Uncertain Reasoning for Creating Ontology Mapping on the Semantic Web

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Outline

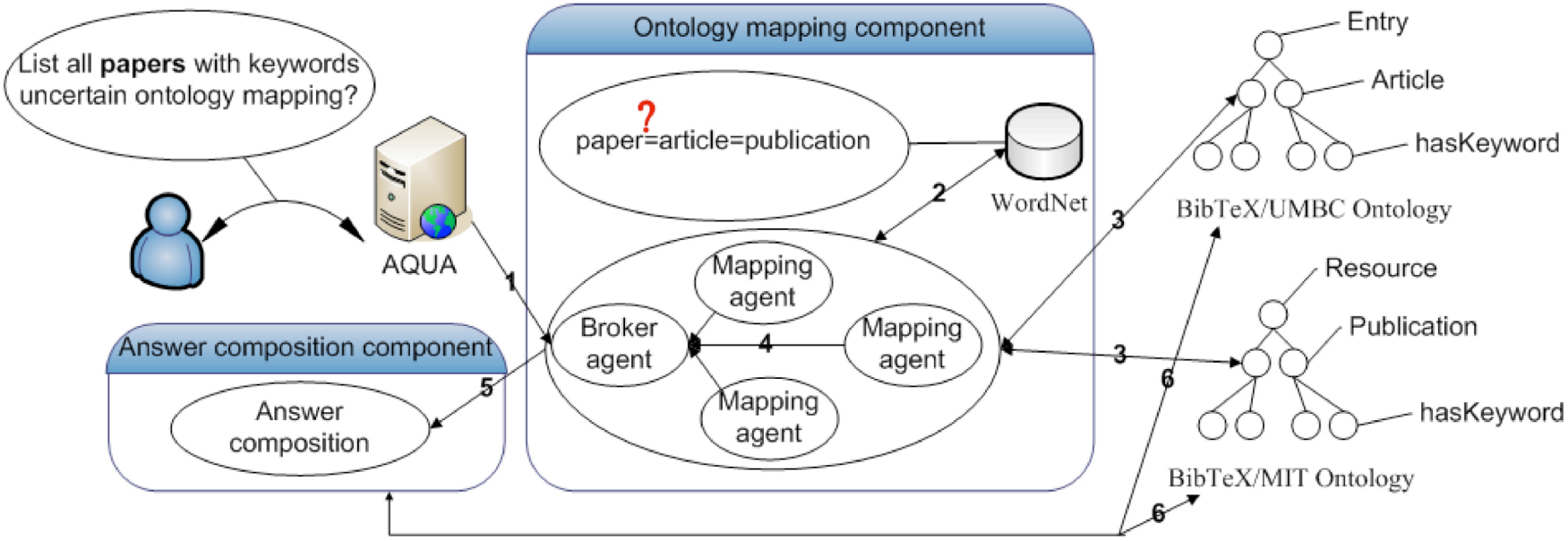
- Introduction and context
- Motivation: Question Answering (QA)
- Belief for uncertain similarities
- Evaluation
- Conclusions

Introduction and context

Ontology mapping on the Semantic Web:

- Need for efficient and effective mapping
- Meaningful similarity combination
- Independent from domain specific parameters

Motivation: Question Answering (QA)



Belief for Uncertain Similarities

Assumptions:

- Similarity measures based on unreliable and inconsistent information
- Agents' background knowledge depends on their perspective
- Knowledge over similarity measure is subjective and context dependent

Uncertainty with Dempster-Shafer

- Uncertain information in a numerical way
- Missing data also can be modeled
- Probabilities are assessed by combining pieces of evidences
- Evidences from two or more sources can be combined using Dempster's rule of combination

Frame of discernment (Θ) **:** Represent the space of hypotheses

Evidence **:** available fact as a result of the observation

Belief mass function (m): finite amount of support for the particular evidence

Belief: sum of all evidence that supports a particular proposition

Dempster's rule of combination:

$$m_{ij}(A) = m_i \oplus m_j = \sum_{E_k \cap E_{k'}} m_i(E_k) * m_j(E_{k'})$$

Evaluation

- Experiments with the existing benchmarks of the 2006 and 2007 Ontology Alignment Evaluation Initiative
- Bibliographic references Ontology (different classifications of publications) contained 33 named classes, 24 object properties, 40 data properties
- Reference Ontology + systematically generated test ontologies starting from the reference ontology and discarding a number of information (data types, properties, instances, class hierarchies)

