Semantic Wikis for Mathematics – a State-of-the-Art Survey

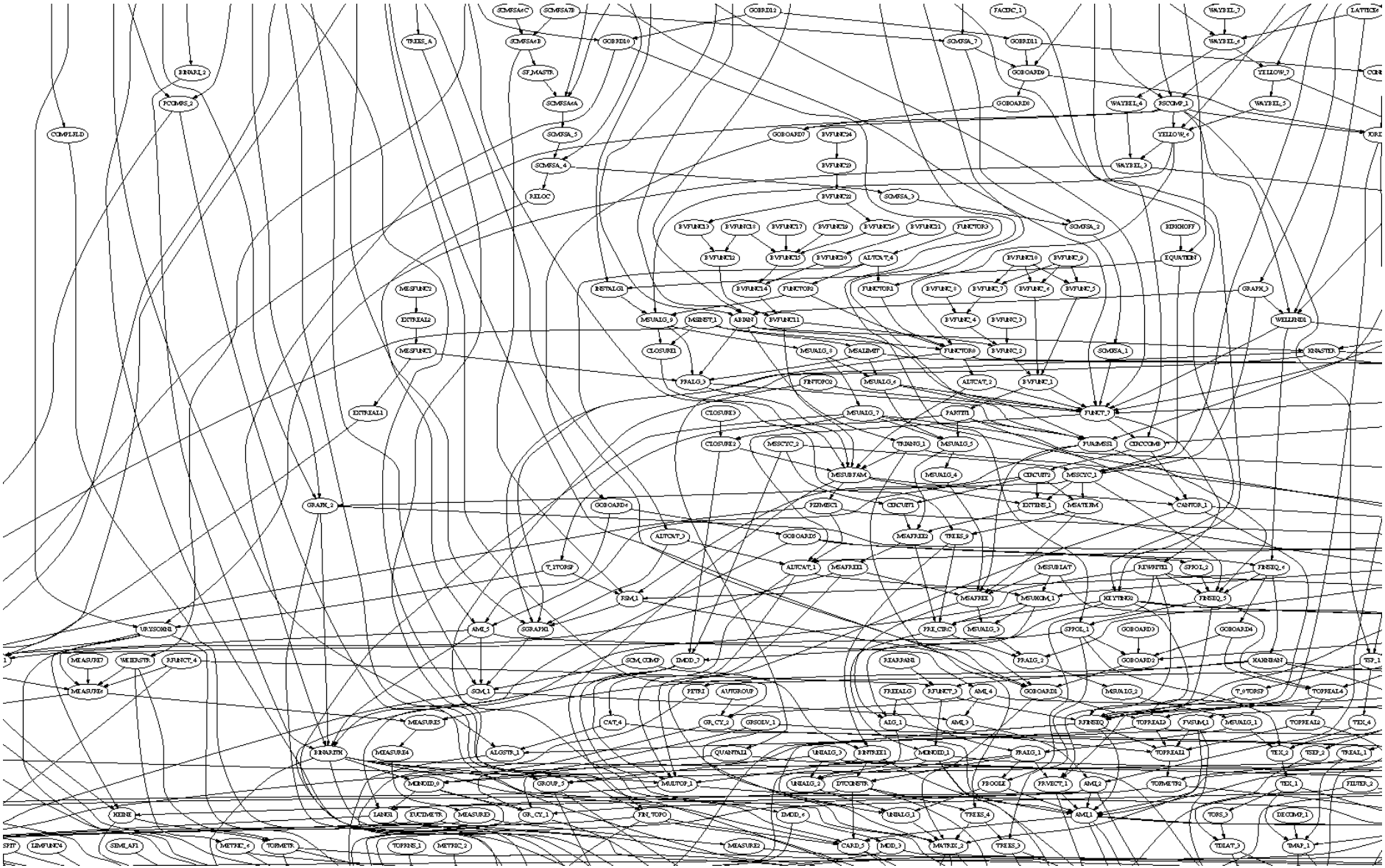
Ontolog Semantic Wiki Mini-Series

Christoph Lange

Jacobs University, Bremen, Germany

KWARC – Knowledge Adaptation and Reasoning for Content

January 22, 2009



Requirements for Managing Mathematical Knowledge on the Web

- Ever-growing mathematical knowledge bases (previous slide: Mizar Mathematical Library, `http://www.mizar.org`)
- Wide acceptance of computer support in formal mathematics
  - automated theorem proving
  - computer algebra systems
- e-learning (e. g. ActiveMath: `http://www.activemath.org`)
- computer-based math publishing: LaTeX, MathML

