Methods and Tools for Modular Ontology Modeling
Introduction to OWLAx and ROWL

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The Protégé OWLAX plug-in

(work with Md Kamruzzaman Sarker and Adila Krisnadhi)
Ontology Axiomatization

- For disambiguating meaning for human (re-)users.
- For deductive ontology reasoning (new inferences).
- For integrity checking.

It turns out that an elaborate (“complete”) axiomatization means adding the same types of axioms over and over again.

We wanted to have an interface that supports our workflow and simplifies repetitive tasks.
Axioms – Systematically

1. $A \cap B \subseteq \bot$
2. $\exists R. \top \sqsubseteq A$
3. $\exists R. B \sqsubseteq A$
4. $\top \sqsubseteq \forall R. B$
5. $A \sqsubseteq \forall R. B$
6. $A \sqsubseteq R.B$
7. $B \sqsubseteq R^{-}.A$
8. $\top \sqsubseteq \leq 1R. \top$
9. $\top \sqsubseteq \leq 1R.B$
10. $A \sqsubseteq \leq 1R. \top$
11. $A \sqsubseteq \leq 1R.B$
12. $\top \sqsubseteq \leq 1R^{-}. \top$
13. $\top \sqsubseteq \leq 1R^{-}. A$
14. $B \sqsubseteq \leq 1R^{-}. \top$
15. $B \sqsubseteq \leq 1R^{-}. A$

1. $A$ DisjointWith $B$
2. $R$ some owl:Thing SubClassOf $A$
3. $R$ some $B$ SubClassOf $A$
4. owl:Thing SubClassOf $R$ only $B$
5. $A$ SubClassOf $R$ only $B$
6. $A$ SubClassOf $R$ some $B$
7. $B$ SubClassOf inverse $R$ some $A$
8. owl:Thing SubClassOf $R$ max 1 owl:Thing
9. owl:Thing SubClassOf $R$ max 1 $B$
10. $A$ SubClassOf $R$ max 1 owl:Thing
11. $A$ SubClassOf $R$ max 1 $B$
12. owl:Thing SubClassOf inverse $R$ max 1 owl:Thing
13. owl:Thing SubClassOf inverse $R$ max 1 $A$
14. $B$ SubClassOf inverse $R$ max 1 owl:Thing
15. $B$ SubClassOf inverse $R$ max 1 $A$

(disjointness) (domain) (scoped domain) (range) (scoped range) (existential) (inverse existential) (functionality) (qualified functionality) (scoped functionality) (qualified scoped functionality) (inverse functionality) (inverse qualified functionality) (inverse scoped functionality) (inverse qualified scoped functionality)
OWLAX Protégé plug-in

In: Proc. ISWC 2016 poster & demos
http://dase.cs.wright.edu/content/ontology-axiomatization-support
The Protégé ROWLTab

(work with Md Kamruzzaman Sarker, David Carral, Adila Krisnadhi)
Problem: directly modeling in OWL (in any syntax, including DL syntax) is error-prone and cumbersome.

It appears that rules are much simpler to use for expressing schema information.

\[
\text{Ru3: } \text{Person}(x) \land \text{hasMother}(x, y) \rightarrow \text{Parent}(y)
\]

\[
\text{Ax3: } \exists \text{hasMother}^{-}. \text{Person} \sqsubseteq \text{Parent}
\]

Hence, we developed a Protégé plug-in which affords the modeling of OWL using rules (to the extent to which rules can be converted into OWL).

Non-convertible rules are stored as SWRL-Rules (with a warning to the user).
ROWL Protégé plug-in

http://dase.cs.wright.edu/content/rowl
User Evaluation

- Subjects: 12 graduate students from Wright State University with some basic knowledge of OWL and at least minimal exposure to Protégé.
- Participants were given 12 natural language sentences to model in Protégé, half with the standard interface, half with ROWL.
  - Easy sentences: atomic subclass inclusions
  - Medium sentences: Required some role restrictions.
  - Hard sentences: Required rolifications.

