A Comparative User Evaluation on Visual Ontology Modeling Using Node-Link Diagrams

Muhammad Rohan Ali Asmat,
Vitalis Wiens,
and Steffen Lohmann

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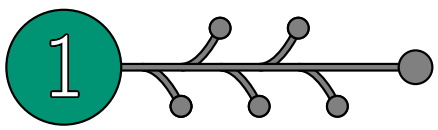
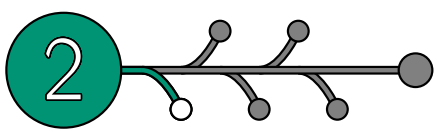


Introduction

- Ontologies are used in scientific and industrial contexts
- Various ontology engineering tools
- Different modeling paradigms



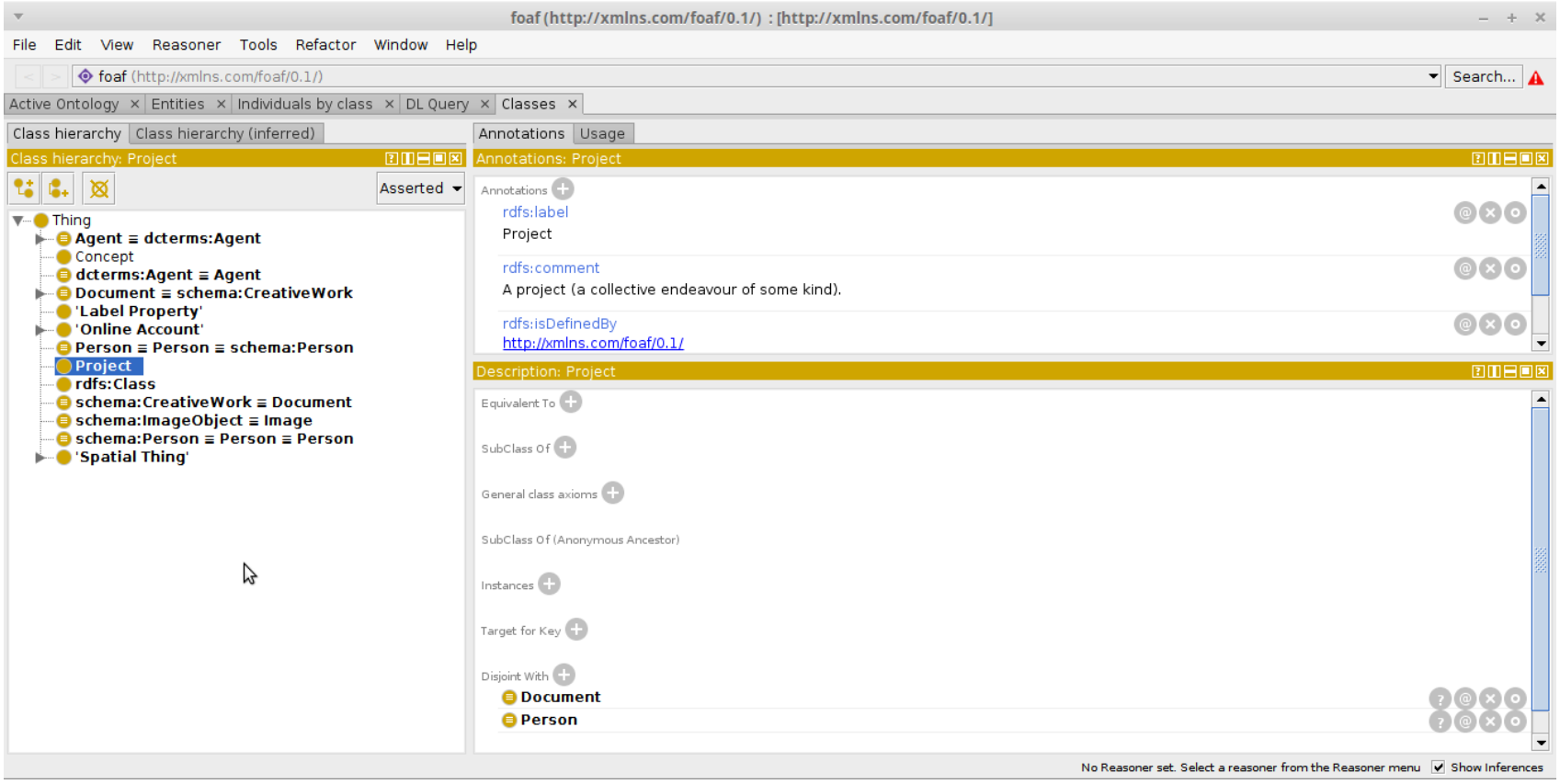
Introduction

- Modeling of ontologies