But: Hardly any systems for Math Collaboration [on the web]!

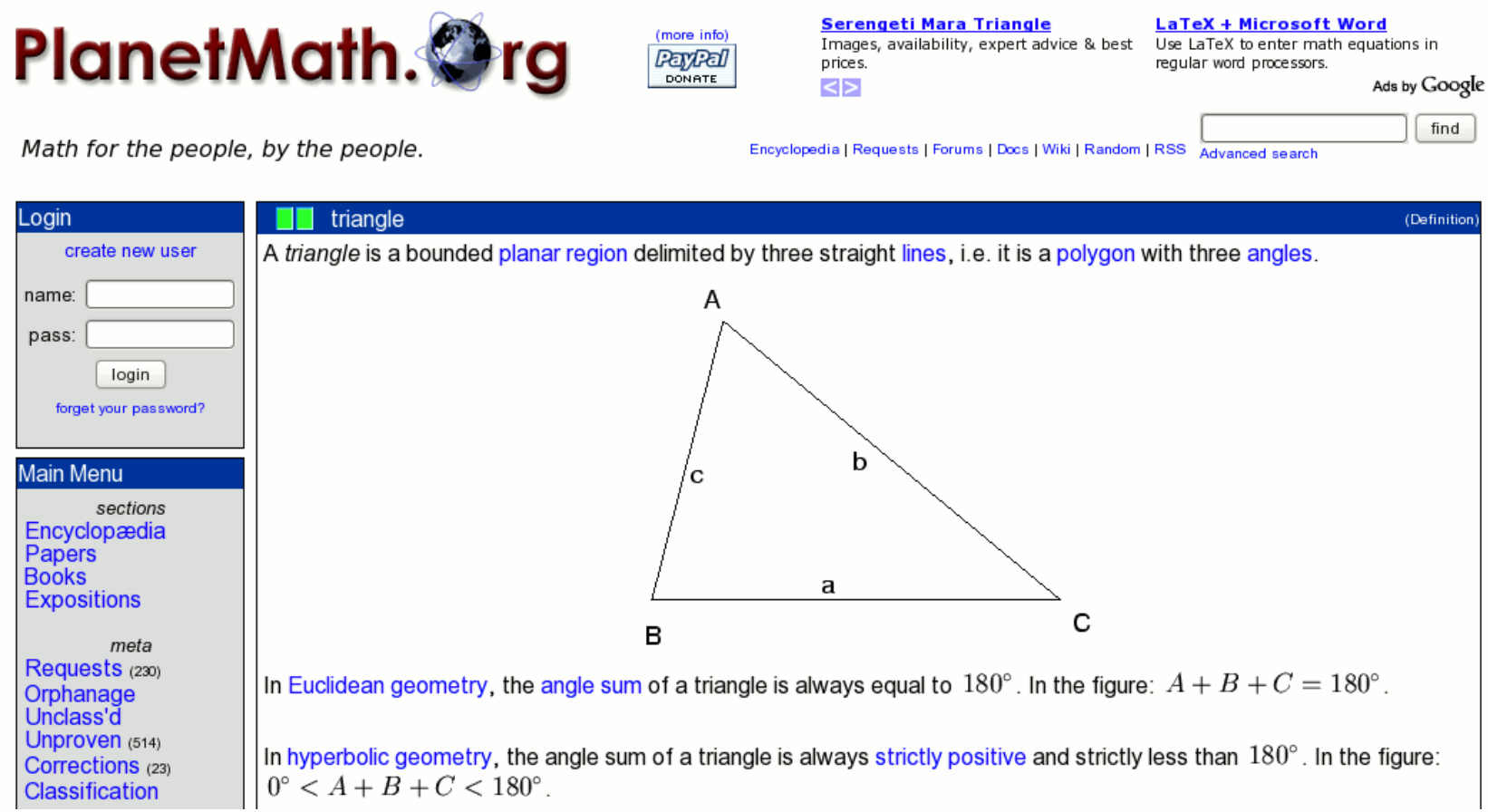
Survey: Wikis for Mathematical Knowledge

