Annotating Rhetorical and Argumentative Structures in Mathematical Knowledge

Summary of my work at DERI (Apr–Oct 2008)

EECS Seminar

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KWARC – Knowledge Adaptation and Reasoning for Content

October 14, 2008

My Home: Mathematical Knowledge Management

- Ph. D. student with Prof. Michael Kohlhase
- Our group does "Mathematical Knowledge Management"
  - dealing with mathematical knowledge
  - formality ranges from human-friendly to computer-verifiable

My Project

- Collaboration on semiformal knowledge
- Using semantic web technologies (a semantic wiki, in particular)

What I Wanted to Learn About the Semantic Web

- engineering ontologies for scientific documents
- user interfaces for annotating and browsing
- relation of social interaction to knowledge

Where?

At DERI, they do this (and more)

DERI (Digital Enterprise Research Institute)

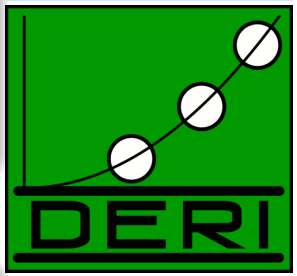
Largest semantic web research institute worldwide (130 members)

Applied Research

- eLearning
- semantic reality (sensor networks, ubiquitous computing)
- web services
- industrial applications
- *Semantic Information Systems and Language Engineering*
- *Social Software*

Foundational Research

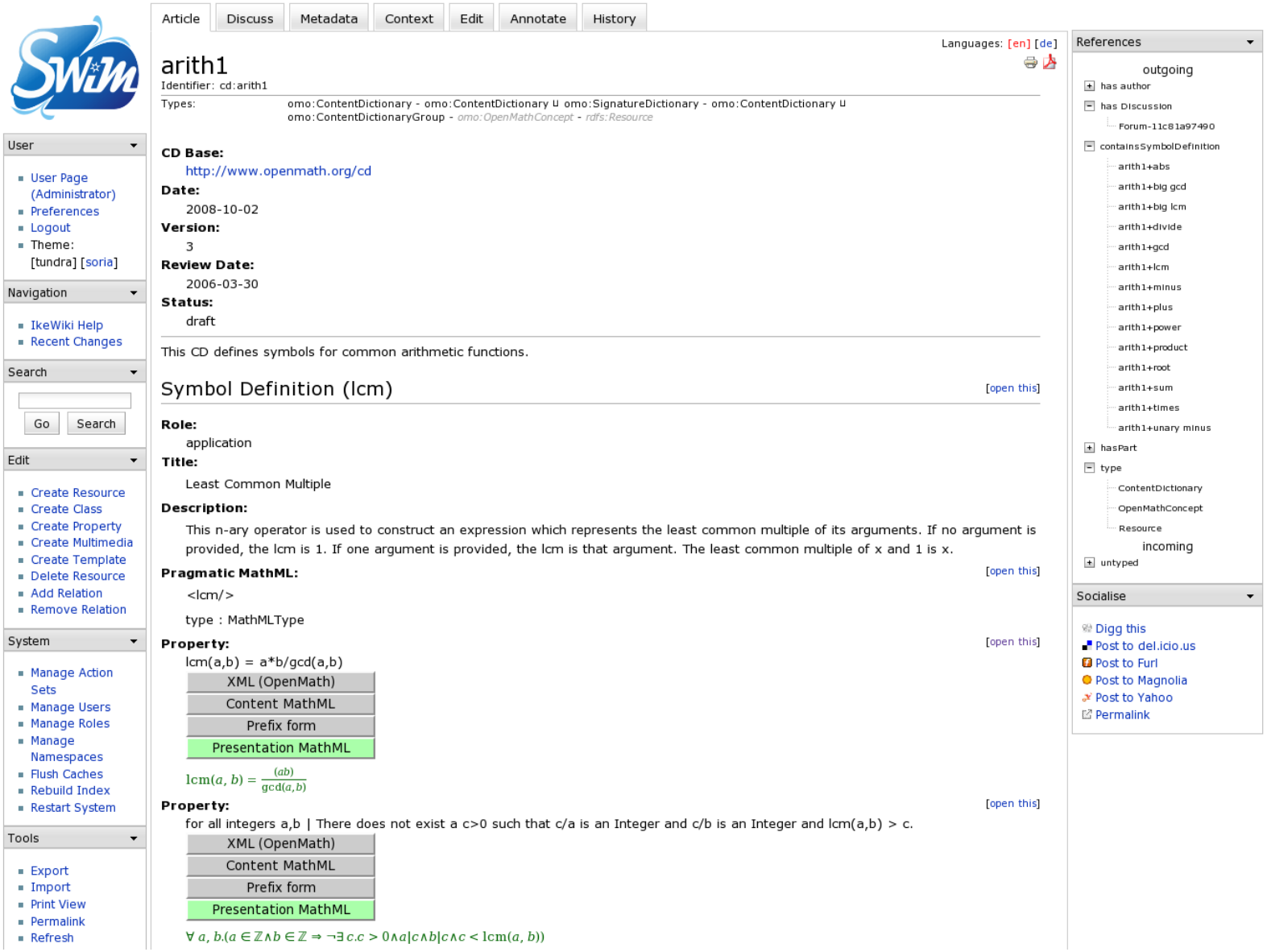
- data intensive infrastructures
- information mining and retrieval
- reasoning and querying