  - Not limited to ontology engineers
  - Different communities pursuing formal representation of domain knowledge
  - Modeling tools are designed for experts (with profound modeling knowledge)
  - Different modeling paradigms (text input, UML-based graphs, widget and hierarchical based GUI, node-link diagrams and hybrid solutions)

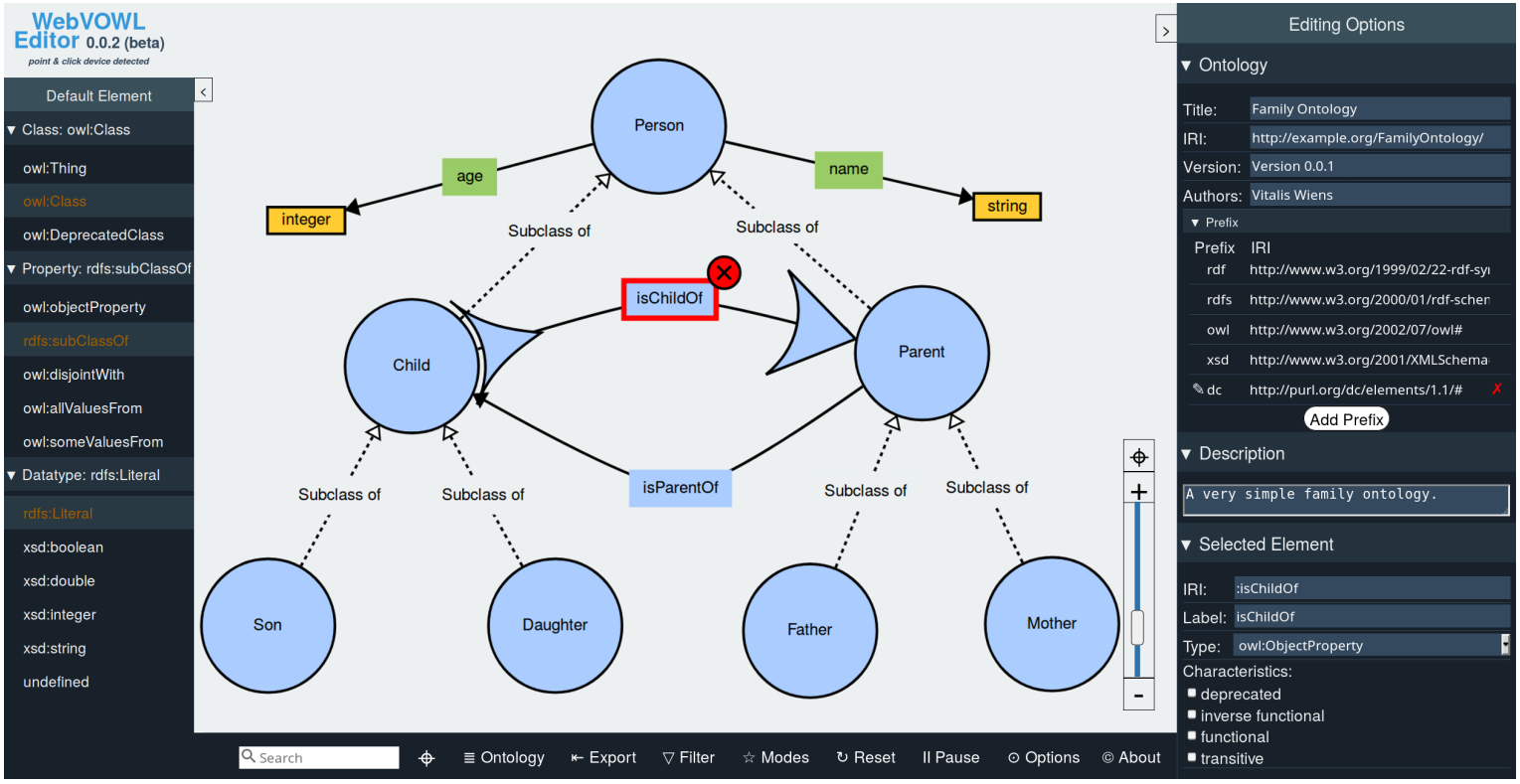
Introduction

- We present an evaluation:
  comparing node-link diagram and widget-based modeling paradigms (WebVOWL Editor and Protégé)