- Wikis for managing mathematical knowledge – some semantic, some not
- Wiki engines with just LaTeX or MathML input don't count
- Wiki sites with an ordinary engine and just mathematical content don't count

Example

Googling for "math wiki" does not help much. Same as the "unreal wiki", which really exists ☺

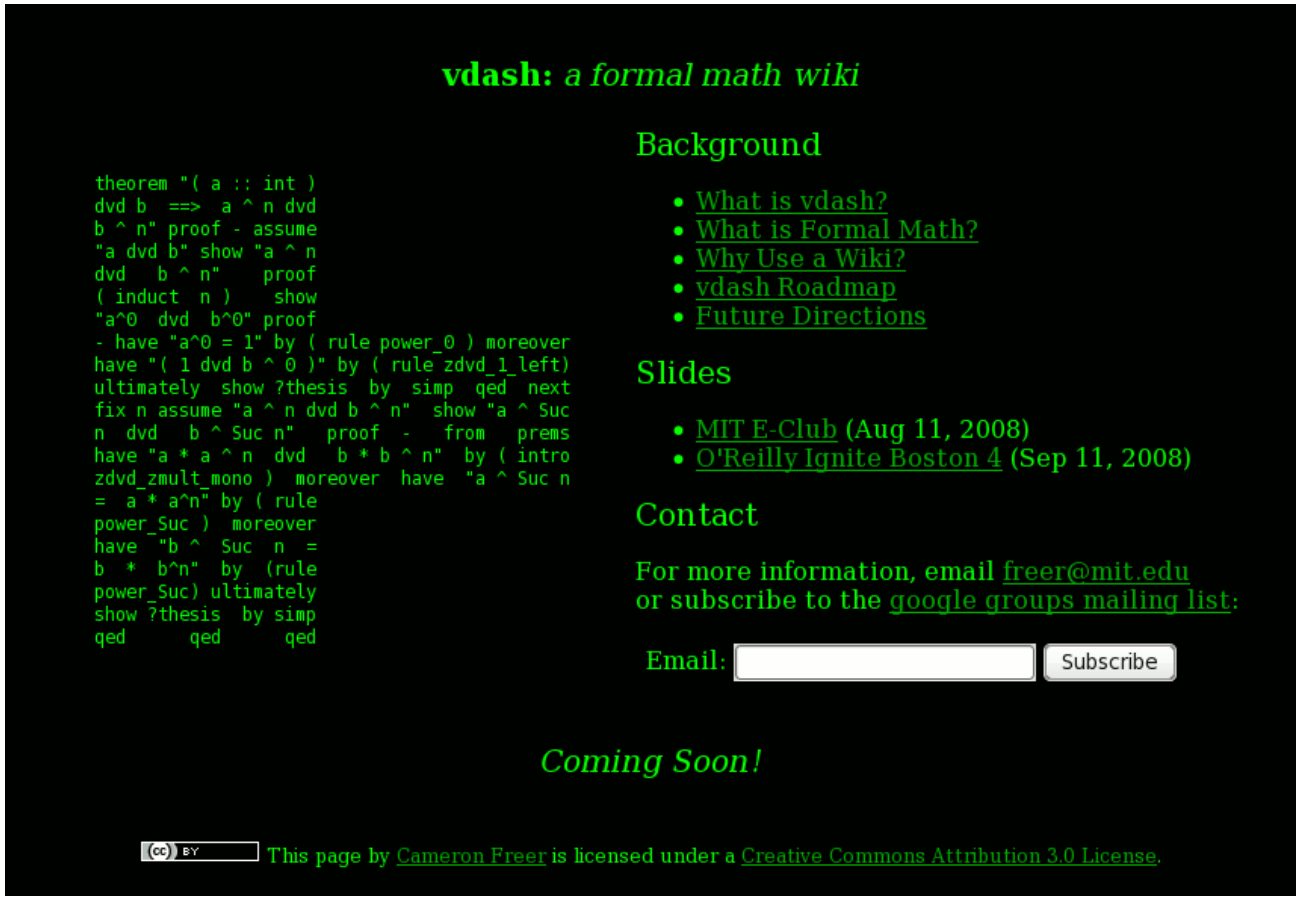
PlanetMath – Free Math Encyclopedia



Dedicated wiki engine, mathematical metadata and keywords used for search and navigation