SmILE

kwarc JACOBS UNIVERSITY

Before: SWiM, a Semantic Wiki for Mathematics

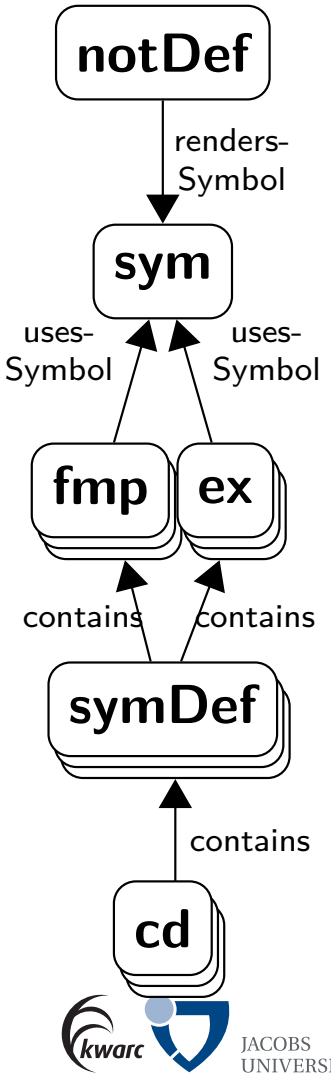


Ontologies for Mathematical Documents (1)

Previous State

I had a basic ontology that modelled structures of mathematical knowledge; mainly *statements* (definition, theorem, proof, examples)

- used in SWiM for navigation, queries, internal bookkeeping



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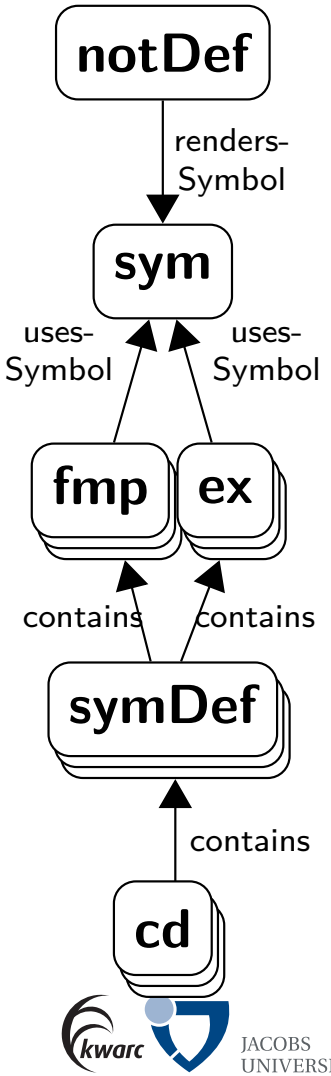
Next Challenge

- Semi-formal knowledge often comes in *documents* that also contain *text*
- There is a document structure (chapter, section, cross-reference), and a rhetorical structure, both of which can be independent from the mathematical structure.