Protégé

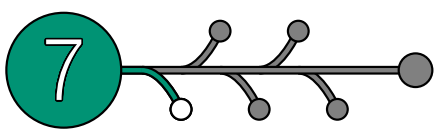

foaf (http://xmlns.com/foaf/0.1/) : [http://xmlns.com/foaf/0.1/]
File Edit View Reasoner Tools Refactor Window Help
foaf (http://xmlns.com/foaf/0.1/)
Search...
Active Ontology
Entities
Individuals by class
DL Query
Classes
Class hierarchy
Class hierarchy (inferred)
Class hierarchy: Project
Asserted
Thing
Agent ≡ dcterms:Agent
Concept
dcterms:Agent ≡ Agent
Document ≡ schema:CreativeWork
'Label Property'
'Online Account'
Person ≡ Person ≡ schema:Person
Project
rdfs:Class
schema:CreativeWork ≡ Document
schema:ImageObject ≡ Image
schema:Person ≡ Person ≡ Person
'Spatial Thing'
Annotations
Usage
Annotations: Project
Annotations
rdfs:label
Project
rdfs:comment
A project (a collective endeavour of some kind).
rdfs:isDefinedBy
http://xmlns.com/foaf/0.1/
Description: Project
Equivalent To
SubClass Of
General class axioms
SubClass Of (Anonymous Ancestor)
Instances
Target for Key
Disjoint With
Document
Person
No Reasoner set. Select a reasoner from the Reasoner menu
Show Inferences

WebVOWL Editor



Overview

- Pre-test
- User study
  - Experimental design
  - Results
- Conclusion



Pre-Test

- Definition of five small concept spaces
- Comprising of common, every-day knowledge (university, zoo, city traffic, media, and family tree)
- Concept spaces defined in a tabular form.

Example: **University concept space**

Staff Member	Person	Professor
University	Student	Graduate Student
has name	teaches	Course
Undergraduate Student	course name	
has*	is a*	

* concepts can be used multiple times

Pre-Test

- Participants
  - Four male participants
    (without any visual, physical or color blind impairment)
  - Profound experience (>2 years) with ontology modeling
  - Age range 27–39

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- Measuring cognitive complexity
  - Participants were asked to model all concept spaces in Protégé
  - Training session with university concept space
  - Alternating order for other concept spaces
  - Recorded modeling completion times

Pre-Test

Completion times measured in seconds.

Participant	Modeling Completion Times			
	Family Tree	**City Traffic**	**Media**	**Zoo**
A	237	302	349	362
B	330	428	429	403
C	389	183	361	270
D	343	416	503	332
Sum	1299	1329	1642	1367
Mean	324.75	332.25	410.50	341.75

Pre-Test

- Completion times indicate cognitive complexity
- Family tree and city traffic have the lowest mean difference

Family tree concept space

Child	child's birthplace	Family Tree
Female	Mother	Grandmother
Male	gives birth	Father
Person	person name	
has*	is a*	

City traffic concept space

Vehicle	Bus	model name
Manufacturer	City Traffic	Public Vehicle
Car	manufactured by	Private Vehicle
Train	manufacturing date	
has*	is a*	

Experimental Design

- User Study:
  - Involved 12 voluntary participants
  - Comprised of 9 tasks
  - Duration per participant 45–60 minutes
- Tasks:

Task	Description
T1	Demographic questionnaire
T2	Model with Protégé
T3	After-Scenario-Questionnaire (ASQ) for T2
T4	Cued Recall Process (highlight concepts in a table)
T5	Computer-System-Usability-Questionnaire (CSUQ)
T6	Model with WebVOWL Editor
T7	After-Scenario-Questionnaire (ASQ) for T6
T8	Cued Recall Process (highlight concepts in a table)
T9	Computer-System-Usability-Questionnaire (CSUQ)

