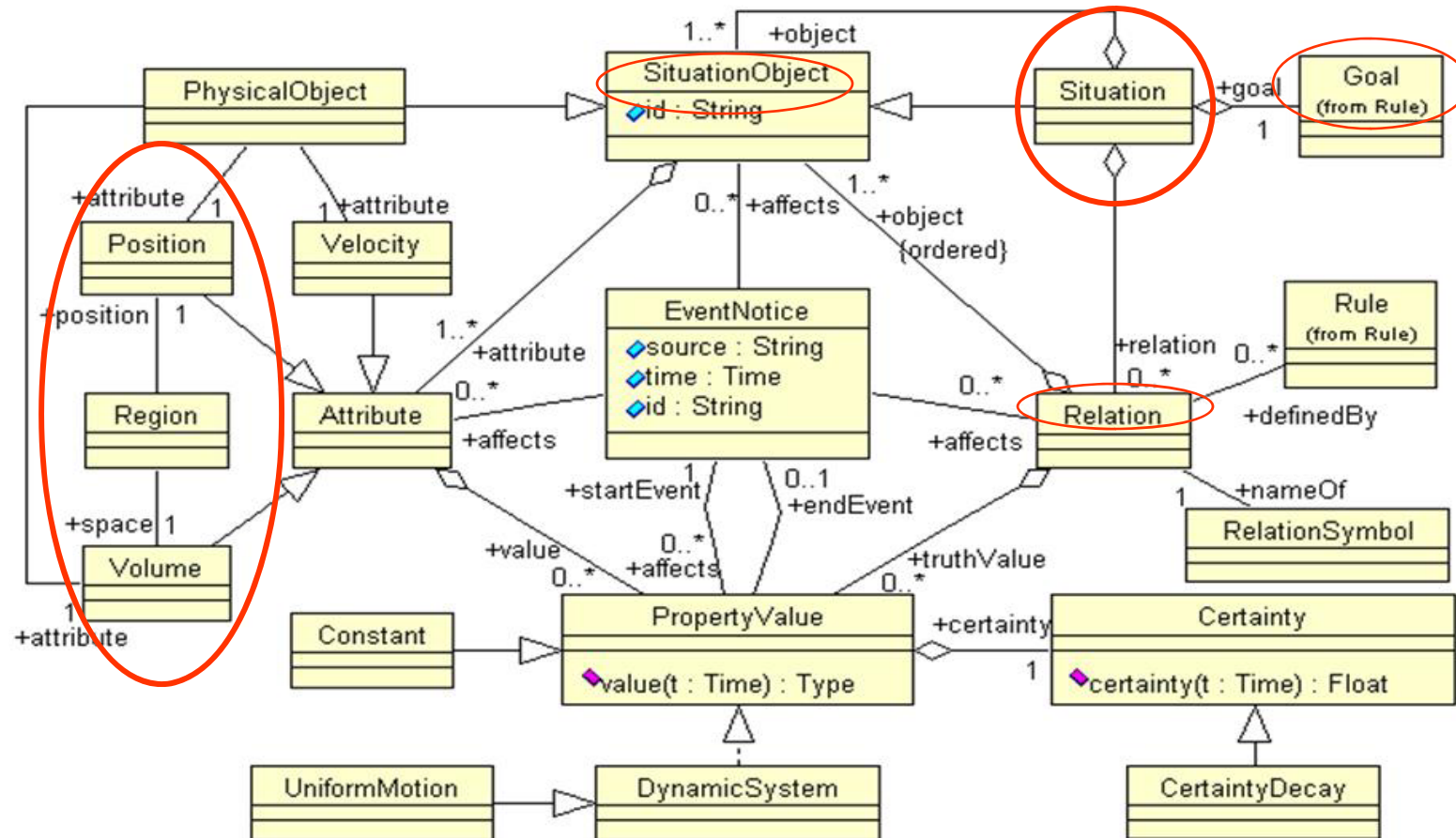
- Properties of relations become better distinguished:
  - Particular part relations for types of entities – physical (mouth, river) or geographic regions (VA, USA)
  - These have relations of parthood, componenthood (as “functional units” for example in disasters), containment
  - Asymmetric relation example
    - Chesapeake Bay is part of MD. The mouth of the Chesapeake is in VA. **Is mouth of the Chesapeake part of MD?**
      - Containment is NOT parthood .
    - NOT all parts of a whole are meaningful components **etc.**

