Ontology Evaluation and Ranking using OntoQA

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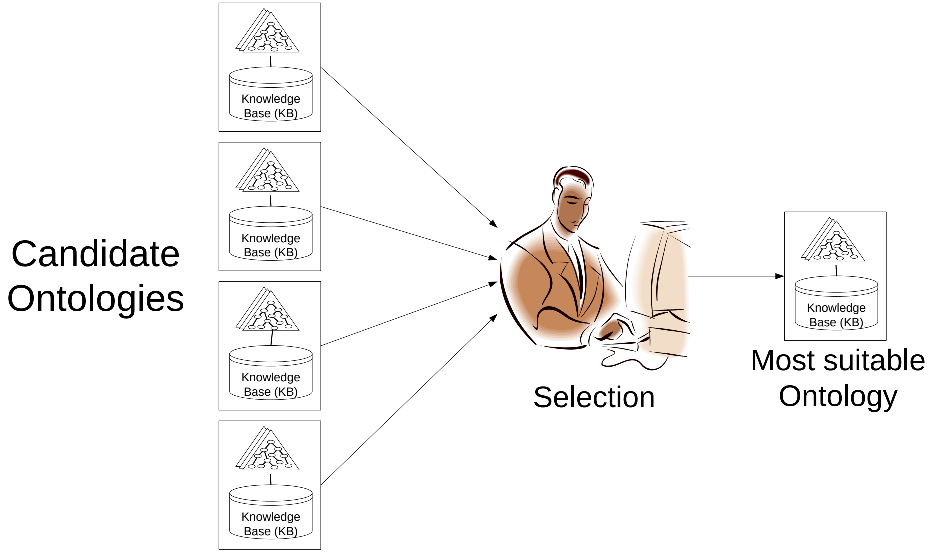
Outline

- Why ontology evaluation?
- OntoQA
  - Overview
  - Metrics
  - Overall Score
  - Results
- Enhancments

Why Ontology Evaluation?

- Having several ontologies to choose from, users often face the problem of selecting the ontology that is most suitable for their needs.

