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

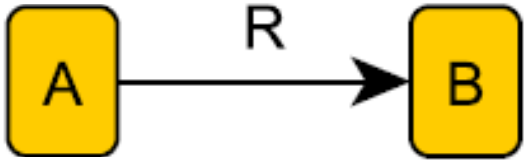
- For disambiguating meaning for human (re-)users.
- For deductive ontology reasoning (new inferences).
- For integrity checking.

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. $A \sqcap B \sqsubseteq \bot$
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. $\top \sqsubseteq \leq 1 R.\top$
9. $\top \sqsubseteq \leq 1 R.B$
10. $A \sqsubseteq \leq 1 R.\top$
11. $A \sqsubseteq \leq 1 R.B$
12. $\top \sqsubseteq \leq 1 R^{-}.\top$
13. $\top \sqsubseteq \leq 1 R^{-}.A$
14. $B \sqsubseteq \leq 1 R^{-}.\top$
15. $B \sqsubseteq \leq 1 R^{-}.A$



1. A DisjointWith B (disjointness)
2. R some `owl:Thing` SubClassOf A (domain)
3. R some B SubClassOf A (scoped domain)
4. `owl:Thing` SubClassOf R only B (range)
5. A SubClassOf R only B (scoped range)
6. A SubClassOf R some B (existential)
7. B SubClassOf inverse R some A (inverse existential)
8. `owl:Thing` SubClassOf R max 1 `owl:Thing` (functionality)
9. `owl:Thing` SubClassOf R max 1 B (qualified functionality)
10. A SubClassOf R max 1 `owl:Thing` (scoped functionality)
11. A SubClassOf R max 1 B (qualified scoped functionality)
12. `owl:Thing` SubClassOf inverse R max 1 `owl:Thing` (inverse functionality)
13. `owl:Thing` SubClassOf inverse R max 1 A (inverse qualified functionality)
14. B SubClassOf inverse R max 1 `owl:Thing` (inverse scoped functionality)
15. B SubClassOf inverse R max 1 A (inverse qualified scoped functionality)