Experimental Design

- Demographic questionnaire (T1):
  - Name
  - Age
  - Profession
  - Experience in ontology modeling
  - Experience with Protégé
  - Experience with WebVOWL
  - Any sort of physical impairment

Experimental Design

- Demographic questionnaire (T1):
  - Name
  - Age
  - Profession
  - Experience in ontology modeling
  - Experience with Protégé
  - Experience with WebVOWL
  - Any sort of physical impairment

- User statistics
  - Age range: 25–36
  - No physical or visual impairment
  - One participant was color blind
  - Participants were employees of Fraunhofer IAIS and students of the universities of Bonn and Aachen

Experimental Design

- Based on answers of task T1
  - Users divided into 2 groups
  - G_1 contained 6 participants with prior experience
  - G_2 contained 6 participants without prior experience

- Training sessions
  - Training with Protégé and WebVOWL Editor
  - Media and zoo concept spaces
  - Approximately 10 min. training for each tool

Experimental Design

- Evaluation setup
  - Dell Precision 3520 laptop
  - Screen size 16”9
  - Resolution 1920×1080
  - Protégé version 5.2.0
  - WebVOWL Editor version 0.0.2

Experimental Design

- Task groups
  - T_{G1}: T2–T5 Protégé related tasks
  - T_{G2}: T6–T9 WebVOWL Editor related tasks
- Counter balancing
  - Alternating order of task groups
    (starting either with Protégé or WebVOWL Editor)
  - Alternating order of concept space
    (starting either with family tree or city traffic)

Concept space \Tool	Protégé	WebVOWL Editor
Family tree	Session 1	
City traffic		Session 2

Experimental Design

Post modeling tasks

- After-Scenario-Questionnaire (ASQ)
  - ease of task completion
  - satisfaction with completion time
  - support of information
  - e.g. :
    "Overall, I am satisfied with the ease of completing the tasks in this scenario."
- Measured using a Likert scale (1–7)
  1 refers to strong disagreement
  7 refers to strong agreement

Experimental Design

Post modeling tasks

- Cued recall process

Family tree concept space

Child	Grandfather	Father	family members
Grandson	child's birthplace	has kids	gives birth
Person	Sister	has*	time of birth
is a*	Male	Aunt	Family Tree
Grandmother	Daughter	Female	Cousin
Son	Mother	Uncle	person name

Experimental Design

Post modeling tasks

- Cued recall process

Family tree concept space

Child	Grandfather	Father	family members
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City traffic concept space

Vehicle	Motor Bike	Private Vehicle	Transport
Jeep	Bus	car name	manufactured by
is a*	Brand name	model name	BMW
Wagon	Car	Suzuki	City Traffic
Public Vehicle	Horsepower	Manufacturer	Intercity Express
manufacturing date	has*	Traffic Signals	Train

Experimental Design

Post modeling tasks

- Computer-System-Usability-Questionnaire (CSUQ)

effectiveness	efficiency
satisfaction	discriminability
guidance	workload
error management	

- CSUQ contains 19 questions
  - "It was easy to learn to use this system."
  - "I believe I became productive quickly using this system."
  - "It was simple to use this system."
- Measured using a Likert scale (1–7)

Experimental Design

Summary

Pre-test
4 Participants
Measuring cognitive complexity
Only Protége
All concept spaces

