Reasoning about Events on the Semantic Web

Ontology Summit 2014 – Track A

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Questions for Ontology Summit 2014

- How are Semantic Web / Big Data applications using ontologies?
- Which ontologies are being used?
- What ontologies are required by these applications?
- If ontologies meeting these requirements exist but are not being used, what are the reasons?
- If ontologies meeting these requirements do not exist, how can they be designed?

The Role of Reasoning

Currently, most event ontologies on the Semantic Web are employed for annotation and retrieval

- What kinds of reasoning is being done with these event ontologies?
- With all of the annotated data, there are many opportunities for reasoning that are not being addressed.

Some Motivating Scenarios

Beyond annotation and retrieval:

Emergency response: Are two reported incidents possibly related?

Context-awareness: Are there any potential delays in my area/path of interest? (construction, accidents, special events...)

Municipal planning: During which time periods are no events scheduled at the location of interest?

Recreational events: Are there any scheduling conflicts between my events of interest at Festival-X?

Research Questions

All of these observations raise the questions:

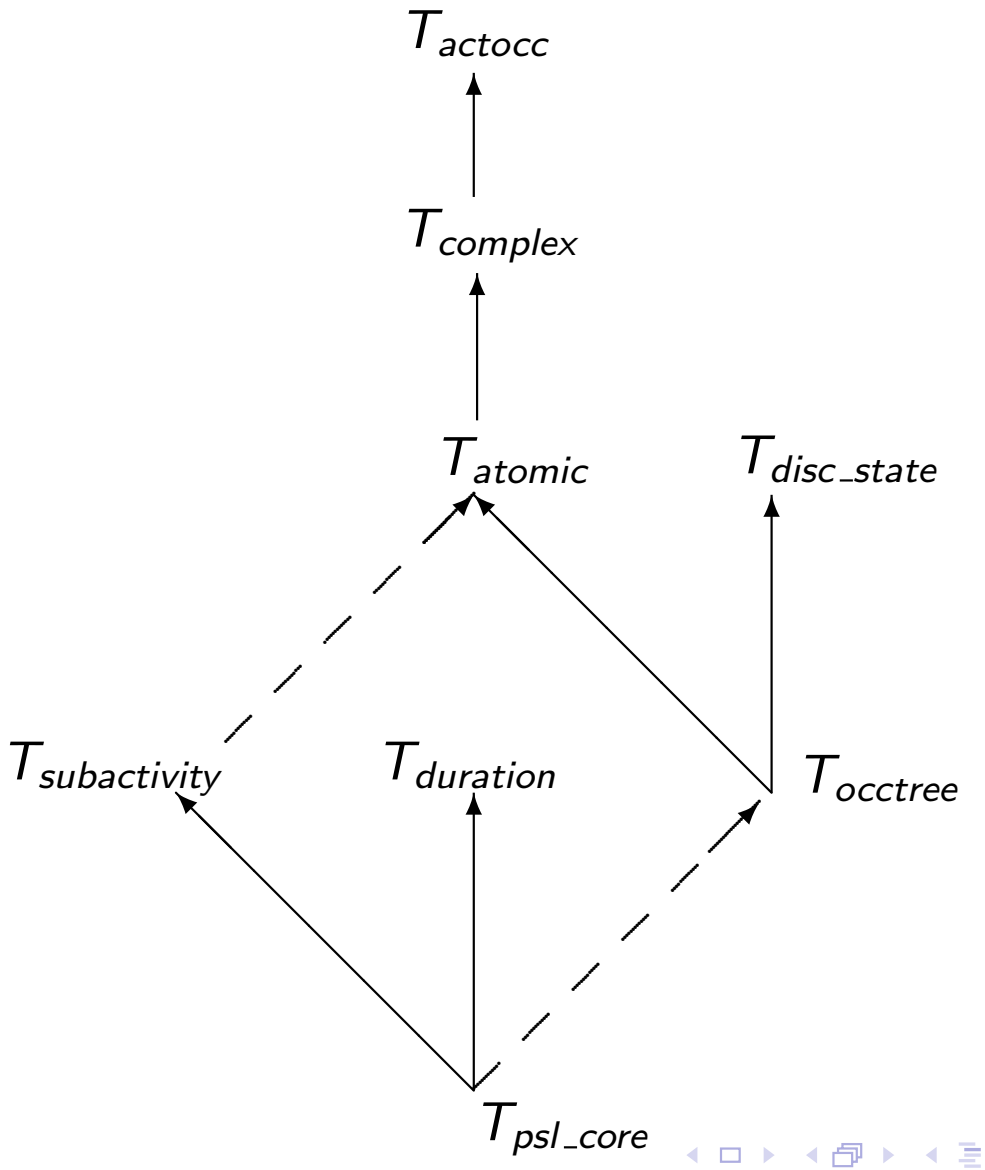
- Are Semantic Web ontologies able to support non-trivial reasoning problems?
- If not, why?
- Are the existing ontologies simply not designed with enough semantics to support these applications, or have they reached the limit of what Semantic Web languages can support?