Ontologies for Mathematical Documents (2)

Getting the Model Right

$$\text{document ont.} \leftrightarrow \text{annotation ont.} \leftrightarrow \begin{cases} \text{rhetorical ont.} \\ \text{mathematical ont.} \end{cases}$$

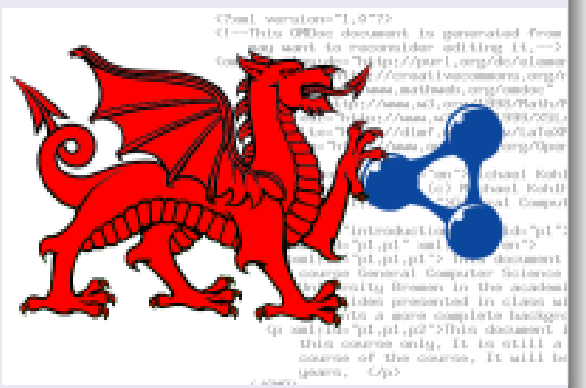
(following the SALT approach)

SALT (Semantically Annotated LaTeX)

semantic authoring framework for creating scientific publications

Implementation

- Expansion of the ontology
- Rules for extracting these concepts from OMDoc documents to RDF
- $\rightsquigarrow$ Krextor XML$\rightarrow$RDF extraction library



User Interfaces for Annotating and Browsing

Improved Annotation Support

More and easier annotation support in the editor

- toolbars for easy selection of types of mathematical knowledge
- from phrase to theory level
- deleting annotations
- auto-completion of link targets (prepared)

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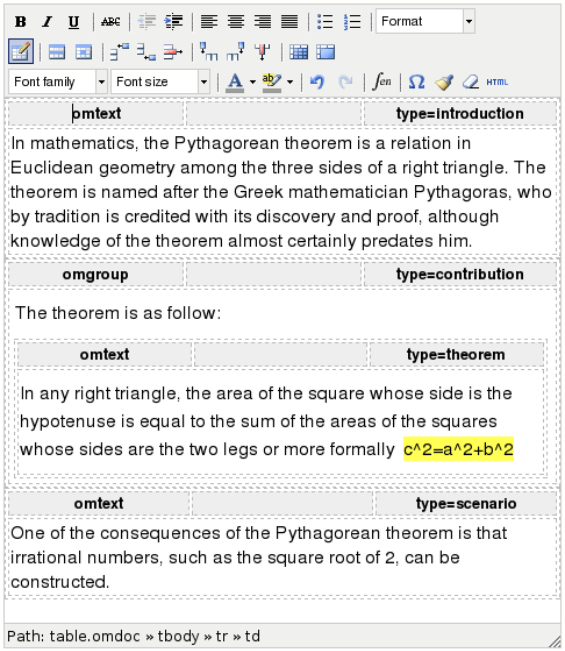
Rhetorical Annotation and Visualisation

- improved and extended syntax for annotating SALT-/RST-like rhetorical structures in OMDoc
  using the SALT ontology within the host language OMDoc, not LaTeX
- ideas for an editing interface
- visualisation of rhetorical relations and blocks implemented
  $\longrightarrow$ *active documents*