Sample ontologies from the benchmark

- Ontology Nr. 103: Language generalisation (OWL Lite)
- Ontology Nr. 204: Different naming conventions
- Ontology Nr. 205: Synonyms
- Ontology Nr. 221: No hierarchy
- Ontology Nr. 222: Flattened hierarchy
- Ontology Nr. 221: Expanded hierarchy
- Ontology Nr. 301: Real ontology –BibTex(MIT)

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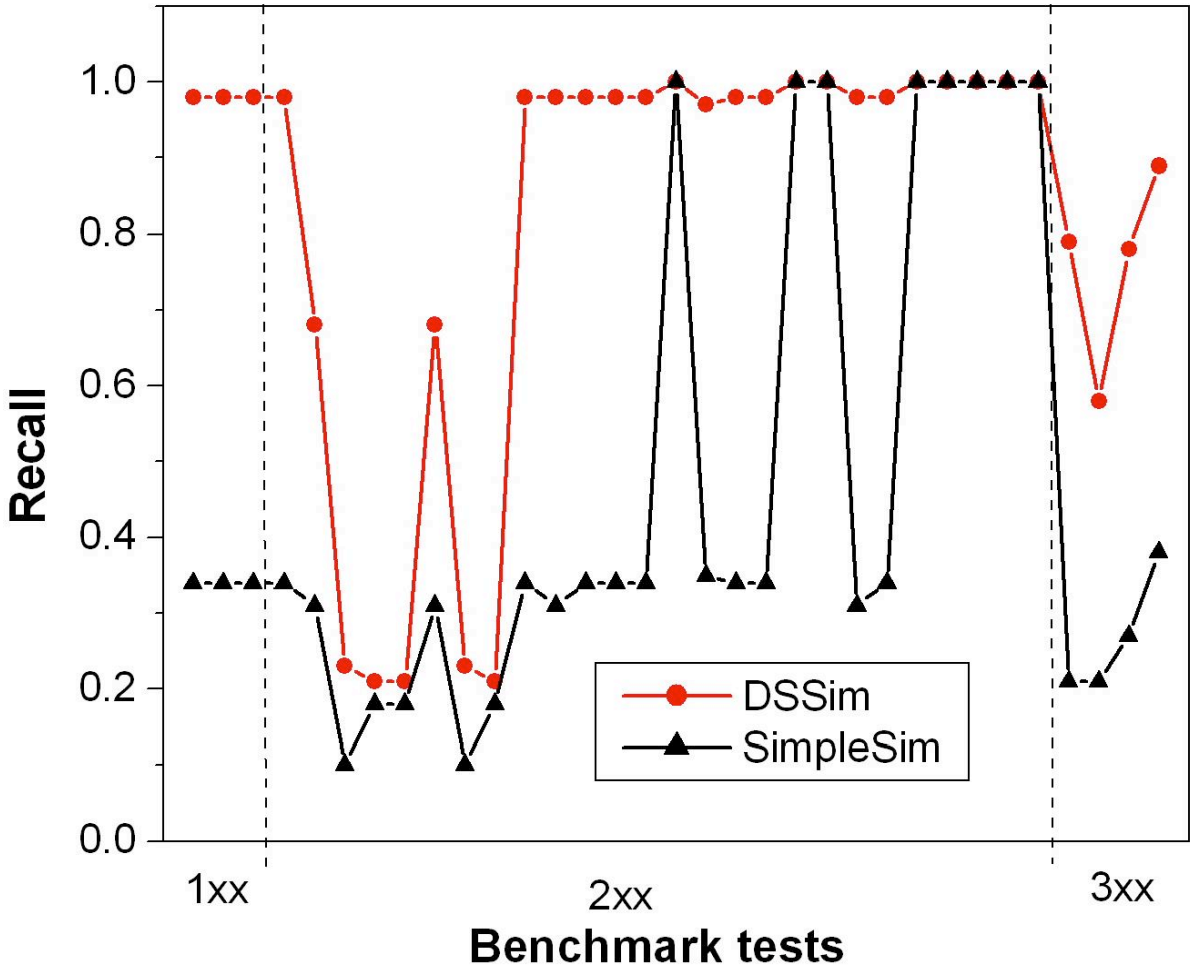

DSSim: uses beliefs for managing uncertainty for similarity combination.