Semantic Web Event Ontologies

Using the reasoning abilities of PSL as a reference point, our investigation is focused on a few well known Semantic Web event ontologies:

- SEM Core
  `http://semanticweb.cs.vu.nl/2009/11/sem/`
- LODE
  `http://linkedevents.org/ontology/`
- The Event Ontology
  `http://purl.org/NET/c4dm/event.owl`

Modules of the PSL Ontology



Process Specification Language

- PSL (ISO 18629) is a modular, extensible ontology capturing concepts required for process specification
- There are 300 concepts across 50 extensions of a common core theory (PSL-Core), each with a set of first-order axioms written using the Common Logic Interchange Format (ISO 24707).

colore.oor.net/process_specification_language/

Extending Ontologies

From PSL, SEM, the Event Ontology, and LODE, we created the following ontologies:

- psl.owl (OWL axiomatization of PSL)
- sem-x.owl (conservative extension of SEM using psl.owl)
- event-x.owl (conservative extension of EVENT using psl.owl)
- lode-x.owl (conservative extension of LODE using psl.owl)

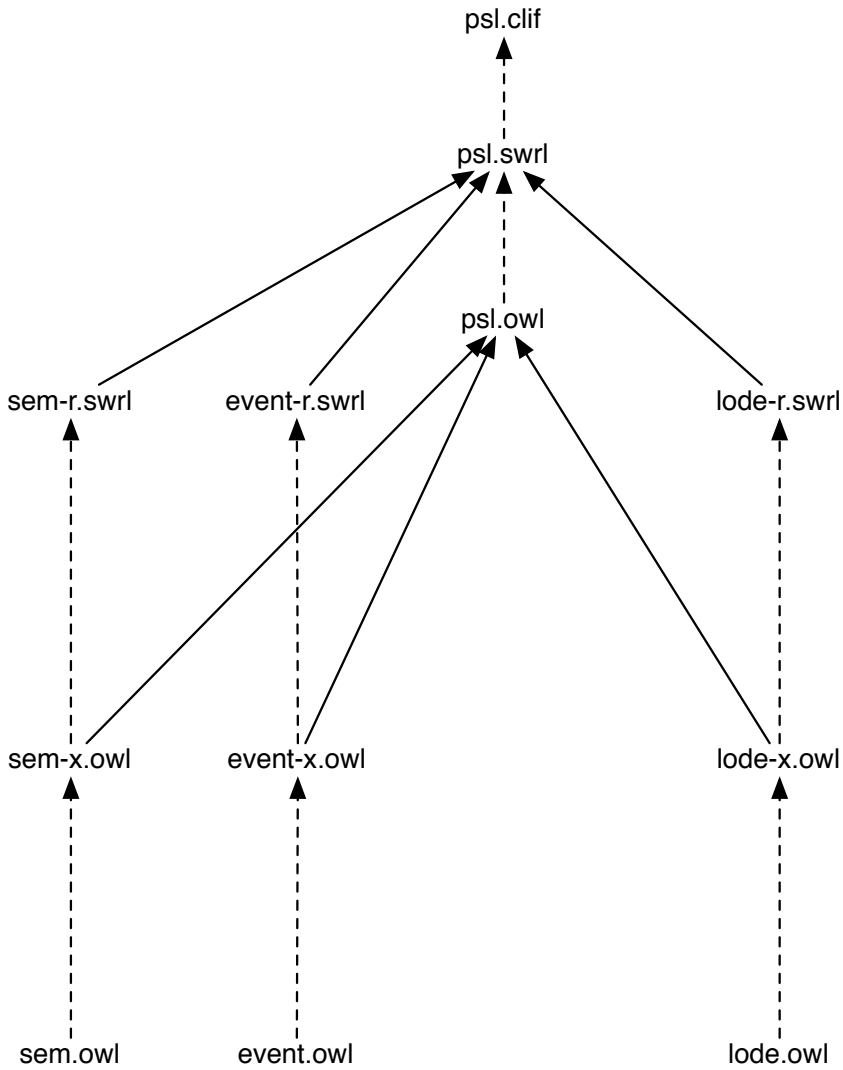
This provides us with a spectrum of ontologies in OWL and First-Order Logic to be evaluated by a set of competency questions derived from motivating scenarios of potential reasoning applications on the Semantic Web.