Annotation



Sections in the editor

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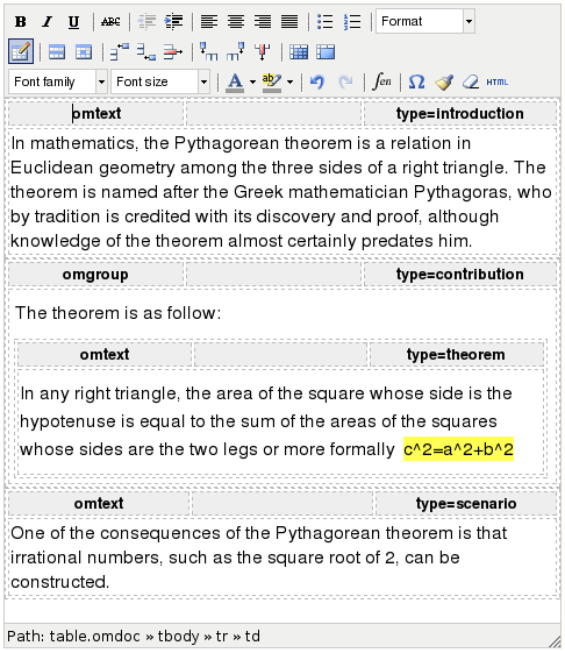
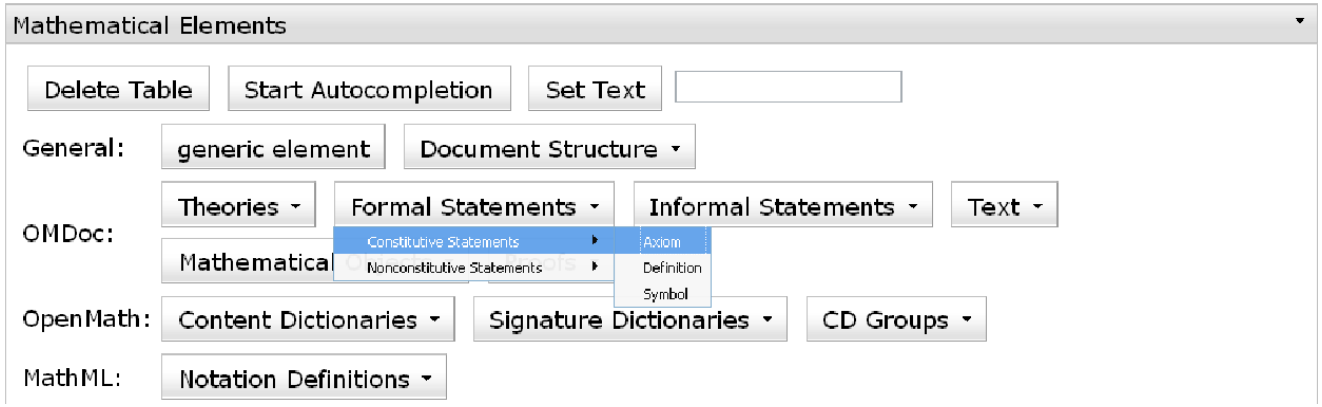
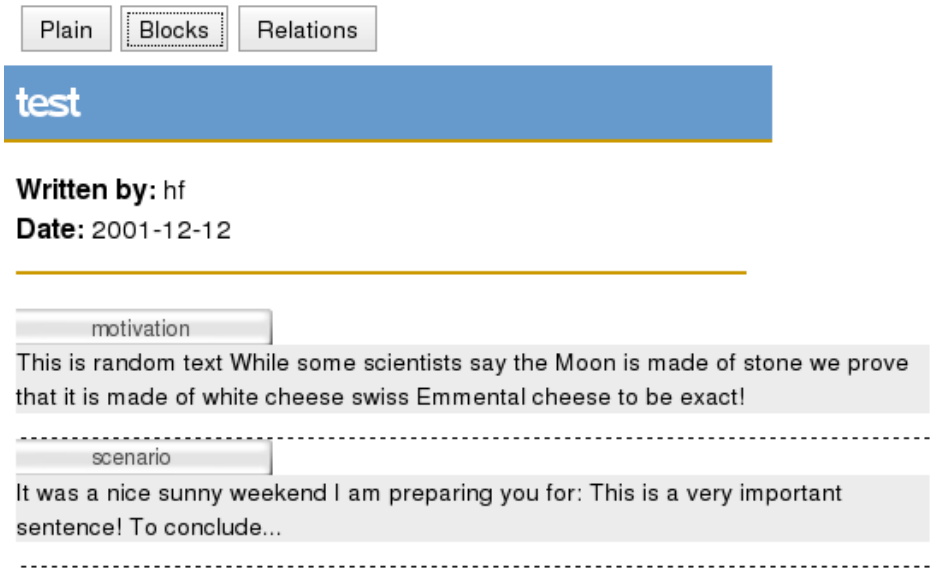