`http://www.planetmath.org`

vdash – Automated Theorem Proving

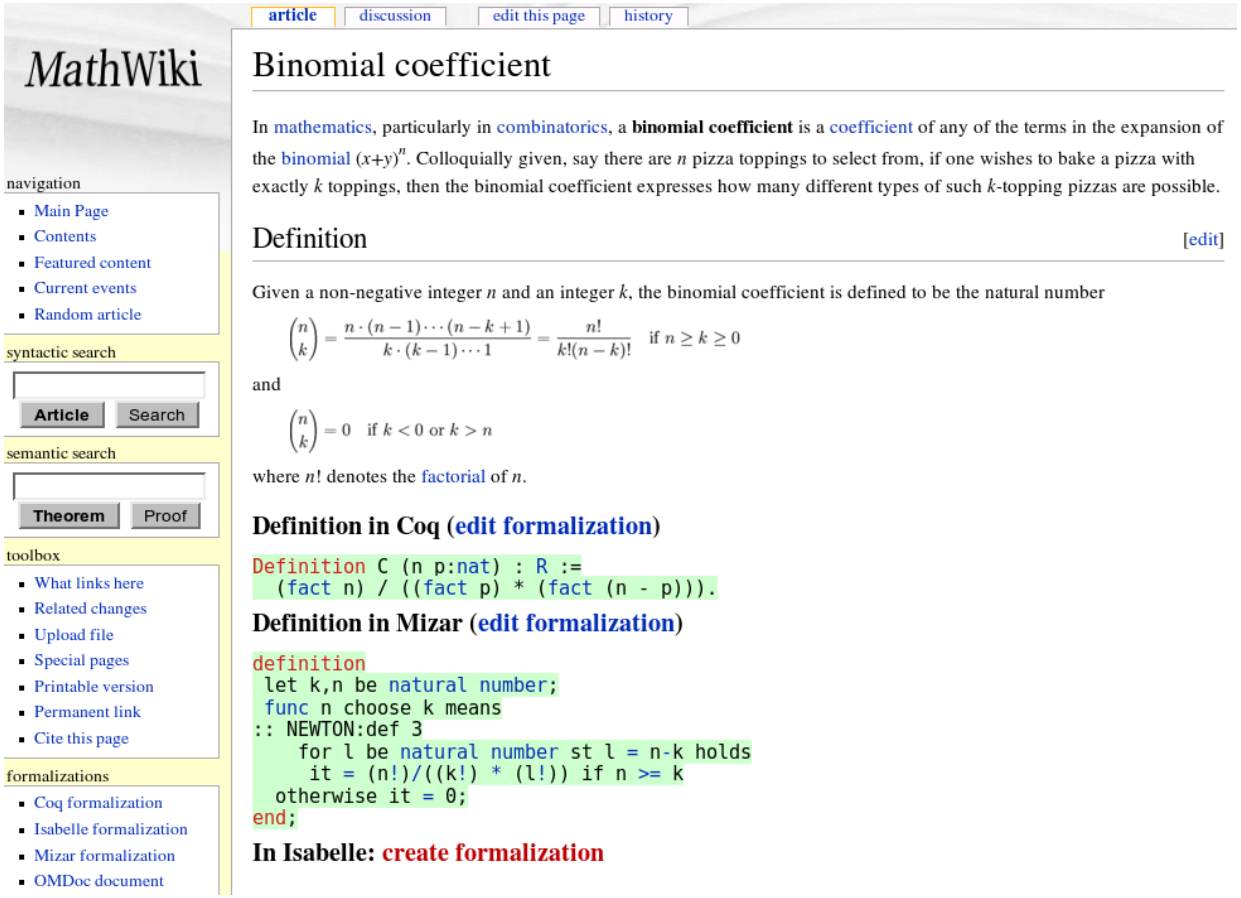


Integrates the automated theorem prover Isabelle

Not yet released but promising roadmap: web crawling, consistency

`http://vdash.org`