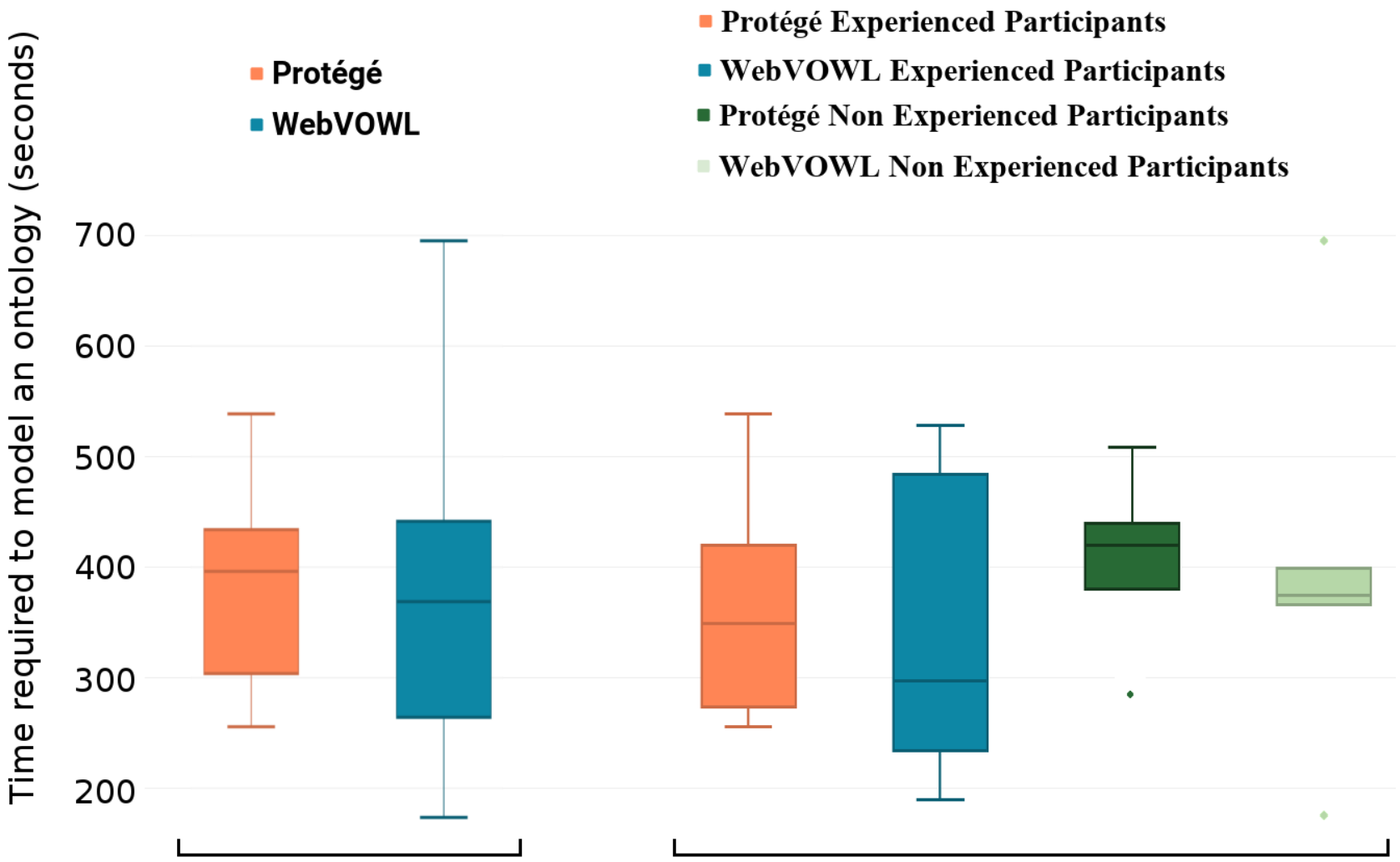
User study
12 Participants
Modeling task
Protégé and WebVOWL Editor
Only **family tree** and **city traffic**

Results

- Performance scores (modeling completion time)
- Scores for recall of concepts (highlighting errors)
- Questionnaire scores (ASQ and CSUQ)

