

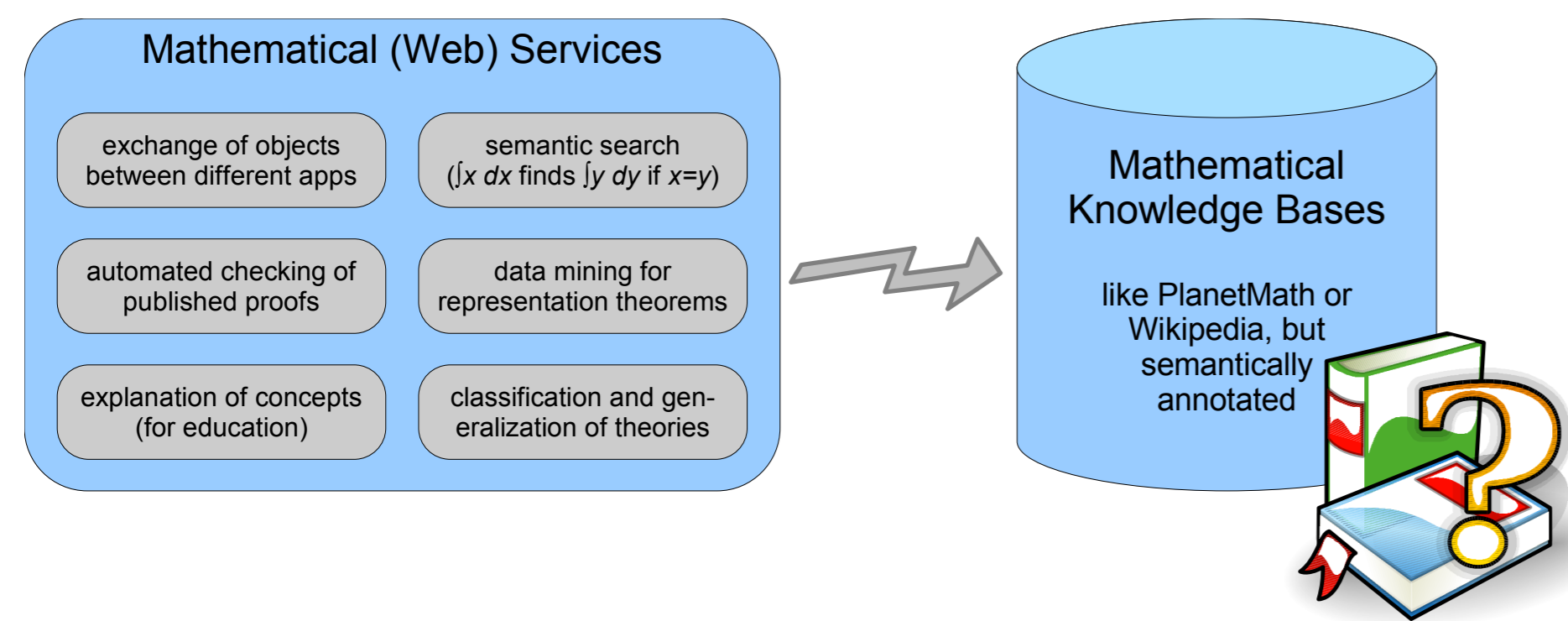
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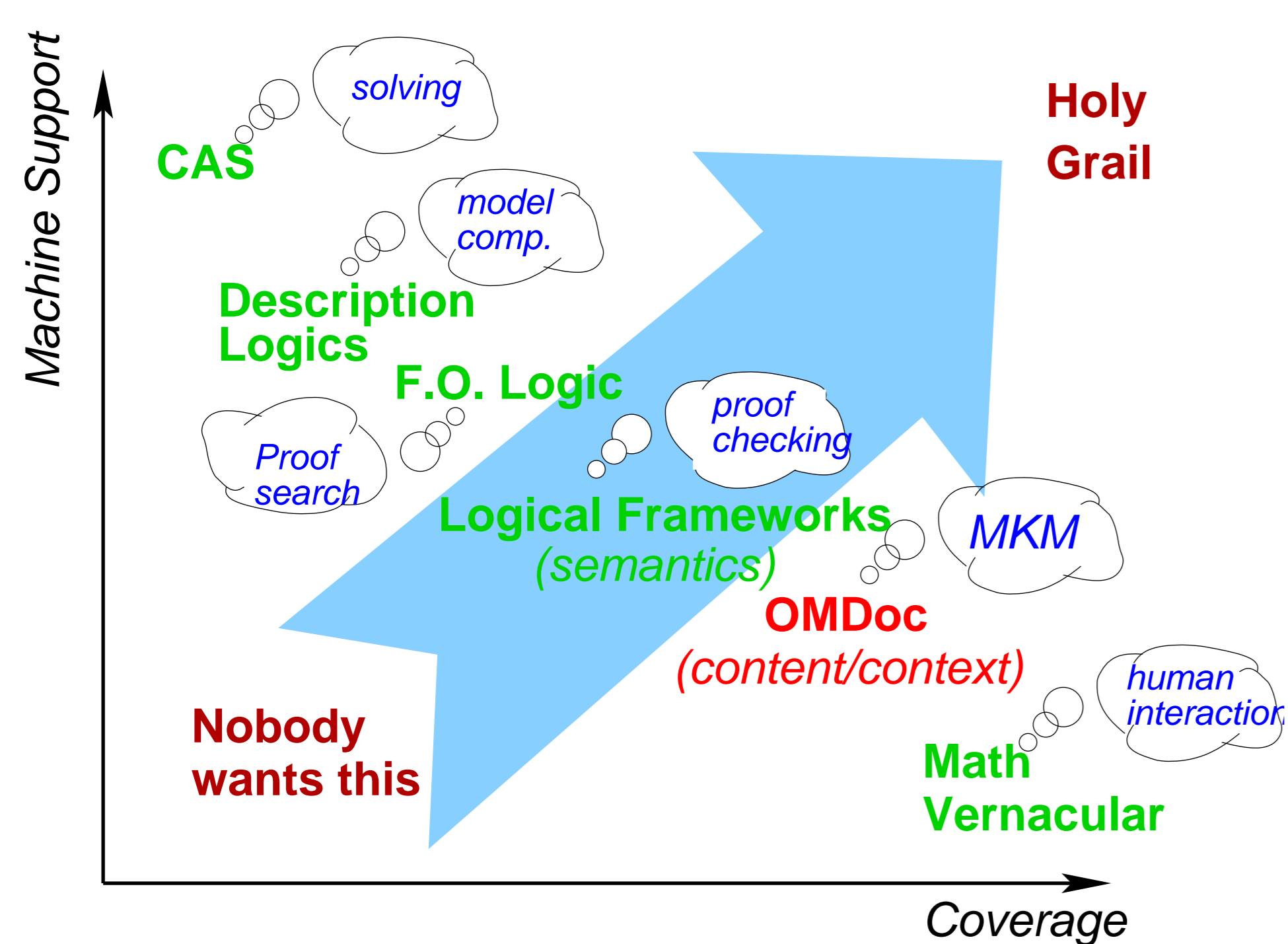
SWiM is a semantic wiki for collaboratively building, editing and browsing a mathematical knowledge base. Its pages, containing mathematical theories, are stored in OMDoc, a markup format for mathematical knowledge. Our long-term objective is to develop a software that facilitates the creation of a shared, public collection of mathematical knowledge (e.g. for education) and serves work groups of mathematicians as a tool for collaborative development of new theories.

