SOWL: Representing Spatio-Temporal Information in OWL

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Abstract. We present SOWL, a model for representing spatio-temporal information in OWL. SOWL enables representation of dynamic information such as objects, concepts and properties changing in time (e.g., moving objects in a video).

1 Introduction and Related Work

Representing spatio-temporal knowledge has motivated research within the Semantic Web community. Existing approaches support only quantitative relations (i.e., relations between regions or time intervals whose locations or end points are known), do not provide reasoning support over all kinds of relations or both [5]. The 4d-fluent (perdurantist) approach [1] shows how temporal information can be represented effectively in OWL. Building upon 4D-fluents, SOWL shows how spatial and spatio-temporal information (in addition to temporal) can efficiently be represented in OWL and also shows how qualitative temporal relations which are common in natural language expressions (i.e., relations between time intervals whose start and end points are not known such as "before", "after"), are represented in the ontology.

2 Spatio-Temporal Ontology

The SOWL ontology comprises of a static and a dynamic part. Time instances and time intervals are represented as instances of a time interval class which in turn is related with time concepts varying in time. Changes occur on the temporal part of the ontology. Specifically, temporal properties (fluents) are represented by means of time-slices (i.e., object instances during specific time intervals). Qualitative relations are represented by means of Allen's qualitative temporal relations (e.g., "before", "after"). Reasoning on basic Allen relations is expressed by SWRL rules and allows for both, inference of unknown relations and consistency checking (i.e., checking if assertions on time intervals or locations lead to contradictions). Spatial entities can be represented by means of quantitative expressions (i.e., a point depicting their exact location or center of gravity, their minimum bounding rectangle, or a set of points surrounding their bounding contour). Also, similarly to temporal, SOWL allows for qualitative expressions in terms of spatial (topologic RCC-8 and cone shaped directional) relations. Reasoning is expressed by SWRL rules based on the composition of spatial relations which are provided by composition tables [3]. Locations are represented as properties of time-slices (fluents) in the case of moving objects. Fig. 1 illustrates the ontology schema representing the scenario "George stayed in Crete from May 15 to May 30, 2010; then, he moved north to Athens". The resulting OWL ontology is characterized by *SRIF(D)* DL expressivity and it is decidable since it doesn't contain role inclusion axioms with cyclic dependencies [4]. Furthermore, by adding spatiotemporal qualitative rules decidability is retained since they are safe rules applying on simple roles.

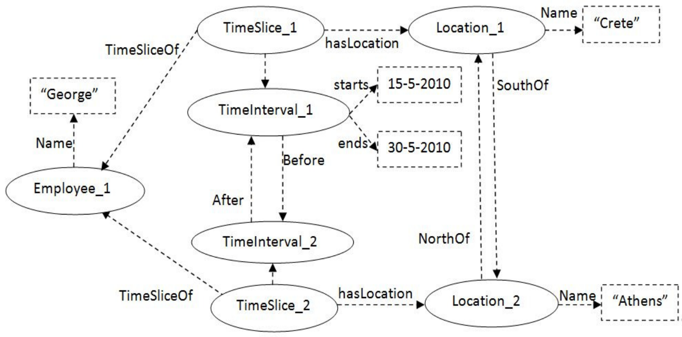

Fig. 1. SOWL example.

3 Conclusions and Future Work

We introduce the SOWL approach for representing static and dynamic spatio-temporal content in OWL ontologies. Querying spatio-temporal information in SOWL using general purpose query languages such as SPARQL leads to complicated queries. Extending the TOQL [2] query language for handling spatio-temporal information in SOWL is an important issue for future research.

References

1. C. Welty and R. Fikes. A Reusable Ontology for Fluents in OWL. *Frontiers in Artificial Intelligence and Applications*, 150:226–236, 2006.
2. E. Baratis, E.G. Petrakis, S. Batsakis, N. Maris and N. Papadakis. TOQL:Temporal Ontology Querying Language Intern. Symp. on Spatial and Temporal Databases (SSTD 2009), pp. 338–354, 2009.
3. J. Renz, and B. Nebel. Qualitative Spatial Reasoning using Constraint Calculi. In Handbook of Spatial Logics, Springer, Netherlands , pp. 161–215, 2007.
4. I. Horrocks, O. Kutz and U. Sattler The Even More Irresistible SROIQ In: Proc. KR 2006, Lake District, UK, 2006.
5. M. Perry, A. Sheth, I.B. Arpinar, and F. Hakimpour. Geospatial and Temporal Semantic Analytics Handbook of Research on Geoinformatics, 2009.