- Ontology developers need a way to evaluate their work



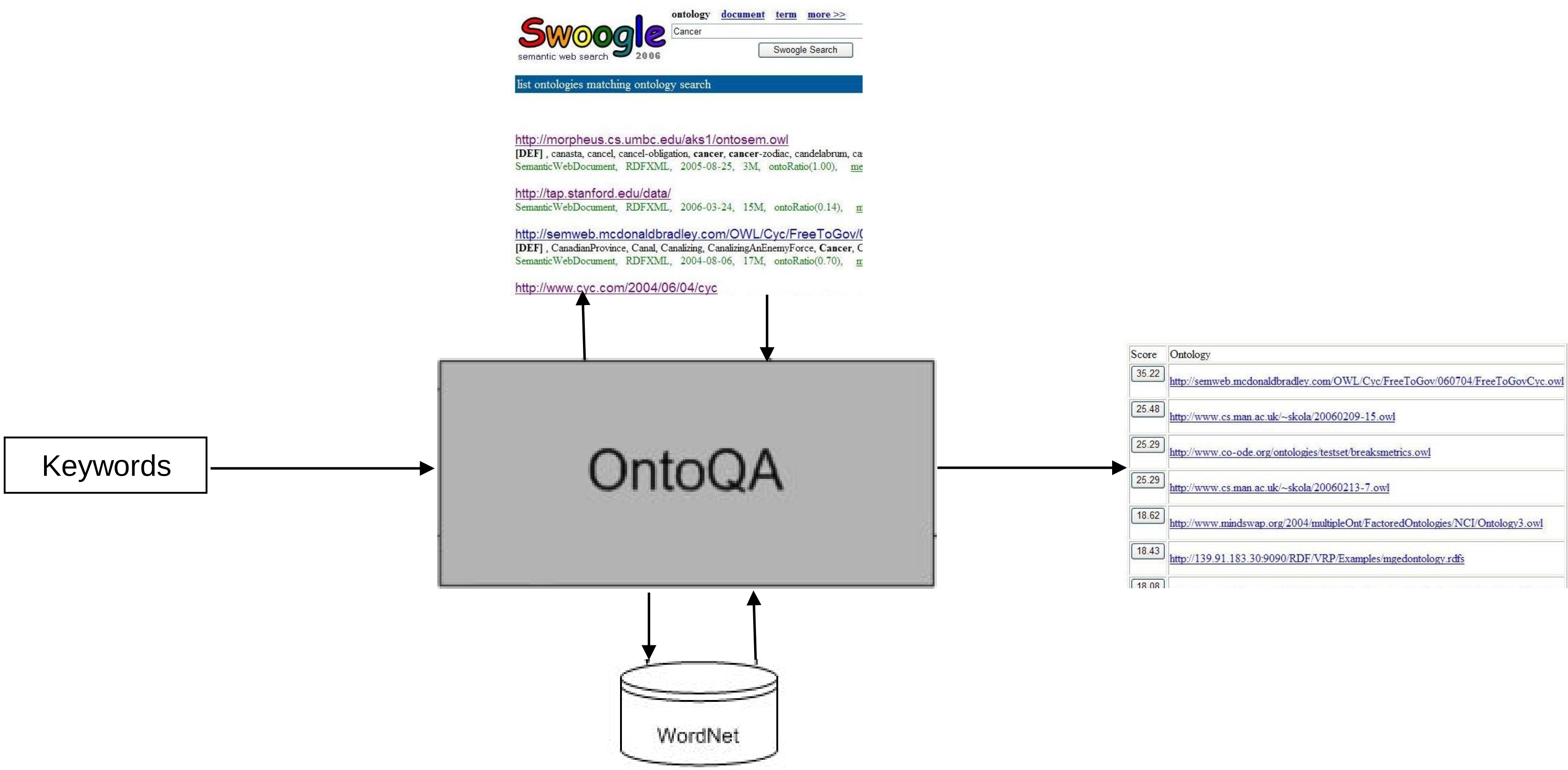
OntoQA

- A suite of metrics that evaluate the content of ontologies through the analysis of their schemas and instances in different aspects.

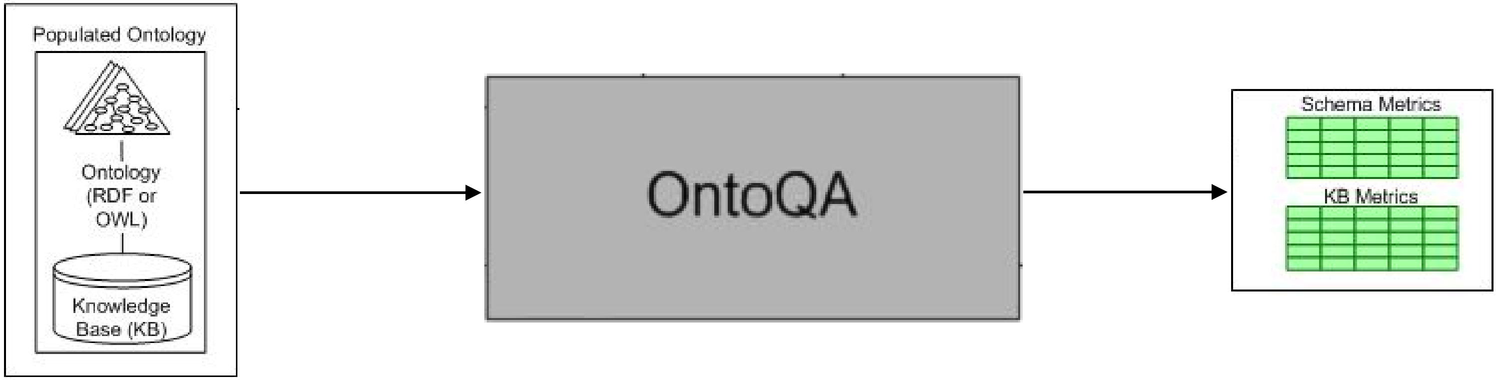
- It has been cited over 170 times.

- OntoQA is
  - tunable
  - requires minimal user involvement
  - considers both the schema and the instances of a populated ontology.