ProofWiki – Automated Theorem Proving

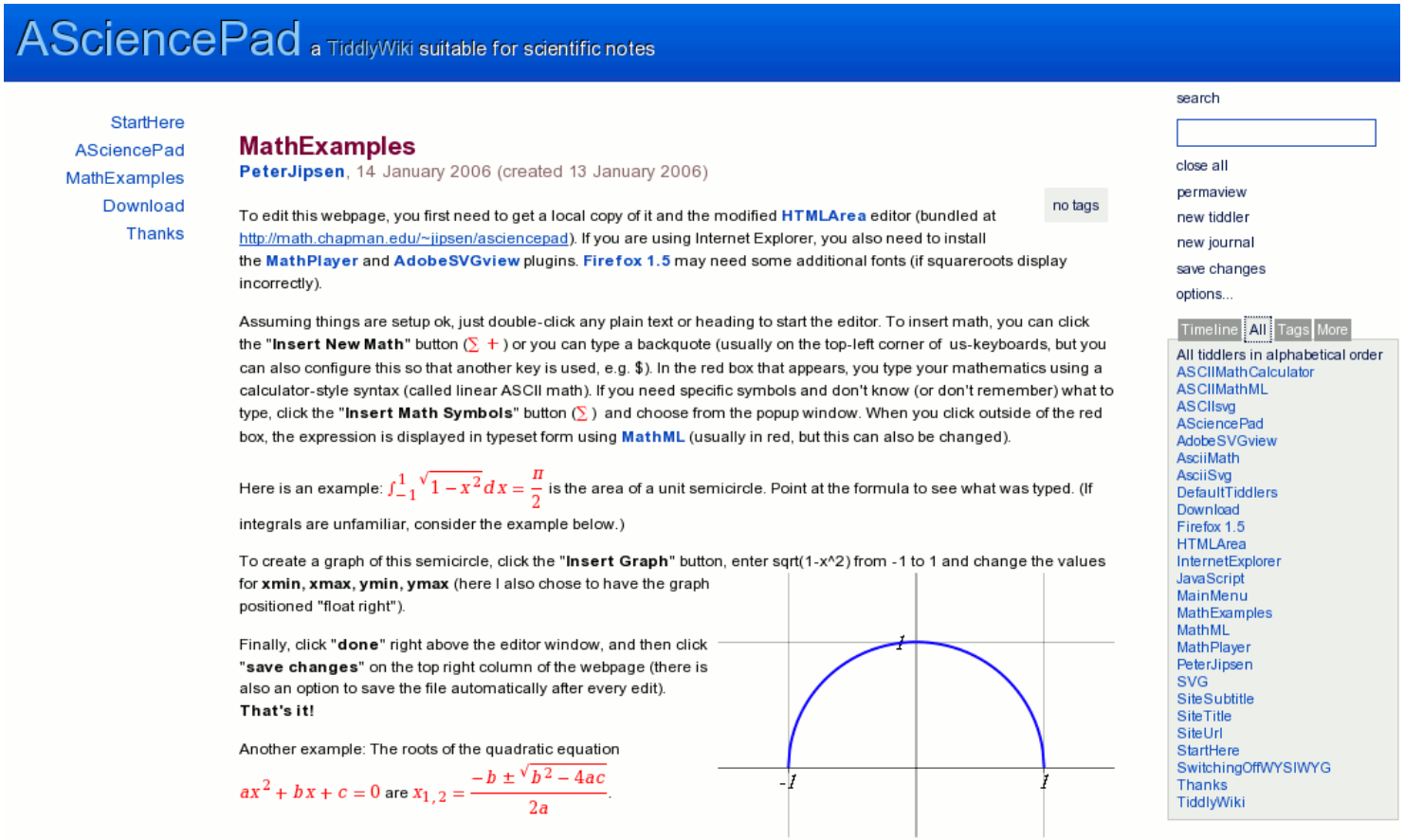


Integrates automated theorem prover Coq (future: more); prototype

Prototype/mockup at `http://prover.cs.ru.nl/wiki.php`

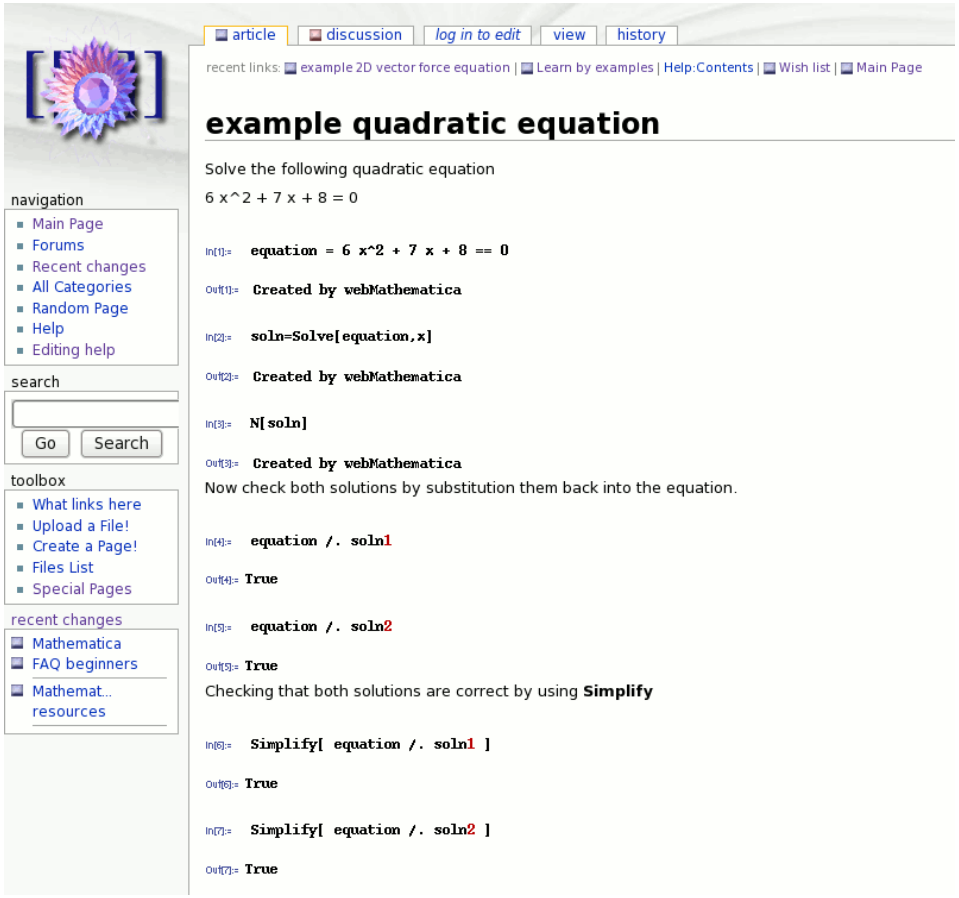
Don't confuse with non-semantic `proofwiki.org`

ASciencePad – Personal Wiki



TiddlyWiki (local, single-user JavaScript wiki) with MathML and SVG
Can calculate and graph
`http://math.chapman.edu/~jipsen/asciencepad/`