Extending Ontologies

From PSL, SEM, the Event Ontology, and LODE, we created the following ontologies:

- psl.swrl (SWRL axiomatization of PSL)
- sem-x.swrl (conservative extension of SEM using psl.swrl)
- event-x.swrl (conservative extension of EVENT using psl.swrl)
- lode-x.swrl (conservative extension of LODE using psl.swrl)

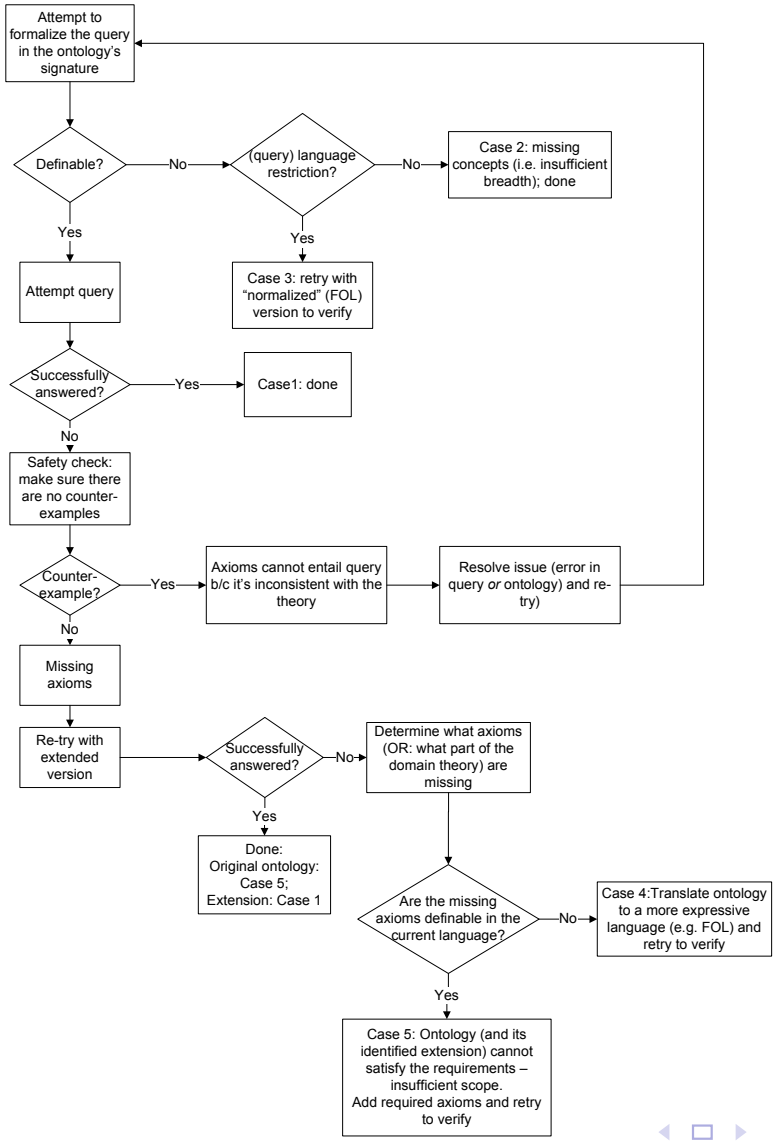
Relationships among Event Ontology Extensions