A Semantic Web for Mathematics Cross-fertilization

In a semantic web (“a web of *data*”) for mathematics, created by humans annotating mathematical knowledge, we could imagine many **value-added services**:



Semantic Markup with OMDoc (Open Math. Documents)



- **exchange** language for theorem provers
- **incremental development** of new theories (from informal text to full formalization)
- **document preparation** language
- basis for **customized textbooks** in education

Level of Formalization	OMDoc Example
Object level <ul style="list-style-type: none"> • Content MathML • OpenMath • ... 	<pre><OMA> <OMS cd="arith1" name="plus"/> <OMV name="X"/> <OMS cd="nat" name="zero"/> </OMA></pre>
Statement level <ul style="list-style-type: none"> • textbook style • definition, theorem, proof, example 	<pre><definition for="#plus" type="recursive"> <CMP>Addition is defined by recursion on the second argument</CMP> <FMP>X+0=0</FMP> <FMP>X+s(Y)=s(X+Y)</FMP> </definition></pre>
Theory level <ul style="list-style-type: none"> • self-contained collections of inter-related statements • imports form dependency graph 	<pre>graph TD ring -- imports --> group ring -- imports --> monoid group -- imports --> monoid monoid -- imports --> semigroup</pre>

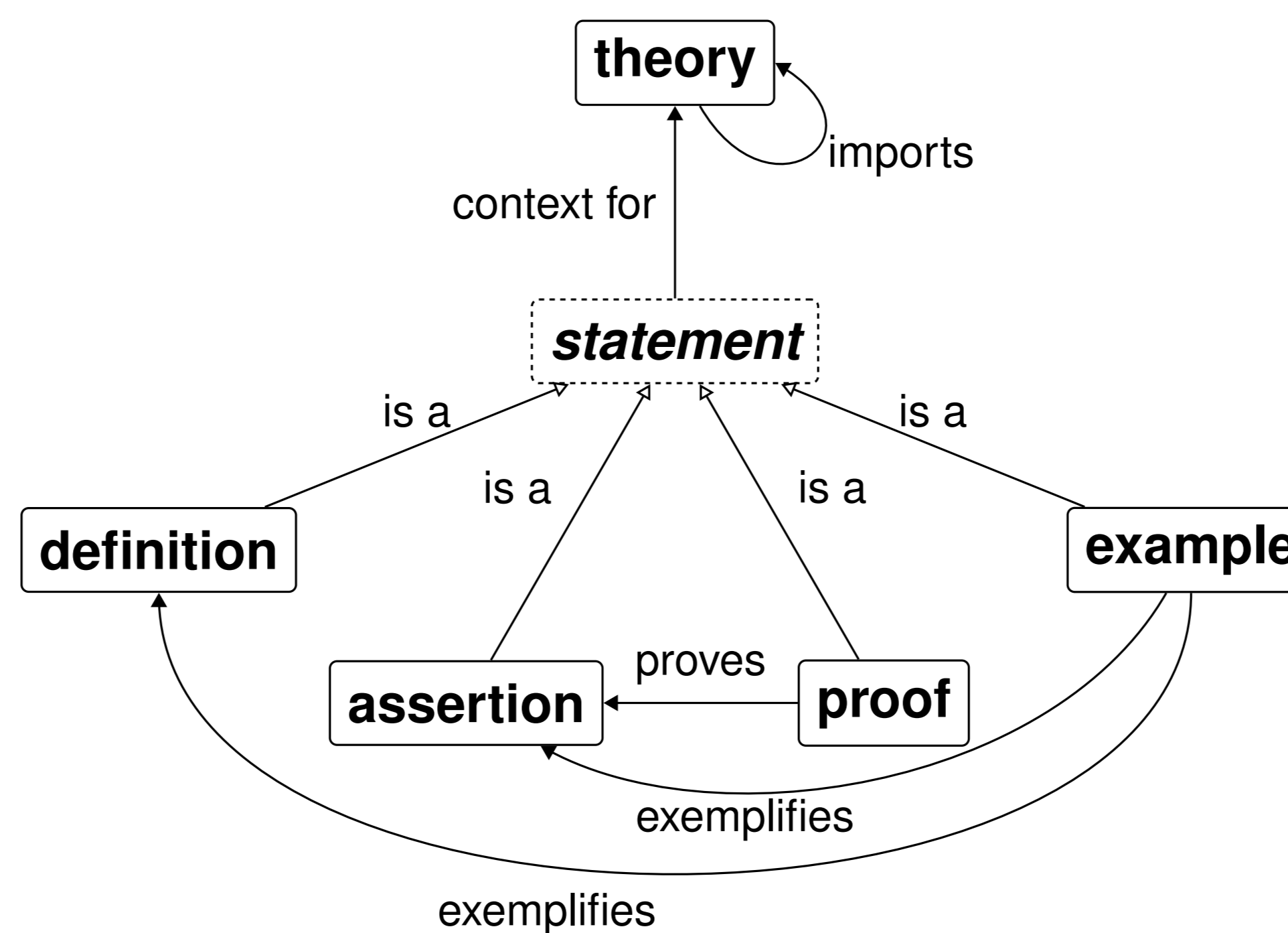
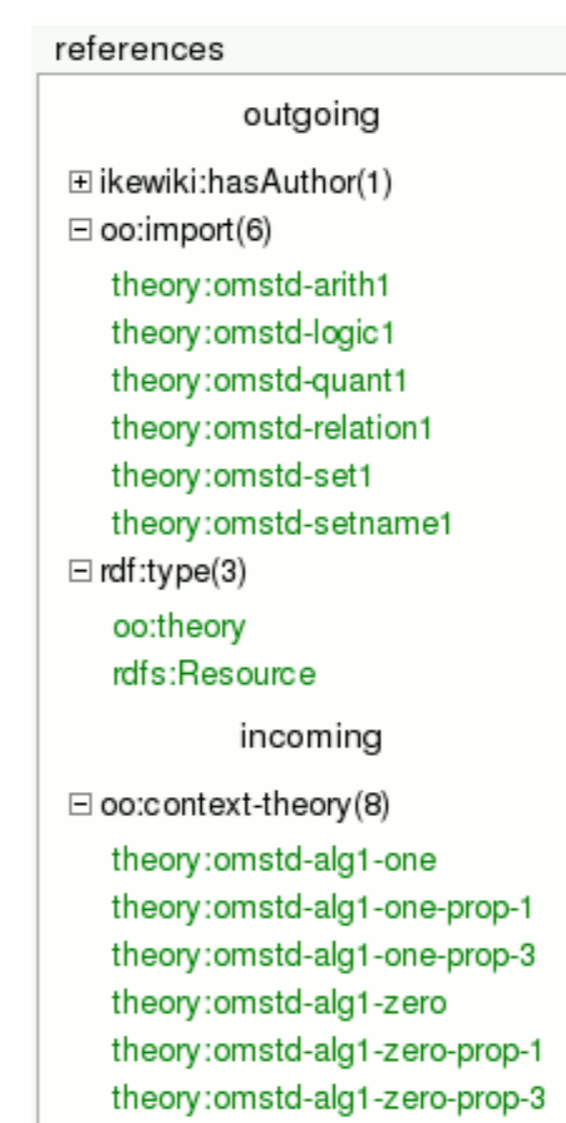
MKM ⇔ Semantic Wikis