Sections in the editor
(Implementation by Gordan Ristovski)



The toolbar

Visualisation of Rhetorical Structures



Rhetorical Blocks (SALT)

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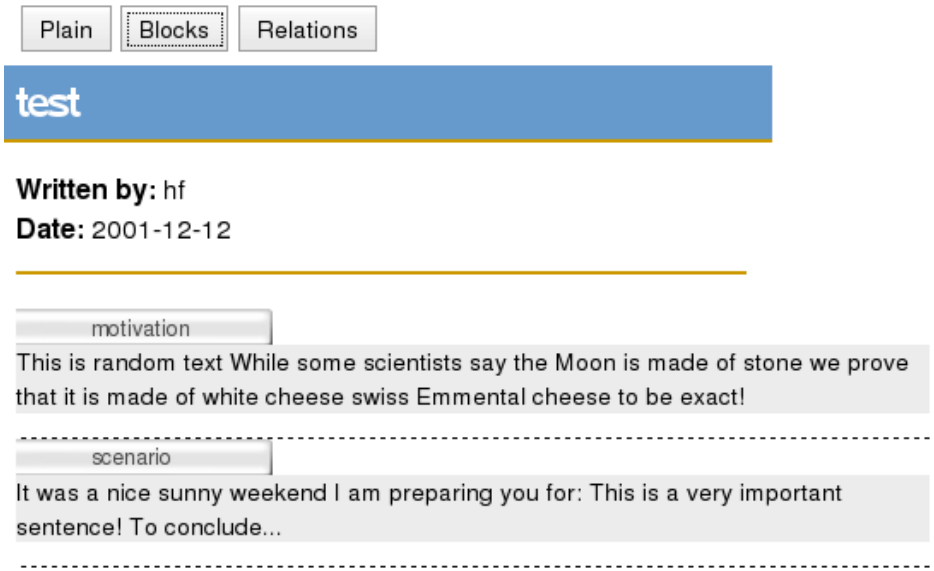
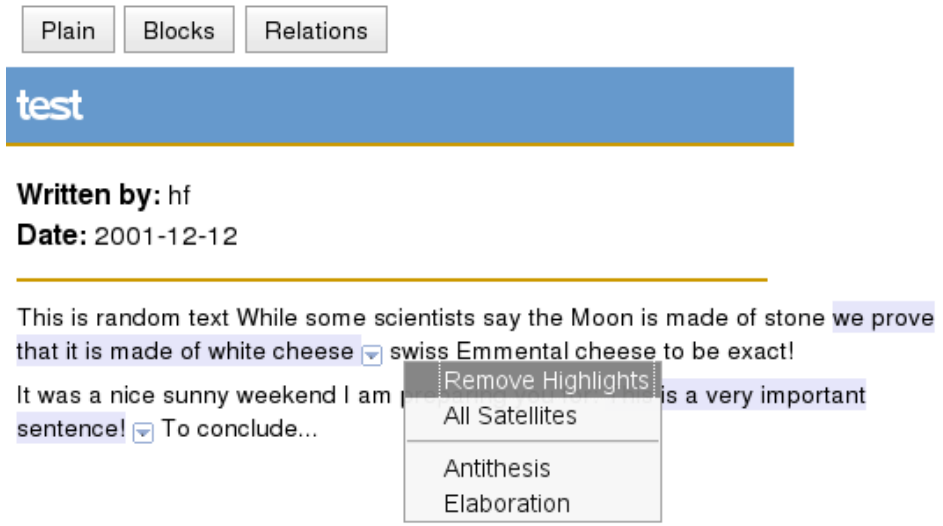


Rhetorical Blocks (SALT)

Rhetorical Relations
(SALT, implementing RST)



(Implementation by Jana Giceva)

Argumentation about Mathematical Knowledge

Idea

Need for structured wiki discussions, well-defined workflow for solving problems with knowledge in a wiki

My Case

- a wiki page is an item of mathematical knowledge, e. g. a theorem
- issues discussed will be quite specific: e. g. "This theorem is hard to understand" (or wrong, or inadequately presented, . . .)