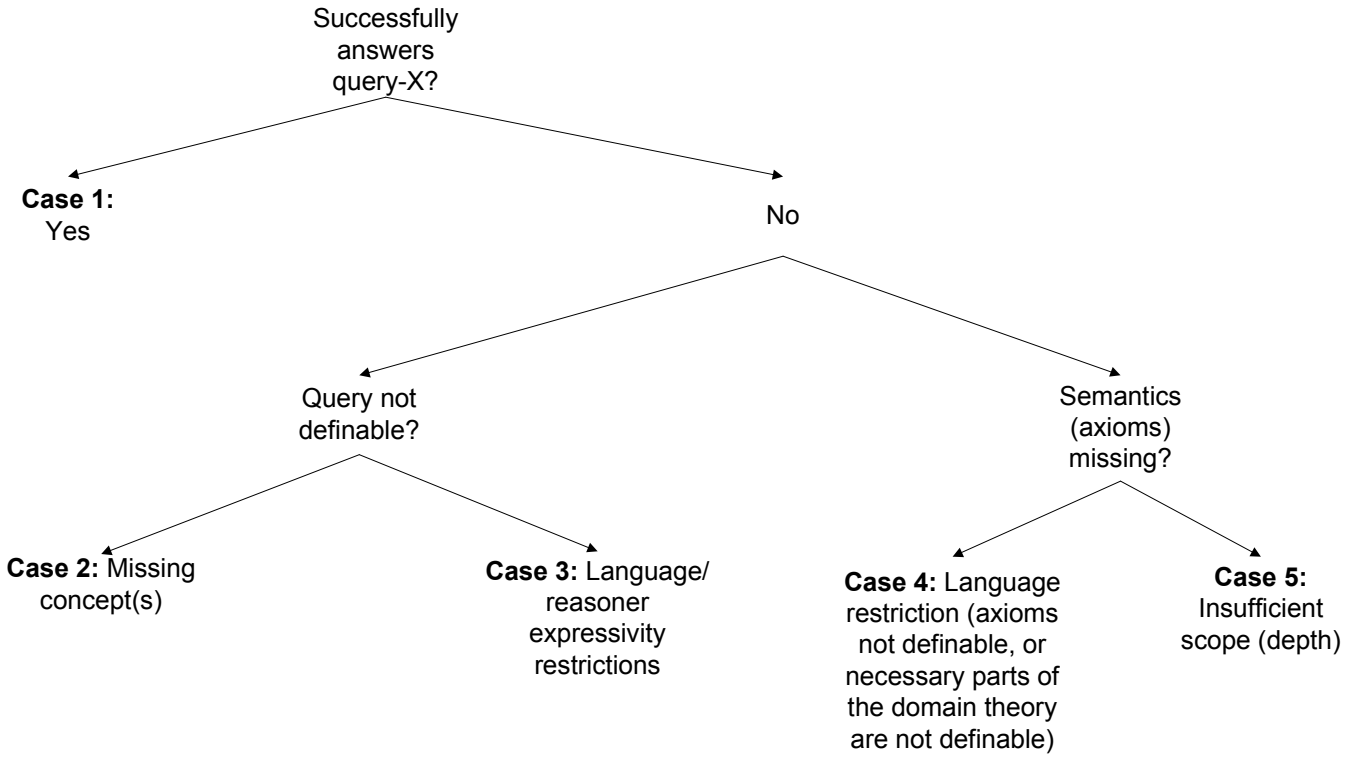
Relationships among Event Ontology Extensions

- Using the relationships between PSL and the event ontologies, we can entail mappings among the event ontologies, and characterize what semantics are shared across these ontologies.
- We also want to use the competency questions to distinguish among the different extensions of the same ontology – what do we get from the additional axioms? What role does the ontology language play?

Evaluation of Ontology Extensions



Possible Outcomes



Discussion

The development of reasoning applications may serve to promote more use of ontologies on the web.

We hope that the outcome of this work will also provide guidance on what is required if we want to be able to perform non-trivial reasoning with ontologies on the Semantic Web.

- Preliminary results indicate that the axiomatizations of the event ontologies on the Semantic Web are too weak to specify and entail competency questions extracted from the motivating scenarios.
- Identify techniques to prove that we have the maximal subtheory of a Common Logic ontlogy in a given ontology language (such as OWL and SWRL).