- ⇐ • A semantic wiki can solve the “MK author’s dilemma” ...
- ... by immediately **rewarding the author** for his work.
- Results from research in ontologies can be applied to avoid breaking dependencies.
- ⇒ • The semantic web divides **data** (RDF-annotated XML fragments) and **context** (ontologies) ...
- ... while OMDoc documents (= mathematical **ontologies**) are referentially closed
- ⇒ ontological bootstrapping becomes possible
- SWiM is a **different semantic wiki**:
 - fixed syntax for annotations given in OMDoc
 - just need to facilitate editing of OMDoc and to extract semantic information

Design of SWiM

Concepts and Relations

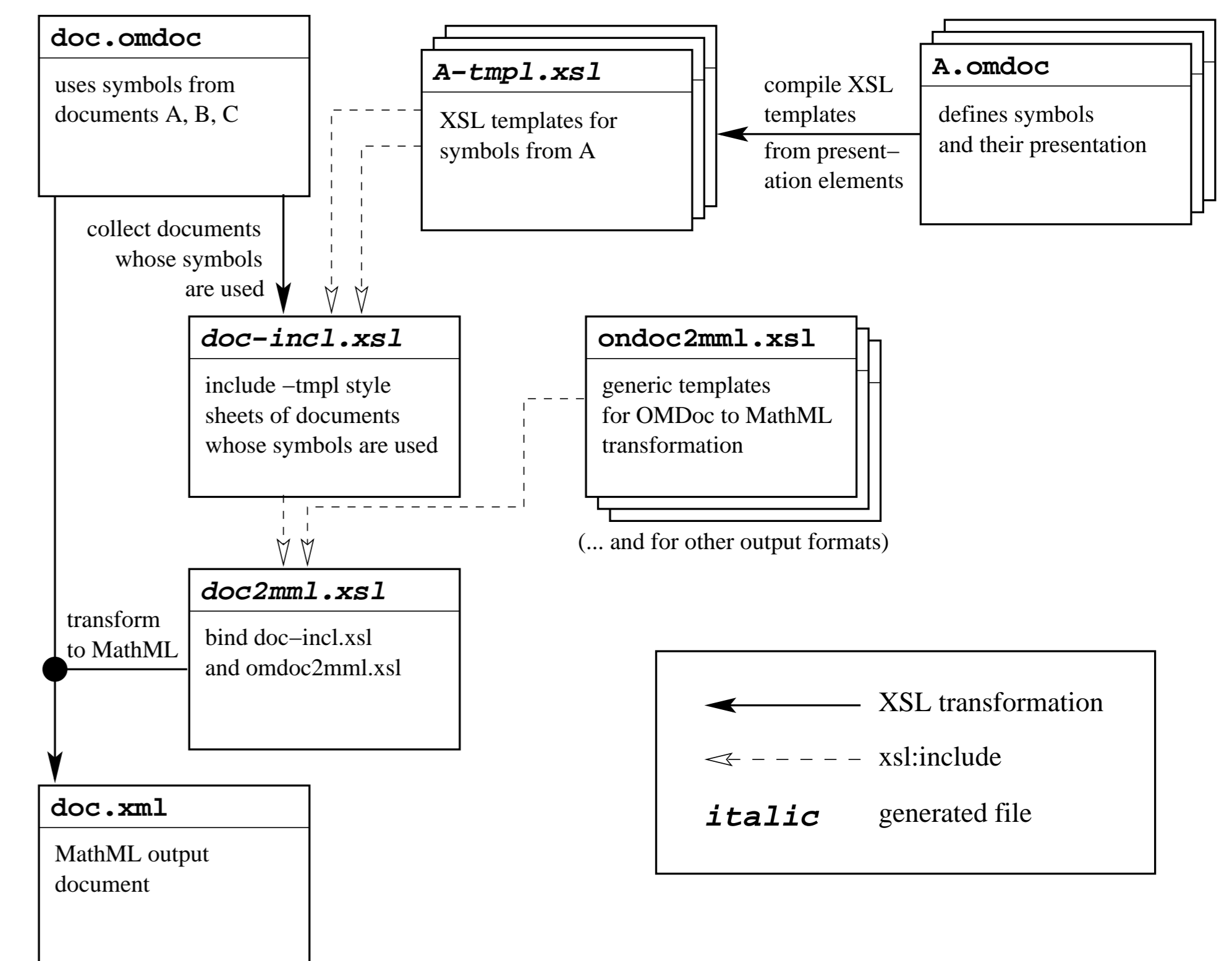
- Pages are the “atoms” of wiki content; in a semantic wiki: **1 page = 1 concept**
- **Small pages** are preferable for usability and mathematical reasons (“little theories”)
- Users keeping pages small are rewarded with more meaningful semantic relations displayed in the navigation box.
- Concepts and relations in OMDoc’s **system ontology** (i.e. in mathematics):



- **Manually annotate** ‘taxonomies’ that cannot easily be inferred (“all differentiable functions are continuous”)
- Consider relations given by **user interaction**: “Who edited which page when?”
- Infer **complex relations**: estimate degree of difficulty of a concept by counting unanswered questions on talk page