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Related Topic

There is also argumentation *within* artifacts of scientific knowledge, but so far I focused more on argumentation *about* them.

Resource | Edit | **Discussion** | History

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Issue	Alice	2008–05–30	[Idea][Argument][Agree][Disagree][Decision]
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Decision Christoph 2008–06–05

So let's do it! (Available in SWiM)

Domain-Specific Argumentation

Assumptions

- Possible problems depend on the type of knowledge item
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- Standard problems have standard solutions, with which software can assist

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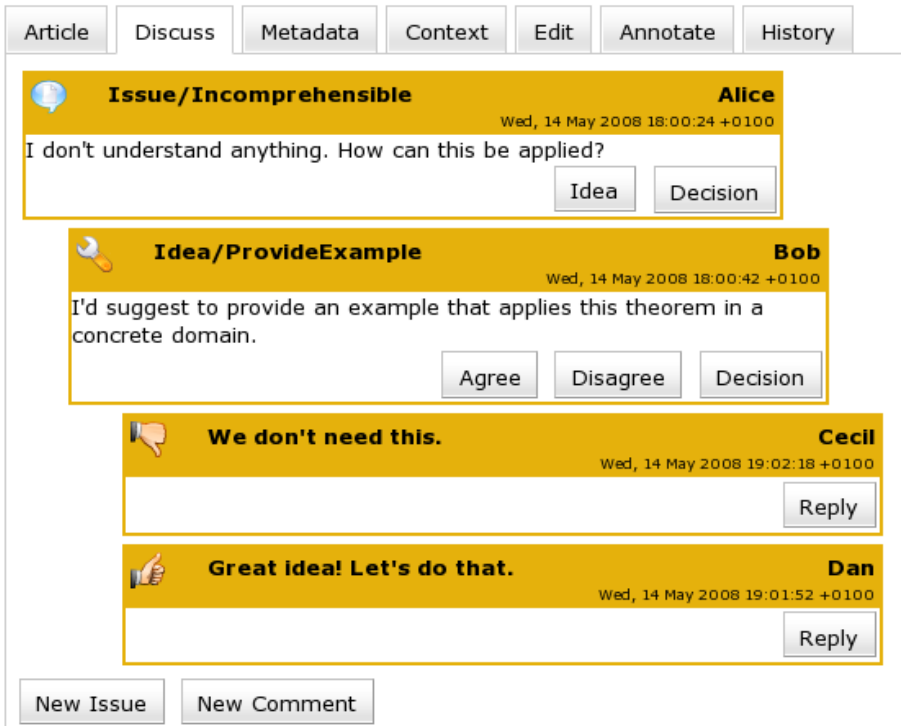
Survey (`tinyurl.com/5qdetd`)