WebMathematica wiki – Computer Algebra



MediaWiki rewrite integrating WebMathematica CAS frontend
Can do computer algebra, computations, graphing, ...
`http://www.mathematica-users.org/webMathematica/wiki/`

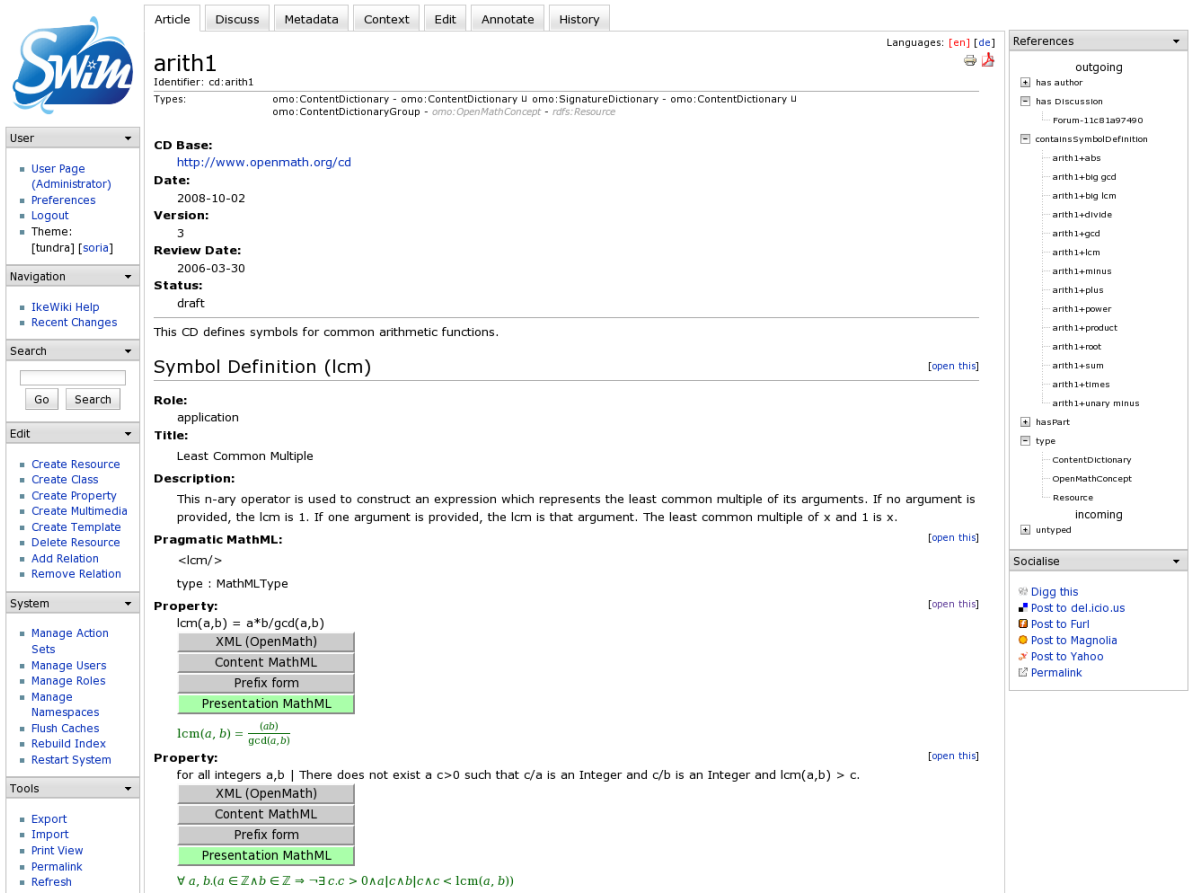
SlugMath – SMW for E-Learning

Semantic MediaWiki containing formal core of math lectures

`http://slugmath.ucsc.edu/mediawiki/`

kwarc JACOBS UNIVERSITY

SWiM – Ontology-based Semantic Wiki



Ontology of math. knowledge structures at the core

Editing, RDF-powered navigation and queries, argumentation

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

Summary

	Planet Math	vdash	Proof Wiki	AScience Pad	Web Mathematica	Slug Math	SWiM
Sem. Web	n	n	n	n	n	y	y
Metadata	y	n	n	n	n	(y)	y
Sem. Formulae	n	y	y/n	n/y	y	n	y
Verification	n	y	y	n	(y)	n	(n)
Computation	n	(y)	(y)	y	y	n	n
Graphing	n	n	n	y	y	n	n
Learning	(y)	n	(y)	n	n	y	(n)