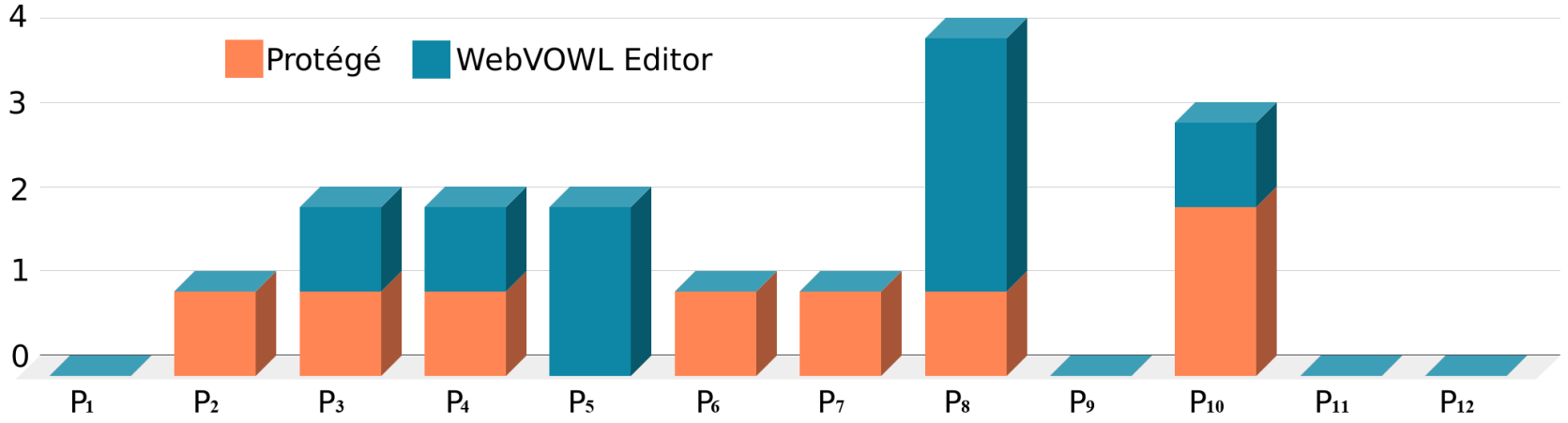
Results

Performance scores



Results

Cued recall scores

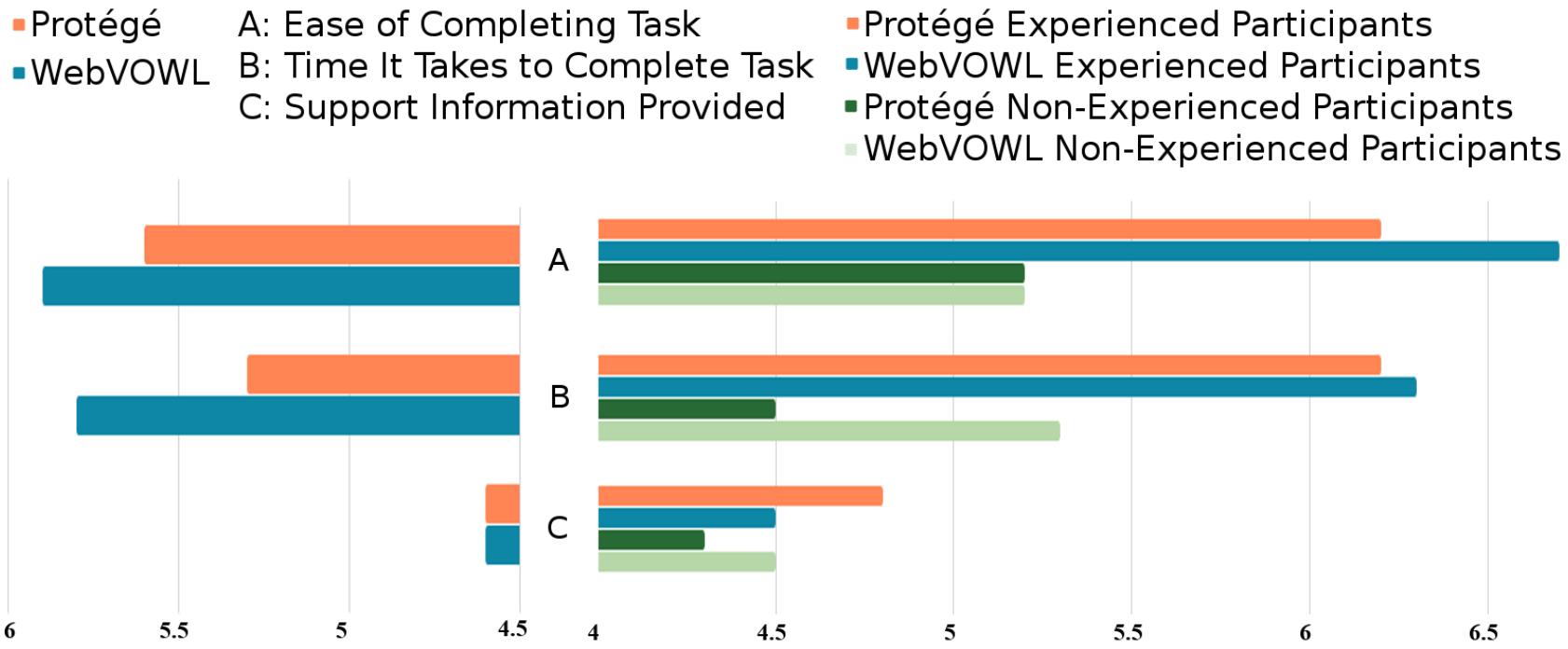


Incorrectly highlighted concepts per participant (P_i) for the two tools.