OntoQA Usage Scenario 1



OntoQA Usage Scenario 2



I. Schema Metrics

- Address the design of the ontology schema.
- Schema could be hard to evaluate: domain expert consensus, subjectivity etc.
- Metrics:
  - Relationship diversity
  - Inheritance depth

I. Schema Metrics

- Relationship diversity
  - This measure differentiates an ontology that contains mostly inheritance relationships (≈ taxonomy) from an ontology that contains a diverse set of relationships.

$$RD = \frac{|P|}{|H| + |P|}$$

- Schema Depth
  - This measure describes the distribution of classes across different levels of the ontology inheritance tree

$$SD = \frac{|H|}{|C|}$$

II. Instance Metrics

- Evaluate the placement, distribution and relationships between instance data

- Can indicate the effectiveness of the schema design and the amount of knowledge contained in the ontology.

II. Instance Metrics

- Overall KB Metrics
  - This group of metrics gives an overall view on how instances are represented in the KB.
- Class-Specific Metrics
  - This group of metrics indicates how each class defined in the ontology schema is being utilized in the KB.
- Relationship-Specific Metrics
  - This group of metrics indicates how each relationship defined in the ontology schema is being utilized in the KB.

Overall KB Metrics

- Class Utilization
  - Evaluates how classes defined in the schema are being utilized in the KB.

$$CU = \frac{|C`|}{|C|}$$

- Class Instance Distribution
  - Evaluates how instances are spread across the classes of the schema.

CID = StdDev(Inst(Ci))

- Cohesion (connectedness)
  - Used to discover instance “islands”.

$$Coh = |CC|$$

Class-Specific Metrics

- Class Connectivity (centrality)
  - This metric evaluates the importance of a class based on the relationships of its instances with instances of other classes in the ontology.

$$Conn(C_i) = |NIREL(C_i)|$$

- Class Importance (popularity)
  - This metric evaluates the importance of a class based on the number of instances it contains compared to other classes in the ontology.

$$Imp(C_i) = \frac{|Inst(C_i)|}{|KB(CI)|}$$

- Relationship Utilization
  - This metric evaluates how the relationships defined for each class in the schema are being used at the instances level.

$$RU(C_i) = \frac{|IREL(C_i)|}{|CREL(C_i)|}$$

Relationship-Specific Metrics

- Relationship Importance (popularity)
  - This metric measures the percentage of instances of a relationship with respect to the total number of relationship instances in the KB.