Ru5: \( \text{Person}(x) \land \text{hasBrother}(x, y) \land \text{hasSon}(y, z) \rightarrow \text{hasNephew}(x, z) \)

Ax5: \( \text{Person} \sqsubseteq \exists R_1. \text{Self}, \quad R_1 \circ \text{hasBrother} \circ \text{hasSon} \sqsubseteq \text{hasNephew} \)
## User Evaluation

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
<th>Difficulty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Every father is a parent.</td>
<td>7. Every parent is a human.</td>
<td>easy</td>
</tr>
<tr>
<td>2. Every university is an educational institution.</td>
<td>8. Every educational institution is an organization.</td>
<td>medium</td>
</tr>
<tr>
<td>3. If a person has a mother then that mother is a parent.</td>
<td>9. If a person has a parent who is female, then this parent is a mother.</td>
<td>hard</td>
</tr>
<tr>
<td>4. Any educational institution that awards a medical degree is a medical school.</td>
<td>10. Any university that is funded by a state government is a public university.</td>
<td>hard</td>
</tr>
<tr>
<td>5. If a person’s brother has a son, then that son is the first person’s nephew.</td>
<td>11. If a person has a female child, then that person would have that female child as her daughter.</td>
<td>hard</td>
</tr>
<tr>
<td>6. All forests are more biodiverse than any desert.</td>
<td>12. All teenagers are younger than all twens.</td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis:

On medium and hard sentences, participants would be able to model quicker with the ROWLTab than without it.

<table>
<thead>
<tr>
<th>Sentence Category</th>
<th>Time (in secs)</th>
<th># clicks</th>
<th>Correctness</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Protégé avg/std</td>
<td>ROWLT avg/std</td>
<td>Protégé avg/std</td>
</tr>
<tr>
<td>easy</td>
<td>79/ 41</td>
<td>47/ 9</td>
<td>44/ 38</td>
</tr>
<tr>
<td>medium</td>
<td>312/181</td>
<td>116/61</td>
<td>216/131</td>
</tr>
<tr>
<td>hard</td>
<td>346/218</td>
<td>160/66</td>
<td>351/318</td>
</tr>
</tbody>
</table>

Paired t-test:

- easy: \( p = 0.002 < 0.01 \)
- medium: \( p = 0.020 < 0.05 \)
- hard: \( p = 0.020 < 0.05 \)
**Correctness**

**Hypothesis:**

On medium and hard sentences, participants would provide more correct answers with the ROWLTab than without it.

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<td>avg/std</td>
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</tbody>
</table>

**Paired t-test:**

- easy: \( p = 1.0000 > 0.05 \)
- medium: \( p = 0.180 > 0.05 \)
- hard: \( p = 0.0001 < 0.01 \)
Clicks

Hypothesis:

None (this was for information only)

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Paired t-test:

- easy: \( p = 0.092 > 0.05 \)
- medium: \( p = 0.030 < 0.05 \) (significant time difference)
- hard: \( p = 0.173 > 0.05 \) (significant time and correctness difference)
The hypotheses for time and for correctness (hard questions) were confirmed. For correctness (medium questions) the hypothesis was rejected.

<table>
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<th>category</th>
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<th>clicks</th>
<th>correctness</th>
</tr>
</thead>
<tbody>
<tr>
<td>easy</td>
<td>significant $(p &lt; 0.05)$</td>
<td>not significant</td>
<td>not significant</td>
</tr>
<tr>
<td>medium</td>
<td>significant $(p &lt; 0.01)$</td>
<td>significant $(p &lt; 0.05)$</td>
<td>not significant</td>
</tr>
<tr>
<td>hard</td>
<td>significant $(p &lt; 0.05)$</td>
<td>not significant</td>
<td>significant $(p &lt; 0.01)$</td>
</tr>
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It appears that medium modeling problems (with some role restrictions) can be done correctly with the standard Protégé interface by this type of user, although more time is needed than when using ROWLTab.

It appears that hard problems (requiring rolification) cannot really be solved using the standard Protégé interface, and the unsuccessful solution attempts in addition require more time.
Thanks!
References


References


References