- Total number of errors for individual tool is 8
- Seven participants were incorrect w.r.t Protégé
- Five participants were incorrect w.r.t WebVOWL Editor

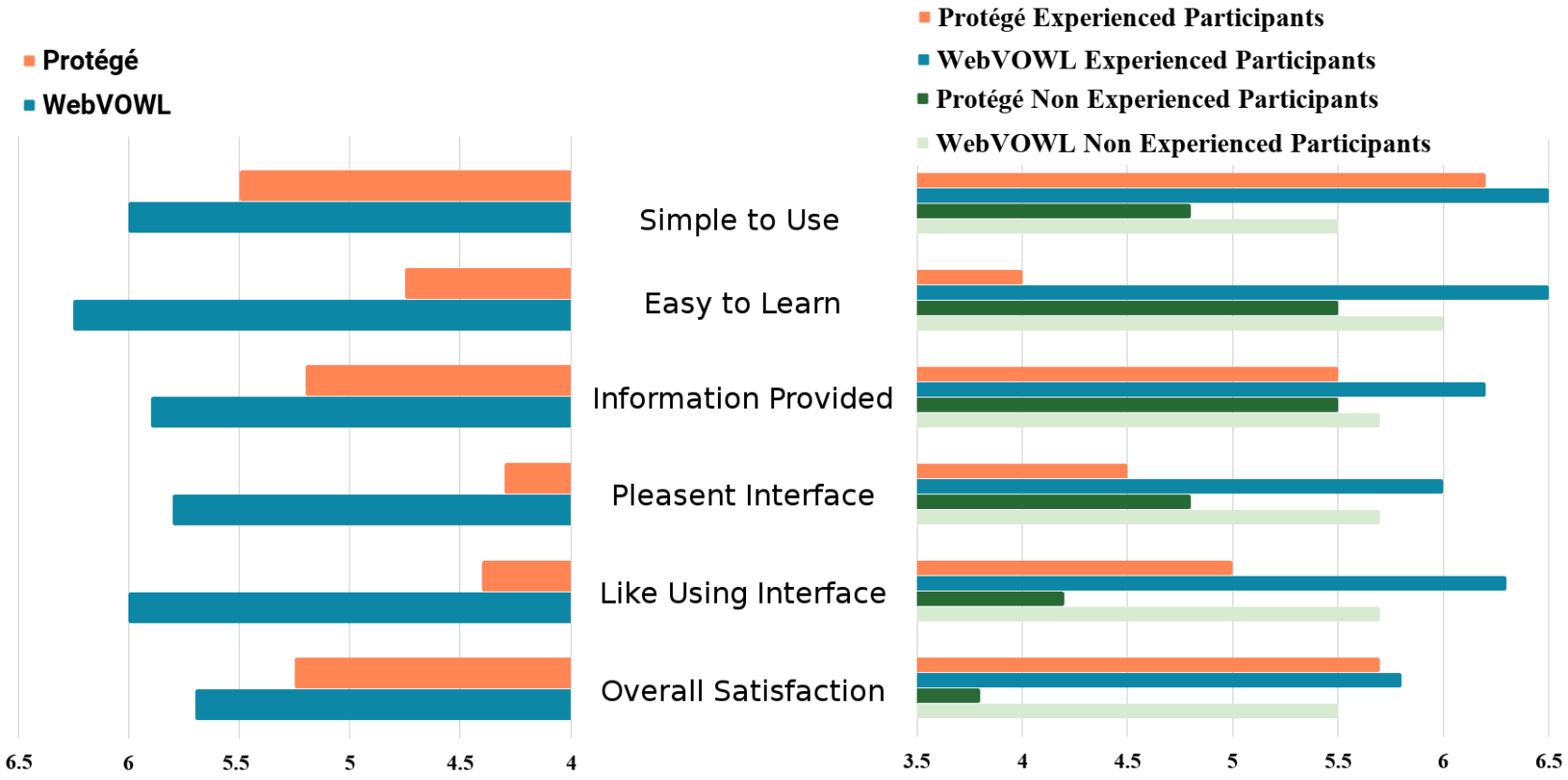
Results

ASQ scores



Results

CSUQ scores

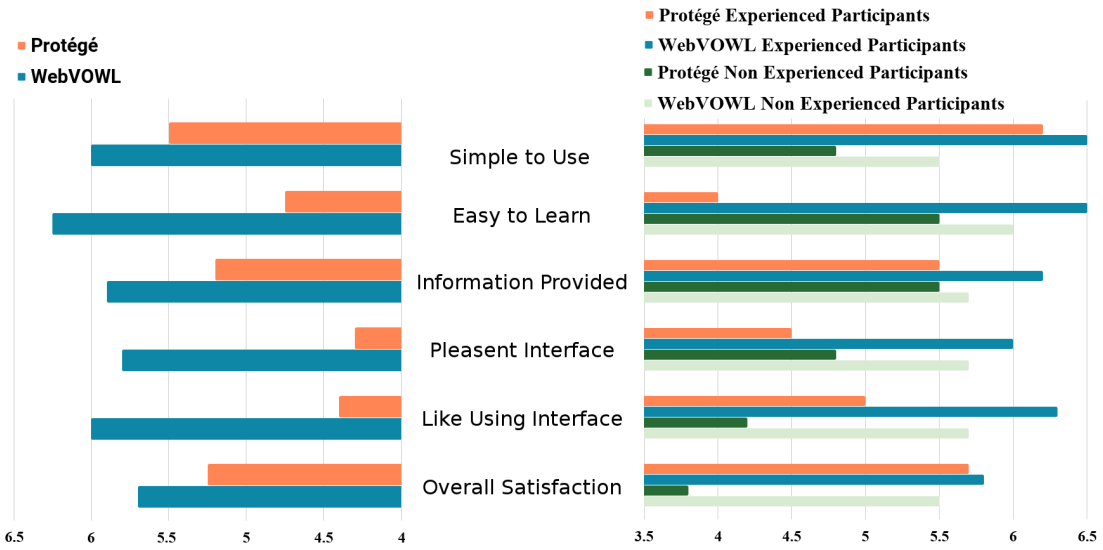


Conclusion

- Compared node-link diagrams and widget-based modeling
- Predefined concept spaces analyzed in pre-test
- Experiments included
  - Modeling of ontologies
  - Answering reflective questions

Conclusion

- Results indicate minor difference in mean performance, WebVOWL Editor having slightly better scores.