$$Imp(R_i) = \frac{|Inst(R_i)|}{|KB(RI)|}$$

Ontology Score Calculation

$$Score = \sum W_i * Metric_i$$

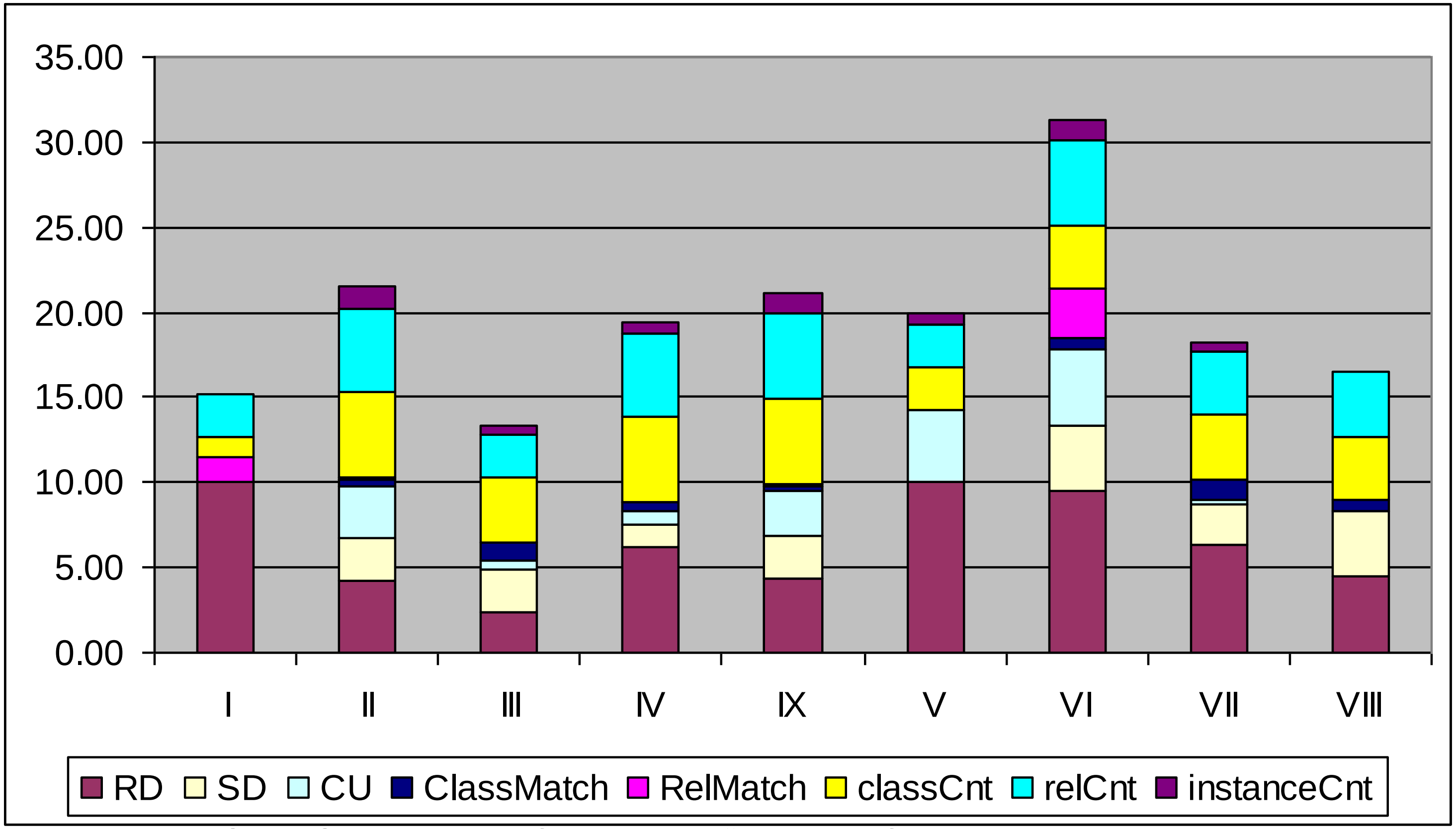
- Metric$_i$:
  - {Relationship diversity, Schema Depth, Class Utilization, Cohesion, Avg(Connectivity(C_i)), Avg(Importance(C_i)), Avg(Relationship Utilization(C_i)), Avg(Importance(R_i)), #Classes, #Relationships, #Instances}
- W$_i$:
  - Set of tunable metric weights

Results

Symbol	Ontology URL
I	http://ebiquity.umbc.edu/ontology/conference.owl
II	http://kmi.open.ac.uk/semanticweb/ontologies/owl/aktive-portal-ontology-latest.owl
III	http://www.architexturez.in/+/--c--/caad.3.0.rdf.owl
IV	http://www.csd.abdn.ac.uk/~cmckenzi/playpen/rdf/akt_ontology_LITE.owl
V	http://www.mindswap.org/2002/ont/paperResults.rdf
VI	http://owl.mindswap.org/2003/ont/owlweb.rdf
VII	http://139.91.183.30:9090/RDF/VRP/Examples/SWPG.rdfs
VIII	http://www.lehigh.edu/~zhp2/2004/0401/univ-bench.owl
IX	http://www.mindswap.org/2004/SSSW04/aktive-portal-ontology-latest.owl