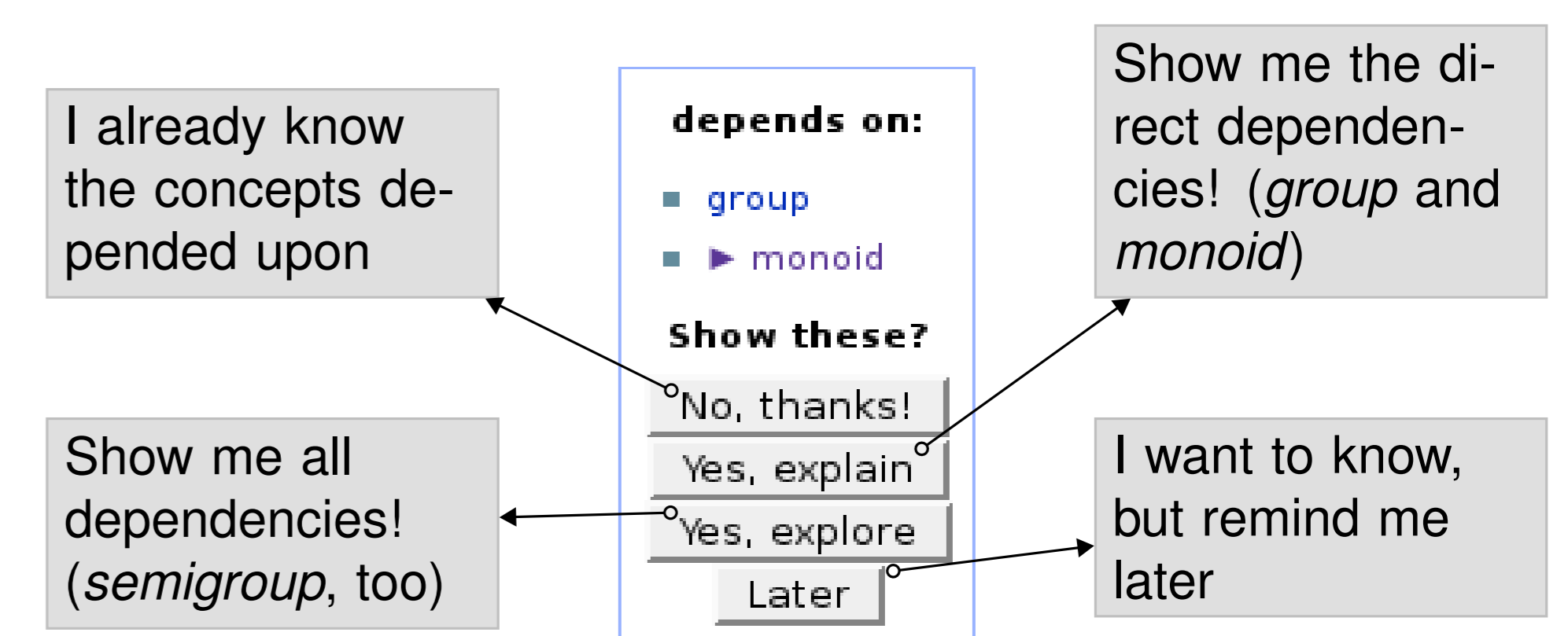
User Interface and Interaction Model

Render pages as XHTML+MathML; browsable source view



Transformation to XHTML+MathML

Editing: section-wise, simplified OMDoc/OpenMath



Interactive navigation on the transitive closure of the dependency relation between concepts (here: from *ring*)

Record the answers for **social bookmarking**. Many explanation requests ⇒ SWiM “learns” that concept is difficult.

Lightweight Management of Change

- **Versioned links**: href="p/version-id"
- Notify next editor of *p'* depending on *p* about updates to *p* happened in the meantime (⇒ **potential conflicts**)
- **Semi-automated link update** from *p/old* to *p/improved*
- ... if *p* has really been improved — not semantically changed!

Implementation Notes

- based on *IkeWiki* (SCHAFFERT et al.):
 - modular design
 - rich semantic web infrastructure
 - user assistance for annotation
 - orientation towards learning
- implemented so far: OMDoc rendering (source and XHTML+MathML) and extraction of semantic relations



SWiM will be a friendly editor, browser, development tool and learning environment for mathematical documents. It extracts metadata and implicit semantic relations from OMDoc and makes them explicit as RDF — thereby contributing to the semantic web.