Teaching Good Biomedical Ontology Design

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Project: Good Ontology Design (GoodOD)

Problem	The knowledge and skills of ontology developers in the biomedical domain are not sufficient.
Guideline	How to develop qualitative good biomedical ontologies for developers with a biomedical background.
Curriculum	Implementation of the guideline in an 8-days course based on an active learning style.
Evaluation	Empirical evaluation of the efficacy of the curriculum and the underlying guideline.

http://www.iph.uni-rostock.de/Project-Summary.732.0.html
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GoodOD Guideline: Objectives

Targeted audience ontology developers (with a biomedical background)

Objectives

- Fundamental knowledge on applied and formal ontology
- Necessary knowledge in semantics and syntax of OWL
- Advice on typical modelling tasks based on a (domain) upper-level ontology and ODPs

GoodOD Guideline: Structure

1. Introduction
2. Fundamentals
3. Description Logics
4. Upper-level Ontology
5. Good Practice Design Principles
6. Ontology Design Patterns
7. Engineering Rules
8. Appendix

GoodOD Curriculum

Ontology Design Patterns	**Module 16 – Spatial disjointness ODP** Representing organ parts with the spatial disjointness ODP
	Module 15 – Closure ODP Representing an animal taxonomy and use the closure ODP
	Module 14 – Introduction in Ontology Design Patterns (ODP) Understang ODPs and using the exception ODP
Using top-level ontologies	**Module 13 – Information objects** Representing plans and documents on animals
	Module 12 – Non-material physical objects Representing habitats and enclosures of animals
	Module 11 – Collective entities Representing feed and groups for animals
	Module 10 – Process and participation Representing locomotion and development of animals
	Module 9 – Introduction into the BioTop domain top-level ontology Using the basic features of BioTop
Practical ontology design	**Module 8 – Typical ontology design errors** Learn to ask the right questions in building an ontology
	Module 7 – Description Logic reasoning Using a DL reasoner in the editing cycle in Protégé
	Module 6 – Introduction in OWL and the Manchester syntax Use the restrictions editor in Protégé
	Module 5 – Relations and mereology Using relations and implementing a partonomy
	Module 4 – Disjoints and polyhierarchies Implementing disjoints and polyhierarchies with Protégé
Basic principles	**Module 3 – The ontology editor Protégé** Implementing an is_a hierarchy with Protégé
	Module 2 – Classification and Taxonomy Building an is_a hierarchy
	Module 1 – Introduction in ontology and philosophical background

Kern D (1998). Curriculum development for medical education: a six step approach

Outline of the study

Participants 24 students from biomedical domains with computer science as minor subject (effective duration 10 days)

1. Shared training (5 days)
2. Randomization
3. Intervention: differential training for each group (1.5 days)
4. Evaluation (2.5 days)

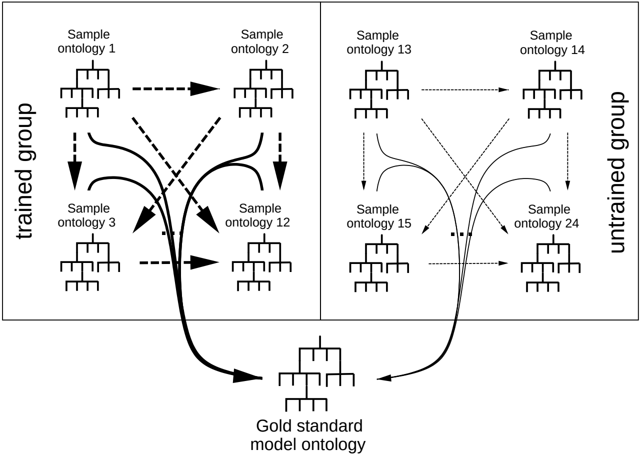
Intervention and Assessment

content type	intervention: teaching sessions group A	group B	data collection: assessment test excercise (Module)
Application of a top-level ontology	Module 10 Process and Participation (PRO)	Module 11 Collective material entity (CME)	Photosynthesis (PRO) Proteinuria (CME) Medical diagnosing (PRO) Penicillin (CME)
	Module 12 Immaterial object (IMM)	Module 13 Information object (INF)	Fetus (IMM) Operation plan (INF) Anatomy stomach (IMM) Pneumonia diagnosis (INF)
Applica-tion of ODPs	Module 15 Closure ODP (CLO)	Module 16 Spatial disjointness ODP (SPA)	Cell membrane (SPA) Circulatory system (CLO) Stomach wall (SPA) Teeth (CLO)