See Odell, J.J. Six different kinds of composition. *Journal of Object Oriented Programming*, 5 (8). 10-15. or

<http://www.w3.org/2001/sw/BestPractices/OEP/SimplePartWhole/>

# Using Ontological Schemas to Integrate “Themes”

SAW is light Situational Ontology (Matheus et al 2003)– Situations (object, events) are defined as a relationship to 3 things: Goals, SituationObjects and Relations



Ontology  
Design  
Pattern-  
Gangemi

To represent bus transportation systems (**Physical Object**) for **Flood Situations** being reported on by environmental sensors, we need both realistic street information that can be overlaid by Bus Stops (**Physical Location**) and also more **abstract** timetables along with circumstances that apply in emergencies as sensors report water height, closed streets etc.

# Some Final Thoughts - Why it is Hard? And Opportunities

Generally we Need Better Ontological Engineering

- Too much from semantically weak methods constrained by weak formalisms (e.g. ERDs) .
- We have to think of robust, adaptive knowledge as more than a thing (**ontology**), **it is a method**, and needs to have some **rigor**
- Knowledge is fluid and approximately maximized, so I agree with the LOA group and people like Pat Hayes and John Sowa that **coherence WON'T emerge from little pieces knowledge built informal when agreed upon by communities without considering semantic issue richer than web-exchangeable logic that are posted on the web.**

## Opportunities

1. We need some modestly larger **modules** of ontological knowledge that can be reused more confidently (ODPs).

These should be built from a more systematic method which addresses how terms are standardized using semantic commitments that stand up to rational analysis while fitting our more robust conceptualizations.

2. **Agent Infrastructure** Another idea builds on what Barbara Poore talked about yesterday - pragmatic knowledge is a characteristic of intelligent agency, that intentionally deal with problems they confront.

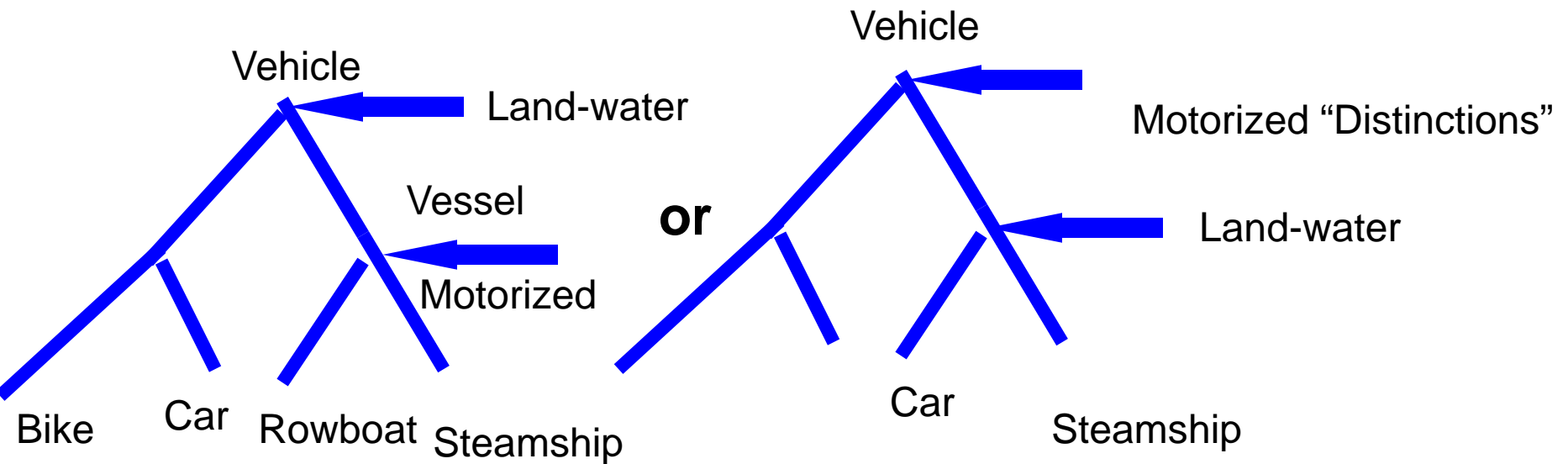
I take the idea that as part of TNM effort there is an opportunity to create, not just a data infrastructure but also some cognitive geospatial capabilities (more than a query) that use the underlying data and knowledge.

