

SWiM – A wiki for collaborating on mathematical ontologies

Ontolog Semantic Wiki Mini-Series

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KWARC – Knowledge Adaptation and Reasoning for Content

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Mathematical Knowledge Management

- Goal: support collaborative authoring of documents usable for knowledge management
- semantic markup common for documents in mathematics: MathML, OpenMath, OMDoc (compare semantic web ontologies)
- layers of knowledge: symbols (cf. concepts), statements (axioms), theories (ontologies), documents
- has many applications, but how to acquire the knowledge?
- \Rightarrow services to support the authoring workflow?

Example (a simple formula?)

```
<apply>
  <csymbol definitionURL="http://openmath.org/cd/arith1">plus</csymbol>
  <cn type="integer">1</cn>
  <ci>n</ci>
</apply>
```

Semantic Wiki and Ontologies

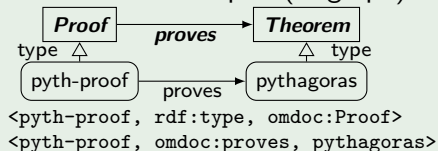
- Semantic wikis found usable to support collaborative formalization
- Difference *here* is: deeply nested markup, lots of cross-references
- Right granularity of pages: one page = one theory, one statement, one formula?
- \Rightarrow extract knowledge relevant for search and navigation, build services on top of that
- RDF graph in terms of an ontology that models the semantics of the markup; direct and inferred relationships: dependency, containment

Example

A wiki page (internally):

```
<omdoc>
  <proof id="pyth-proof"
    for="pythagoras">
    ...</proof>
</omdoc>
```

Extracted RDF triples ($\hat{=}$ graph):



SWiM: IkeWiki + Mathematical Markup

- editing, presentation, navigation, discourse, semantic services
- See <http://swim.kwarc.info>, <http://wiki.openmath.org>

The screenshot shows the SWiM wiki interface for the article 'arith1'. The page is structured into several sections:

- Navigation:** Article, Discuss, Metadata, Context, Edit, Annotate, History.
- Language:** Languages: [en] [de]
- Header:** arith1, Identifier: cd:arith1, Types: omo:ContentDictionary - omo:ContentDictionary u omo:SignatureDictionary - omo:ContentDictionary u omo:ContentDictionaryGroup - omo:OpenMathConcept - rdfs:Resource
- User:** User Page (Administrator), Preferences, Logout, Theme: [tundra] [soria]
- Navigation:** IkeWiki Help, Recent Changes
- Search:** Search box with Go and Search buttons.
- Edit:** Create Resource, Create Class, Create Property, Create Multimedia, Create Template, Delete Resource, Add Relation, Remove Relation
- System:** Manage Action Sets, Manage Users, Manage Roles, Manage Namespaces, Flush Caches, Rebuild Index, Restart System
- Article Content:**
 - CD Base:** <http://www.openmath.org/cd>
 - Date:** 2008-10-02
 - Version:** 3
 - Review Date:** 2006-03-30
 - Status:** draft
 - Description:** This CD defines symbols for common arithmetic functions.
 - Symbol Definition (lcm):**
 - Role:** application
 - Title:** Least Common Multiple
 - Description:** This n-ary operator is used to construct an expression which represents the least common multiple of its arguments. If no argument is provided, the lcm is 1. If one argument is provided, the lcm is that argument. The least common multiple of x and 1 is x .
 - Pragmatic MathML:** $\langle \text{lcm} / \rangle$
 - Property:** $\text{lcm}(a, b) = a * b / \text{gcd}(a, b)$
 - Property:** $\text{lcm}(a, b) = \frac{a * b}{\text{gcd}(a, b)}$
- References:** outgoing, has author, has discussion, Forum-11081a97490, containsSymbolDefinition, arith1+abs, arith1+tag gcd, arith1+tag lcm, arith1+divide, arith1+gcd, arith1+lcm, arith1+minus, arith1+plus, arith1+power, arith1+product, arith1+root, arith1+sum, arith1+times, arith1+binary minus
- Socialise:** Diggy this, Post to del.icio.us, Post to Furl, Post to Magnolia, Post to Yahoo, Permalink