OWLAx Protégé plug-in

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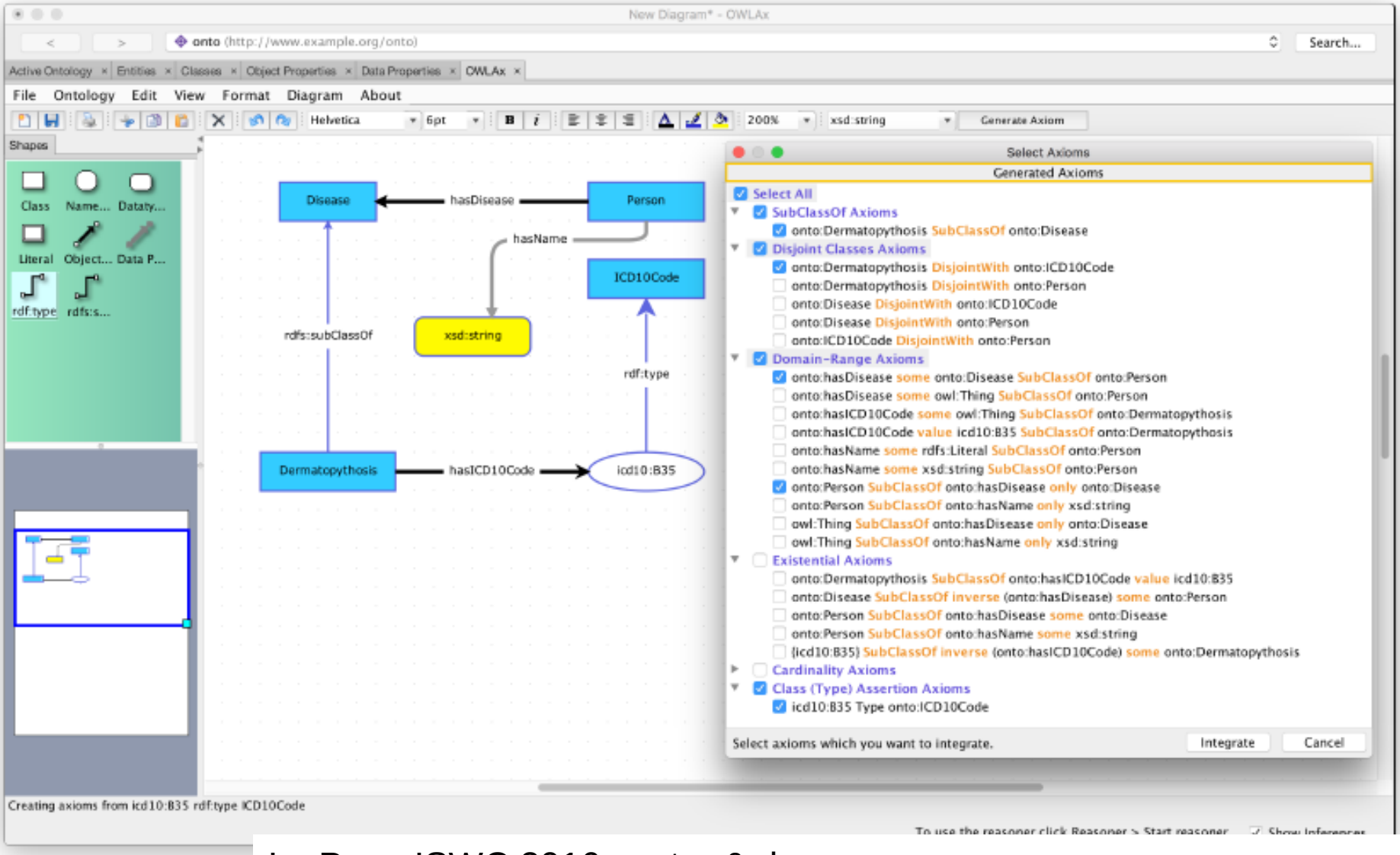


WRIGHT STATE UNIVERSITY

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)



Modeling OWL with Rules

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.