- Results of the questionnaires (ASQ and CSUQ) indicate the potential of visual modeling being :
  - more efficient
  - supporting mental map creation
  - satisfying more users.



Conclusion

Limitations

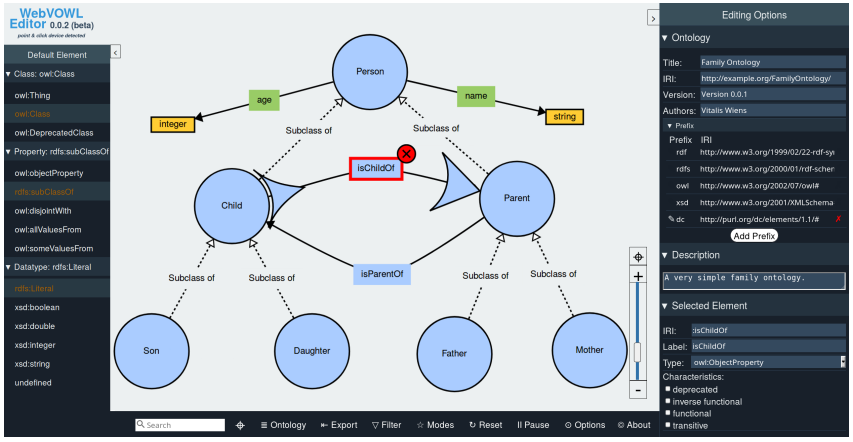
- Small sample size
- Small ontology (controlled setting)
- Only small increase in performance

Future Work

- Increased number of participants
- Field study
- Larger ontology
- Controlling prior experience

Thank You

WebVOWL Editor will be presented
in the demo and poster session of ISWC



Give it a try at
http://w3id.org/webvowl/editor

Contact:
Muhammad.Rohan.Ali.Asmat@iais.fraunhofer.de
Vitalis.Wiens@gmail.com
Steffen.Lohmann@iais.fraunhofer.de