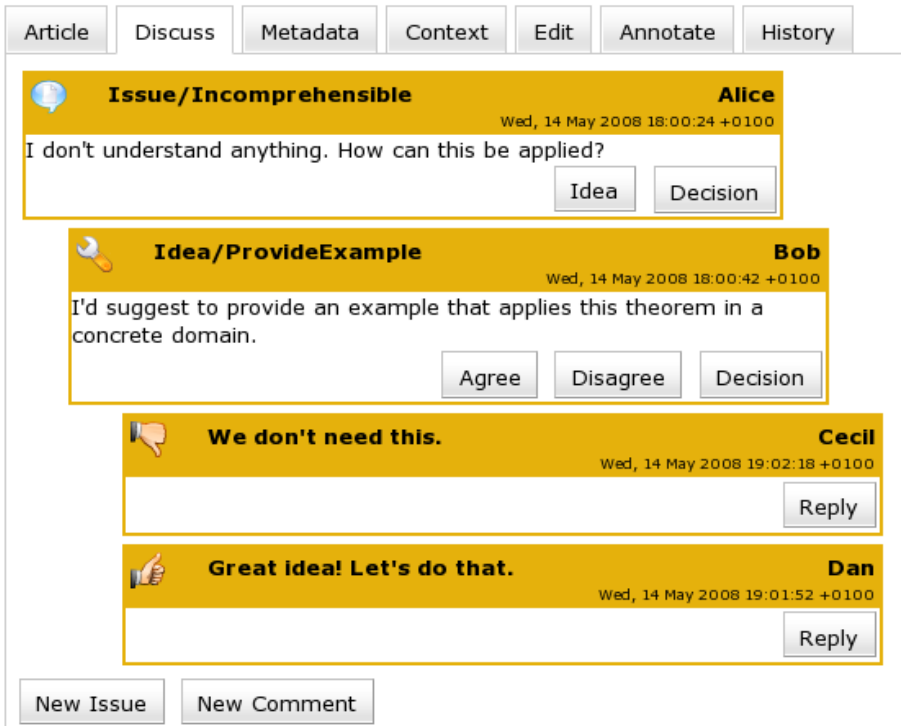
- Common issues: wrong, incomprehensible, uncommon style, underspecified, redundant, truth uncertain
- Common solutions: directly improve affected knowledge item, split it
- When issues remain unresolved, it's mostly due to insufficient restructuring support

Domain-Specific Argumentation (Example)



User Interface

Domain-Specific Argumentation (Example)