Types of evaluation

- Questionnaire on students' opinions and attitudes
  - Ratings on didactics
  - Opinions and feelings on progress and relevance
- Quantitative outcome evaluation
  - Evaluation of knowledge and *skills* (performance tests)
    - Test result ontology on requirements/standards
      - *Competency questions* in DL query tab
    - Compare result ontology with a predefined reference ontology
      - similarity with a *gold standard model*

Gold standard based evaluation hypothesis



Student evaluation

	Mininum (module)	Maximum (module)	Mean (SD) n=24
Didactics	1.5 Taxonomy	2.7 Immaterial object	2.1 (0.84)
Difficulty	1.8 Taxonomy	3.3 Immaterial object	2.5 (0.92)
Relevance	1.5 Process, Closure	2.4 Design errors	1.8 (0.96)

Results: Comparison with the gold standard model

	group	topic	ontology	fm ontology diff. [abs %]	fm ontology efx [C'd]
similarity with gold standard model	A	CLO	tee	-0.4	-0.03
			bud	6.6	0.51
		IMM	sto	11.1 ~	0.63 ~
			fet	-5.4	-0.30
		PRO	pho	1.6	0.12
			dia	1.7	0.12
	B	CME	pru	-4.7	-0.38
			pen	-3.6	-0.34
		INF	pne	-6.0	-0.46
			ope	1.0	0.05
		SPA	cem	0.5	0.04
			sta	7.0	0.37

Dellschaft K, Staab S (2006). On How to Perform a Gold Standard Based Evaluation of Ontology Learning
Vrandecic D, Sure Y (2007). How to Design Better Ontology Metrics

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similarity with gold standard model	group	topic	ontology	fm ontology diff. [abs %]	fm ontology efx [C'd]	fm topic diff. [abs %]	fm topic fm efx [C'd]
	A	CLO	tee	-0.4	-0.03	3.1	0.23
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		PRO	pho	1.6	0.12	1.6	0.12
			dia	1.7	0.12		
	B	CME	pru	-4.7	-0.38	-4.1	-0.36
			pen	-3.6	-0.34		
		INF	pne	-6.0	-0.46	-2.5	-0.16
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Results: Comparison with the gold standard model

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A	CLO	tee	-0.4	-0.03	3.1	0.23	2.5	0.17
		bud	6.6	0.51				
	IMM	sto	11.1 ~	0.63 ~	2.8	0.16		
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	PRO	pho	1.6	0.12	1.6	0.12		
		dia	1.7	0.12				
B	CME	pru	-4.7	-0.38	-4.1	-0.36	-1.0	-0.07
		pen	-3.6	-0.34				
	INF	pne	-6.0	-0.46	-2.5	-0.16		
		ope	1.0	0.05				
	SPA	cem	0.5	0.04	3.7	0.24		
		sta	7.0	0.37				

Limitations of the Study

- No validated and standardized method for objective/quantitative/standardized ontology evaluation available.
- Similarity/distance measures in combination with gold standard ontology too insensitive.
  - No prior prototyping of the study
- Very high complexity of the study and the outcome parameters, many confounders.
- A comparison of training vs. NO-training is insufficient to prove superiority of an instructional method.

Interpretation

No evidence for an effect of a guideline based training on the quality of resulting ontologies.

Arguments for a continuation of the presented approach

- Limitations of the study
- Learning/practicing time too short to consolidate knowledge
- Test cases too complex

Conclusions

- GoodOD-Guideline: Compilation of foundational knowledge on good ontology design for ontology developers (with a biomedical background)
- Implementation and evaluation of the GoodOD guideline in a curriculum/study.
  - The curriculum was rated largely positively by students.
  - The (intermediate) quantitative analysis could not empirically proof a positive effect of the training based on the guideline on the quality of ontologies.
    - Severe limitations of the study (metrics, complexity)
    - Interpretation: too much content in too short time (no consolidation of knowledge and skills)
- To improve the quality of ontology
  - professionalize training for certain groups of developers (and users) of ontologies
  - develop (standardized) empirical measures to assess the quality of ontology

Ontology Similarity/Distance Measures

Dellschaft/Staab: Common Cotopy based metrics
Euzenat et. al.: metrics for the NEON project
Vrandecic: ”Normalization” algorithm

Dellschaft K, Staab S (2006). On How to Perform a Gold Standard Based Evaluation of Ontology Learning
Euzenat et. al. (2009). NeOn: Lifecycle Support for Networked Ontologies - D3.3.4: Ontology distances for contextualization
Vrandecic D, Sure Y (2007). How to Design Better Ontology Metrics