Editing Support

- Dedicated editors for documents (statements, theories), metadata, formulæ
- Import/export from and to semantic markup languages, Subversion repository integration (support legacy workflows)

The screenshot displays a web-based editor for a mathematical document. The main window shows a document titled "MathematicalDocument" with a text area containing a paragraph and a formula: $\sum_{n=0}^{\infty} \lambda_n \cdot (x^n)/(n!)$. A dialog box titled "Insert / edit embedded entities" is open, showing a preview of the formula and a list of mathematical symbols categorized under "Variables", "Arithmetic", and "Algebra". The "Arithmetic" section includes symbols like $a+b$, ab , a^b , $n!$, $a-b$, $\frac{a}{b}$, $\sqrt[n]{a}$, \sqrt{a} , $\sum_{i=1}^n a_i$, $\prod_{i=1}^n a_i$, $|x|$, $-a$, $\text{lcm}(a, b)$, $\text{gcd}(a, b)$, $\text{round}(x)$, $\text{quot}(a, b)$, $a \bmod b$, $\text{trunc}(x)$, $\text{min}(a, b)$, $\text{max}(a, b)$, $|x|$, $|x|$, φ , n , j , $a+b$, $!c$, \int , a^n , Δc , and \arg . Below the document, there is a section for "Imports" with a table structure and a "Summary:" field. At the bottom, a "Mathematical Elements" panel shows configuration options for "generic element", "Document Structure", "OMDoc", "Text", "OpenMath", "Constitutive Statement", "Math Objects", "Signature Dictionaries", "Nonconstitutive Statement", and "CD Groups".

Argumentative Discussions

- Structured workflow for discussing problems and solutions
- Argumentation ontology (SIOC module) with domain-specific extensions (Survey: tinyurl.com/5qdetd)
- assistance with standard solutions

Article Discuss Metadata Context Edit Annotate History

Discussion about SampleDefinition

Issue (UnclearWhetherUseful): Is this definition of any use? **Administrator**

Mon, 27 Oct 2008 01:05:07 +0100

Can it be applied for anything relevant?

Idea general idea Elaboration Argument Position Decision Reply

Position: Re: Is this definition of any use? **Administrator**

Mon, 27 Oct 2008 01:23:03 +0100

Oh, come on, don't complain, mathematics is the science of abstract nonsense, after all.

Reply

Elaboration: Re: Is this definition of any use? **Administrator**

Mon, 27 Oct 2008 01:13:50 +0100

I mean, I cannot imagine any application in science or technology where this might be helpful.

Argument Reply

Idea (ProvideExample): Re: Is this definition of any use? **Administrator**

Mon, 27 Oct 2008 01:27:43 +0100

Why don't you provide an example that shows how to apply this to the domain of rocket science?

Elaboration Argument Position Decision Reply

New Issue general issue New Comment

supporting Example
challenging Evaluation
justification

Dictionaries of Symbols and Proof Formalization

OpenMath 3: revision of the content dictionaries (collections of symbol definitions – a lightweight, modular ontology)
user interface: editing formulae, metadata, symbol notations;
argumentation

“Let’s write multiplication as $a \times b$ instead of $a \cdot b$!”

<http://wiki.openmath.org>

Flyspeck: Formalizing a **P**roof of the **K**epler conjecture:
hundreds of proof sketches, collaboratively transform them
into something machine-verifiable
formalizing, annotating, discussing, project management

The SWiM Approach: Good for Math and other Domains

- SWiM makes mathematical documents editable collaboratively and facilitates common workflows by exploiting the knowledge they contain.
- Domain-specific semantic markup and ontology allows for advantages over generic semantic wikis, and over non-semantic mathematical wikis (more and easier knowledge management)
- Approach considered transferable to other domains (e. g. chemistry): decide on page granularity, capture semantics in ontology, extract RDF, integrate suitable editors

`http://swim.kwarc.info`
`http://wiki.openmath.org`