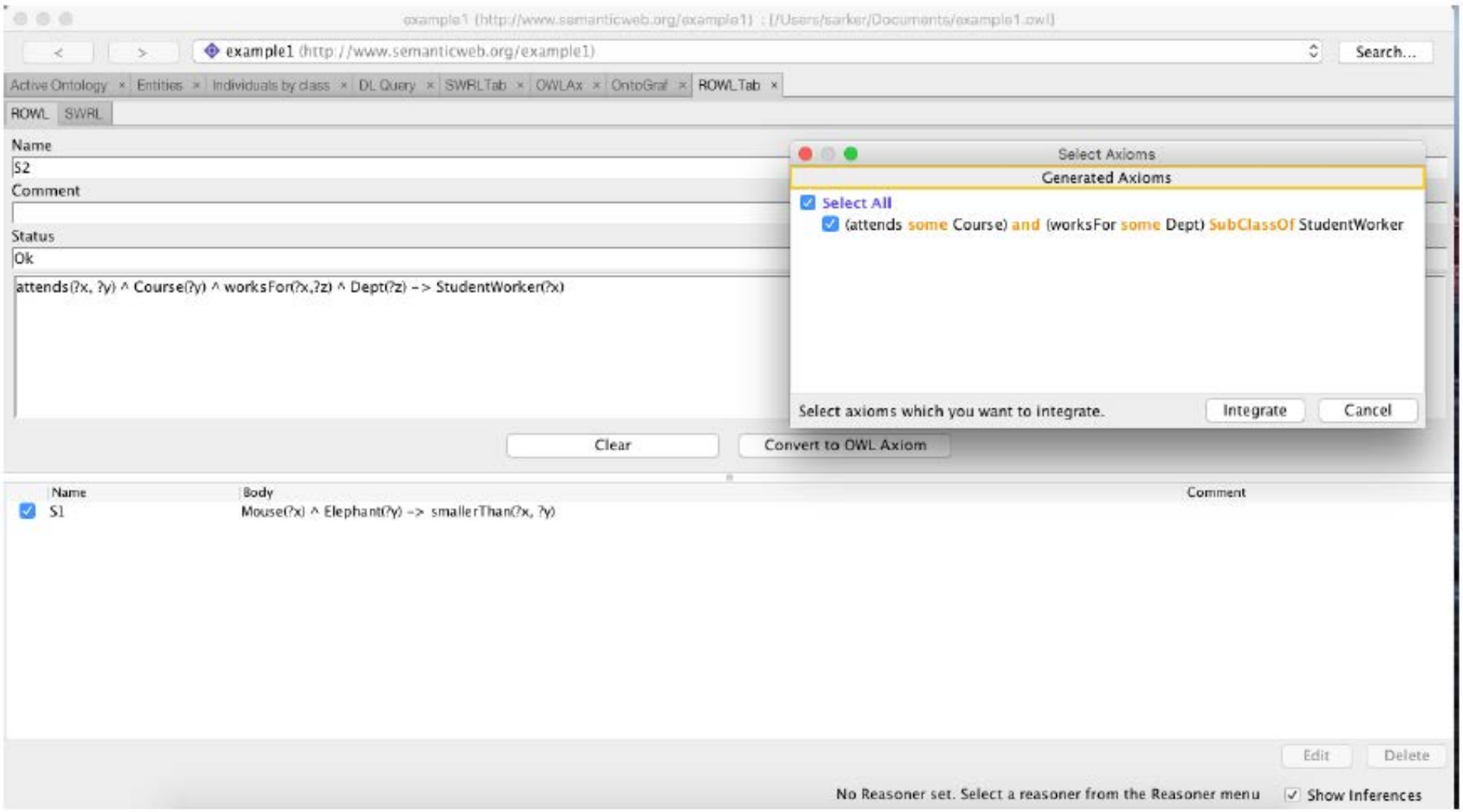
$$\text{Ru3: } \text{Person}(x) \wedge \text{hasMother}(x, y) \rightarrow \text{Parent}(y)$$

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

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.**

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

$$\text{Ax5: } \text{Person} \sqsubseteq \exists R_1.\text{Self}, \quad \text{R}_1 \circ \text{hasBrother} \circ \text{hasSon} \sqsubseteq \text{hasNephew}$$

User Evaluation

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

Time used

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Hypothesis:

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

Sentence Category	Time (in secs)		# clicks		Correctness	
	Protégé avg/std	ROWL avg/std	Protégé avg/std	ROWL avg/std	Protégé avg/std	ROWL avg/std
easy	79/ 41	47/ 9	44/ 38	59/ 19	2.9/0.3	2.9/0.3
medium	312/181	116/61	216/131	141/ 91	2.2/0.5	2.5/0.8
hard	346/218	160/66	351/318	228/168	0.9/0.7	2.5/0.7

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.

Sentence Category	Time (in secs)		# clicks		Correctness	
	Protégé avg/std	ROWL avg/std	Protégé avg/std	ROWL avg/std	Protégé avg/std	ROWL avg/std
easy	79/ 41	47/ 9	44/ 38	59/ 19	2.9/0.3	2.9/0.3
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hard	346/218	160/66	351/318	228/168	0.9/0.7	2.5/0.7

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)

Sentence Category	Time (in secs)		# clicks		Correctness	
	Protégé avg/std	ROWL avg/std	Protégé avg/std	ROWL avg/std	Protégé avg/std	ROWL avg/std
easy	79/ 41	47/ 9	44/ 38	59/ 19	2.9/0.3	2.9/0.3
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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)**

Assessment

- **The hypotheses for time and for correctness (hard questions) were confirmed. For correctness (medium questions) the hypothesis was rejected.**

category	time	clicks	correctness
easy	significant ($p < 0.05$)	not significant	not significant
medium	significant ($p < 0.01$)	significant ($p < 0.05$)	not significant
hard	significant ($p < 0.05$)	not significant	significant ($p < 0.01$)

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!

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