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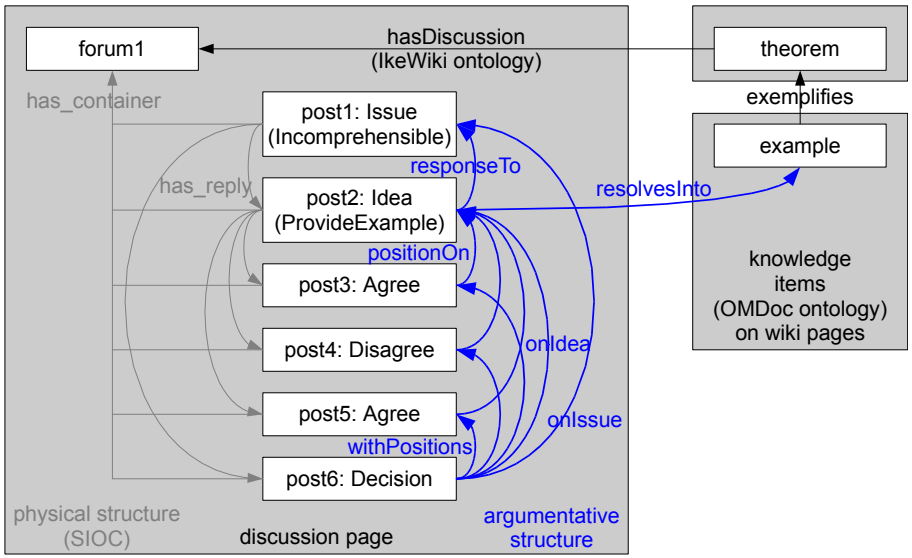
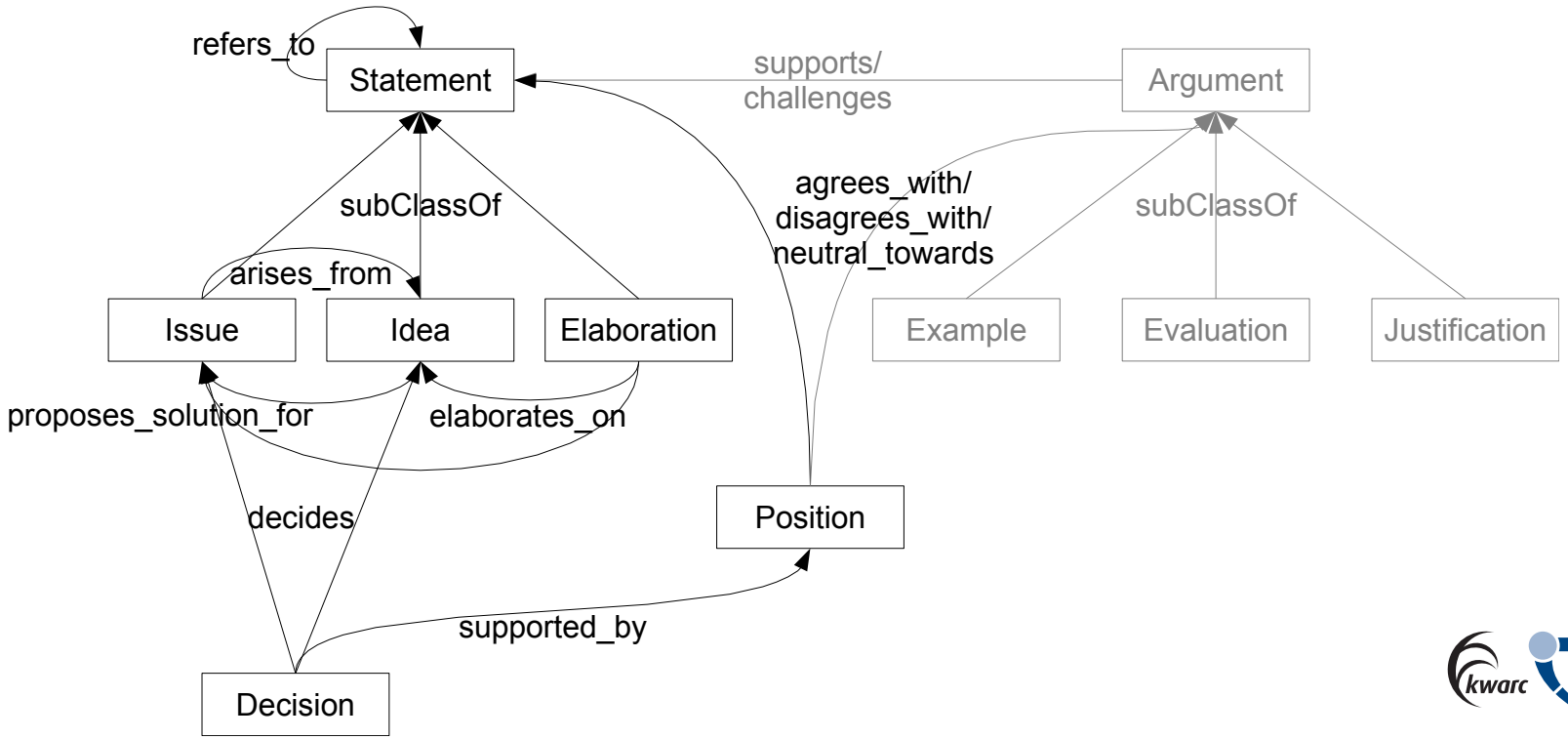


RDF Graph

General Argumentation on Social Media Sites

- developing an argumentation module for SIOC (ontology for Semantically Interlinking Online Communities)
- joint work with Uldis Bojārs (SIOC) and Tudor Groza (SALT)
- use cases, model, guidelines for usage
- implementation and evaluation to be done



OpenMath Case Study

- lightweight mathematical ontology engineering (`http://wiki.openmath.org`)
  - no rhetorical structures, no documents
    but still a lot of structures to annotate!
  - definitions, formal properties, examples, notations
  - local argumentation
- small group of knowledge engineers (domain experts)
- specialised editors: structured definitions, formulas, metadata
- evaluation needed

Summary

What I hope(d) to learn – to use it for mathematical knowledge management:

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What I hope to contribute to the semantic web:

- mathematics as a complex use case pointing out limits of the semantic web
- an ontology for a complex domain, with document structure, mathematical structure, and rhetorical structure
- domain-specific argumentation

Further Work

Active Documents

Interactive editing and previewing of notations

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   $\longrightarrow$ import metadata vocabularies as theories
2. Document these vocabularies in OMDoc
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Semantic Web Empowering MKM