Formality Challenge

- Wiki is informal and agile
- Mathematical knowledge should be correct
- Currently different wikis for different formality levels
- Ultimate goal: one wiki for formal and informal mathematics
  - evolving an informal proof sketch into a formal proof
  - explaining a formal definition informally
  - combining formal and informal data (e. g. for search)
  - multi-level validation: syntax, link structure, theory structure, proofs
  - OMDoc (SWiM's language) has the potential, but it's a long way

Vision: Active Mathematical Documents

- Mathematical documents that you can adapt, edit, and interact with like spreadsheets
- Adapt symbols:
  - Select different notations: $\mathcal{C}_n^k \rightsquigarrow \binom{n}{k}$
  - Edit notation on the fly
  - Give natural-language explanation

Vision: Active Mathematical Documents

- Mathematical documents that you can adapt, edit, and interact with like spreadsheets
- Adapt symbols:
  - Select different notations: $\mathcal{C}_n^k \rightsquigarrow \binom{n}{k}$
  - Edit notation on the fly
  - Give natural-language explanation
- Explain the structure of a formula:
  - Show all brackets:
    $(5 \cdot (x+y)^{(n+3)}) \leq ((a \cdot b)!)) \vee ((\neg p) \wedge (\neg(q \leq \pi)))$
  - Fold/unfold/abbreviate subterms: $W_{\text{pot}}(R) \leftrightarrow \frac{-e^2}{4\pi\epsilon_0 R/2}$.

Vision: Active Mathematical Documents

- Mathematical documents that you can adapt, edit, and interact with like spreadsheets
- Adapt symbols:
  - Select different notations: $\mathcal{C}_n^k \rightsquigarrow \binom{n}{k}$
  - Edit notation on the fly
  - Give natural-language explanation
- Explain the structure of a formula:
  - Show all brackets:
    $(5 \cdot (x+y)^{(n+3)}) \leq ((a \cdot b)!)) \vee ((\neg p) \wedge (\neg(q \leq \pi)))$
  - Fold/unfold/abbreviate subterms: $W_{\text{pot}}(R) \leftrightarrow \frac{-e^2}{4\pi\epsilon_0 R/2}$.
- Interlink symbols and their definitions:
  - Expand a definition
  - Fill concrete values into an expression
  - Guided tour: explain all definitions and their definitions

more ... $\longrightarrow$

Vision: Active Mathematical Documents (2)

cont'd:

- Select term and then:
  - Search this ($\longrightarrow$ MathWebSearch, `http://search.mathweb.org`)
  - Simplify/solve this
  - Prove this
  - Graph this

Vision: Active Mathematical Documents (2)

cont'd:

- Select term and then:
  - Search this ($\longrightarrow$ MathWebSearch, `http://search.mathweb.org`)
  - Simplify/solve this
  - Prove this
  - Graph this
- Beyond formulas, browse ...
  - structured proofs
  - rhetorical structures of informal math content

Vision: Active Mathematical Documents (2)

cont'd:

- Select term and then:
  - Search this ($\rightarrow$ MathWebSearch, `http://search.mathweb.org`)
  - Simplify/solve this
  - Prove this
  - Graph this
- Beyond formulas, browse ...
  - structured proofs
  - rhetorical structures of informal math content
- Some services possible inside single document, others need client/server connection
- First examples and core of a JavaScript framework: `https://jomdoc.omdoc.org/wiki/JOBAD`
- SWiM integration to be done