SimpleSim: combines different similarities producing an average measure.

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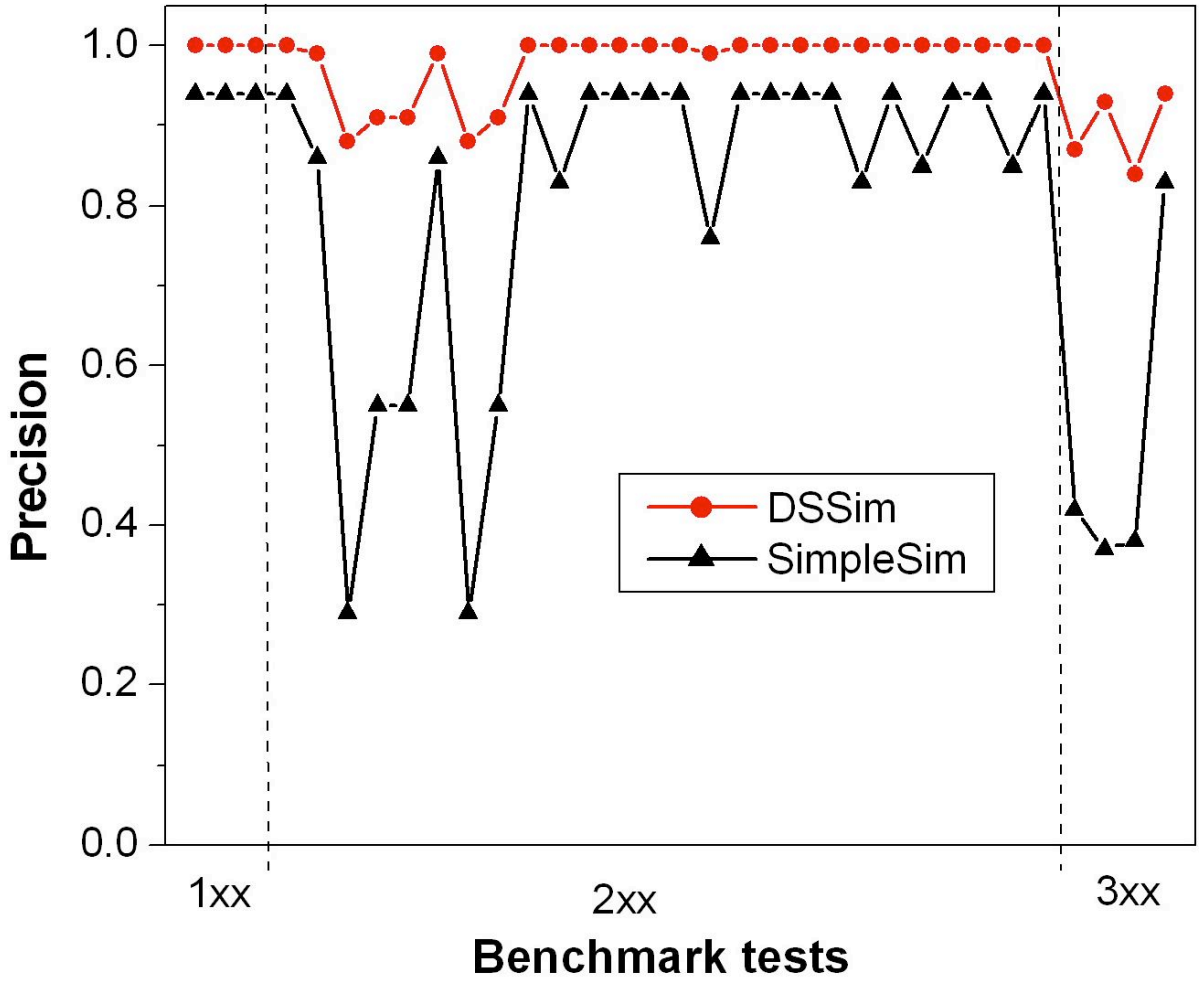