One strategy for this is to use translators to convert ontological representations to agent representations, customizing some agent knowledge for particular ontological inference/procedural knowledge.

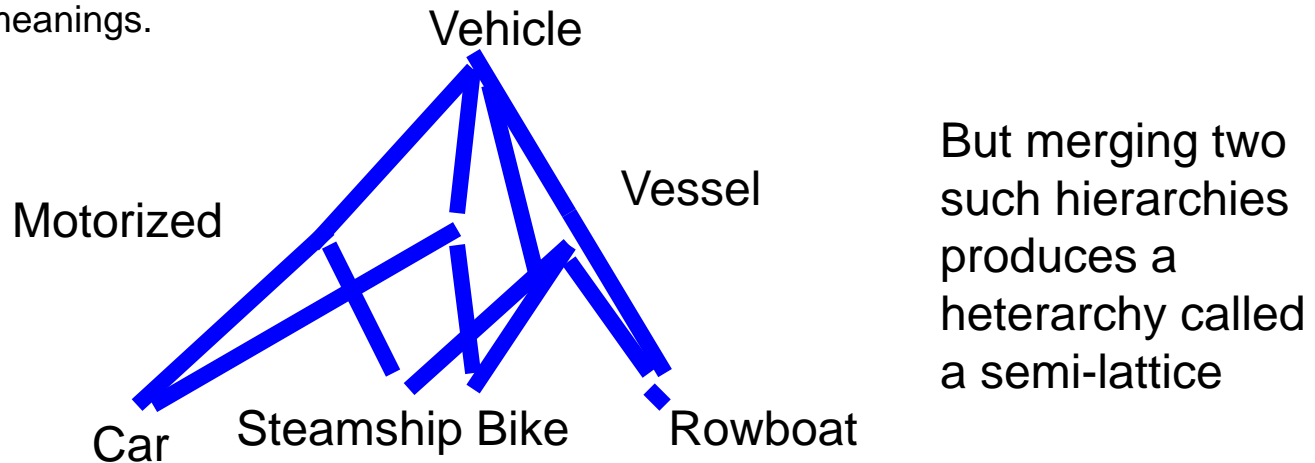
An additional idea is to use explanation-based learning to cache ontological inferences..

Backup

# Conceptualizing Taxonomic Structure can be Complex



Distinctions can be applied in any order and this may produce artifacts (like non-motorized air vehicle that is not relevant to intended meanings).



But merging two such hierarchies produces a heterarchy called a semi-lattice

# Semantic Integration

- Many Reference Models and their Components are often Quite Informal, Lack Content or are Preliminary -; Simple Taxonomies can have Pseudo Semantics.
- This is illustrated by challenges with the eight USGS thematic data layers – each different “data models” and challenged to face the needs of disaster situation:

But within these we have some very concrete, fixed features of topography mixed with others that are quite abstract and particular concepts bridge themes.