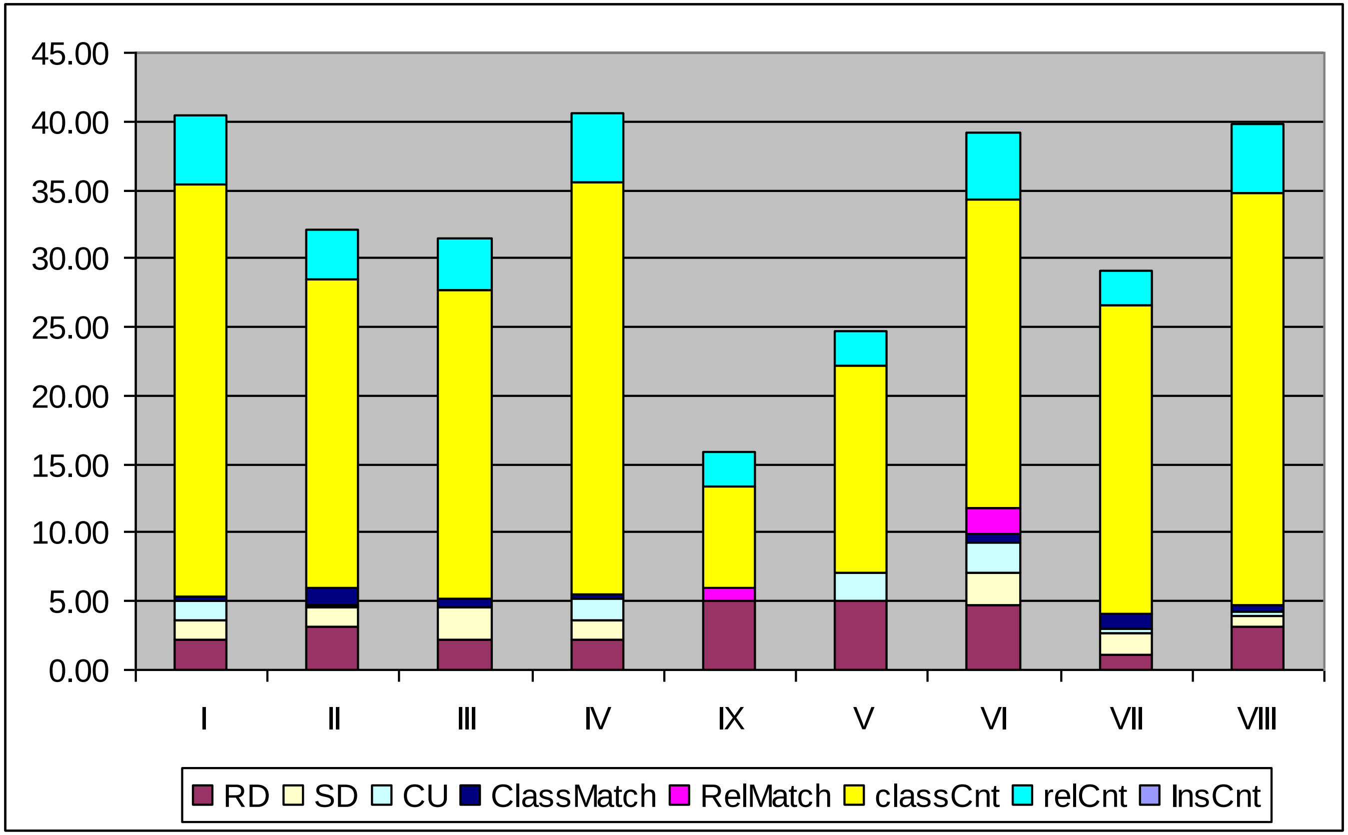
Swoogle Results for "Paper"

OntoQA Ranking - 1



OntoQA Results for "Paper“ with default metric weights

OntoQA Ranking - 2



OntoQA Results for "Paper“ with metric weights biased towards larger schema size

OntoQA vs. Users

Ontology	OntoQA Rank	Average User Rank
I	2	9
II	5	1
III	6	5
IV	1	6
V	8	8
VI	4	4
VII	7	2
VIII	3	7
IX	9	3

Pearson's Correlation Coefficient = 0.80

Comparison to Other Approaches

Approach	User Involvement	Ontologies	Schema/KB
[1]	High	Entered	Schema
[2]	High	Entered	Schema
[3]	High	Entered	Schema + KB
[4]	Low	Entered	Schema
[5]	High	Entered	Schema
[6]	Low	Crawled	Schema
[7]	Low	Crawled	Schema
[8]	Low	Entered	Schema
[9]	Low	Entered	Schema
OntoQA	Low	Enter/Crawl	Schema + KB

Possible Enhancements

- Enable the user to specify an ontology library (e.g. OBO) to limit the search in ontologies that exist in that specific library.

- Use BRAHMS instead of Sesame as a data store since BRAHMS is more efficient in handling large ontologies that are common in bioinformatics.

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Thank you