Ontology Modeling 2.0: Next Steps

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A module is a part of an ontology which corresponds to a conceptual part of the domain which can be summarized under one (key) notion within the topic domain.

E.g., in a chess games ontology there may be an “opening” module, and an “tournament” module.

E.g., in a travel planning support ontology, there may be a “hotel” module, and a “trajectory” module.

We understand ontologies to be composed of modules.

We understand modules to be obtained by instantiating, joining and modifying patterns.
Modules
Divide and Conquer

Problem Decomposition

identify modules
identify patterns

Ontology Assembly

instantiate patterns
assemble modules
assemble ontology
Module identification:

- Main notions relevant to data and modeling problem.
- Driven by competency questions, use case descriptions, and inspection of available data sources.
- Best done on a whiteboard.
Decomposition

Pattern identification:

• For each module, which pattern(s) reflect the nature of this module?
• Driven by competency questions, use case descriptions, inspection of available data sources, identified modules, repository of available patterns.
• Best done on a whiteboard(?)
• E.g. (chess),
  “moves” → list pattern
  “players” → agent role pattern
  “tournament” → event pattern
Pattern instantiation:

- Identified (generic) patterns to be used as templates:
  - Instantiate (change class/property names), and import to local namespace
  - Modify (adapt to the specific need)
- Provenance information (which pattern was used and how) should be kept.
- Strong tool support needed. Could be graphical, but needs to work on axiom level.
  (draft solution: Karl Hammar’s XD Protégé plug-in)
Player as AgentRole

```
owl:Thing providesAgentRole AgentRole

AgentRole performedBy TimeInstant
startsAtTime, endsAtTime

BlackPlayerRole rdfs:subClassOf AgentRole
providesAgentRole ChessGame

WhitePlayerRole rdfs:subClassOf AgentRole
```

Agent

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XD plug-in

[Hammar]
XD plug-in

[Hammar]
Module assembly:

- From instantiated patterns.
- Plus additional modifications/additions as needed.
- Modules may contain other modules.
- Provenance information (which pattern was used an how) should be kept.
- Modules should be identifiable from the OWL file.

- Strong tool support needed. Could be graphical, but needs to work on axiom level.
  (draft solution: Karl Hammar’s XD Protégé plug-in)
XD plug-in

[Hammar]
Graphical mock-up

[Diagram showing relationships between ChessTournament, ChessOpening, ChessGame, WhitePlayerRole, BlackPlayerRole, and Agent roles with properties such as hasName, hasOpening, hasResult, encodedAsSAN, providesAgentRole, performedBy, rdfs:subClassOf]
Assembly

Ontology assembly:

- From developed modules.
- Plus additional modifications/additions as needed.
- Modules should be identifiable from the OWL file.
- Used patterns should be identifiable from the OWL file.

- Strong tool support needed. Could be graphical, but needs to work on axiom level.
Axiomatization support

- **OWLAX Protégé plug-in [ISWC2016 demo]**
  - Start with schema diagram.
  - Quick and easy addition of most common axioms using check-box selection.

- **ROWL Protégé plug-in [ISWC2016 demo]**
  - Rule-based interface for adding complex OWL axioms.
  - Evaluated [ESWC2017 paper] showing that it improves modeling efficiency.
## Axioms – Systematically

| 1. $A \cap B \sqsubseteq \bot$ | 6. $A \sqsubseteq R.B$ | 11. $A \sqsubseteq \leq 1R.B$ |
| 2. $\exists R. T \sqsubseteq A$ | 7. $B \sqsubseteq R^{-}.A$ | 12. $T \sqsubseteq \leq 1R^{-}.T$ |
| 3. $\exists R.B \sqsubseteq A$ | 8. $T \sqsubseteq \leq 1R.T$ | 13. $T \sqsubseteq \leq 1R^{-}.A$ |
| 4. $T \sqsubseteq \forall R.B$ | 9. $T \sqsubseteq \leq 1R.B$ | 14. $B \sqsubseteq \leq 1R^{-}.T$ |
| 5. $A \sqsubseteq \forall R.B$ | 10. $A \sqsubseteq \leq 1R.T$ | 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
ROWL Protégé plug-in

http://dase.cs.wright.edu/content/rowl
The hypotheses for time and for correctness (hard questions) were confirmed. For correctness (medium questions) the hypothesis was rejected.

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.

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<td>significant ($p &lt; 0.05$)</td>
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<td>significant ($p &lt; 0.01$)</td>
</tr>
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</table>
Keeping track

• Keeping track of modules and patterns within an ontology, and of their origins.

• Simple proposed solution: OPLa (Ontology Pattern Language):


  See the presentation on this later today.
What is missing?

• High-quality (well-documented) sets of ODPs. Perhaps we need to get away from loose collections of ODPs, and rather start talking (and developing) "ODP suites" which consist of uniformly modeled ODPs.

• Instantiation and composition tools (like Hammar's prototype, but on steroids). They require an ODP language, and graphical support.

• Good, well-written (textbook-style) tutorials tailored to the tools and suites.
Thanks!


References


Adila Krisnadhi, Ontology Pattern-Based Data Integration. Dissertation, Department of Computer Science and Engineering, Wright State University, 2015.


Karl Hammar, Content Ontology Design Patterns: Qualities, Methods, and Tools. Dissertation. Linköping University, Sweden 2017