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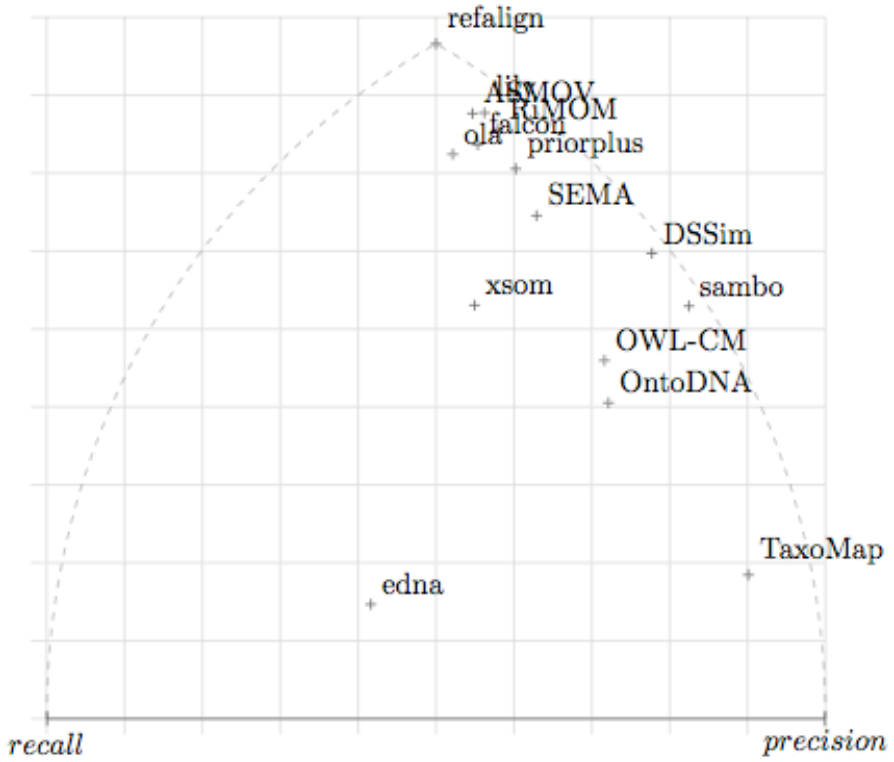
Comparison of different algorithms based on OAEI 2007 benchmarks(*)

algo	DSSim		SEMA		falcon		OWL-CM		xsom	
test	Prec.	Rec.	Prec.	Rec.	Prec.	Rec.	Prec.	Rec.	Prec.	Rec.
1xx	1	1	1	1	1	1	1	1	0.99	0.99
2xx	0.99	0.6	0.92	0.72	0.92	0.85	0.82	0.51	0.73	0.67
3xx	0.89	0.67	0.67	0.79	0.89	0.79	0.95	0.37	0.94	0.68
H-mean	0.99	0.64	0.9	0.74	0.96	0.89	0.85	0.54	0.76	0.7

* Jérôme Euzenat , Antoine Isaac, Christian Meilicke, Pavel Shvaiko, Heiner Stuckenschmidt, Ondřej Šváb, Vojtěch Svátek, Willem Robert van Hage, Mikalai Yatskevich(2007). **First results of the Ontology Alignment Evaluation Initiative 2007,** *In Proceedings of The Second International Workshop on Ontology Matching* , Busan, Korea.

Position of the systems considering Precision/Recall(*)



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DSSim Pros and cons

- ✓ Our method is not heavily dependent on subclass, sub property, disjointness or equivalency relationships among classes and properties
- ✓ Query terms are extended with their synonyms from WordNet so the uncertainty can be distributed sufficiently
- × Dempser's combination rule is computationally expensive therefore optimalisation is necessary
- × WordNet terms are not domain specific

Conclusions

- Proposed a solution for the problem of inconsistency and incompleteness during ontology mapping
- Increased the mapping precision with utilizing uncertainty
- Proved that uncertainty handling with Dempster-Shafer theory is a promising alternative to traditional Bayesian solutions

Thank You!