

# System Description: KAT an Annotation Tool for STEM Documents

Mircea Alex Dumitru, Deyan Ginev, Michael Kohlhase, Vlad Merticariu,  
Stefan Mirea, and Tom Wiesing

Computer Science  
Jacobs University Bremen  
<http://kwarc.info>

**Abstract.** We present the KAT system, a browser-based annotation tool for linguistic/semantic annotations in structured (XHTML5) documents. As it is parametric in the annotation ontology and represents annotations as RDF, it can easily be integrated into RDF-based corpus management systems; we present an integration into the CorTeX system.

## 1 Introduction

Current natural language understanding systems do not work particularly well on mathematical and technical documents as they cannot deal with formulae, diagrams, and the special, technical vocabularies and discourse conventions of such documents. To retrain existing tools and evaluate new ones specifically developed for STEM documents, we need to establish manually annotated document corpora. Unfortunately, even the annotation tools used in computational linguistics do not work well with mathematical documents. The main problem is that they assume that the underlying documents are essentially sequences of characters – older systems do not even support Unicode strings. But with STEM documents, we need to be able to cope with mathematical/chemical formulae, tables, and diagrams, which form constitutive – and non-atomic – parts of the discourses. In a way the whole point of the exercise of extending linguistic methods to STEM documents is to cope with these new symbolic actors.

STEM documents are usually authored in *i*) word processors from the various office suites or *ii*)  $\text{\LaTeX}$  for printing or PDF distribution, or *iii*) directly in HTML for the Web – HTML5 has extended HTML4 with support for diagrams (SVG) and formulae (MathML). In all cases, the distribution formats DOCX, ODF, PDF, and HTML5 are not mere character strings, in fact the markup portions outweigh the text part by far. Therefore, simply annotating the serialization of the (Unicode) authoring syntax of the documents forbids itself, since the annotator would have to read and annotate the – essentially illegible – marked up text. Nevertheless, some existing systems, e.g. *brat* [BR], *Yawas* [YW], and *Annotatie* [AN] have been used to annotate STEM texts. The usual approach is to strip out the document markup and replace formulae by placeholder words such as “some-math317”. While such approach allows some linguistic annotations, the

placeholder words are structurally opaque and can therefore only participate in the linguistic relations to a very limited extent. In particular, we cannot annotate examples such as “*Let  $x \in \mathbb{R}$  be ...*”, where we would like to annotate the subformula “ $x$ ” as the grammatical subject of the sentence and the subformula “ $\in \mathbb{R}$ ” as an appositional elaboration to that (see [Wol13]). A way out of this would be to gloss – i.e. to “read out” – the formula into a phrase like “ *$x$  in the real numbers*” which can be annotated structurally, but this assumes a successful formula analysis which is either substantial work for the human annotator or the goal we wanted to facilitate with the annotation in the first place – Catch 22!

The KAT system takes the bull by the horns and realizes an open, parametric, browser-based annotation system for HTML5 that takes ideas from *brat*, *Yawas*, and *Annotatie*. We give a brief overview over the system here and refer the reader to the KAT manual [Dum+14] for details.

## 2 System Architecture and Realization

As KAT is based on XHTML5, we can employ the XML tool chain and rely on standard libraries for the implementation. In particular, we can use uniform resource identifiers (URI) to identify text fragments and represent annotations in RDF – subject/predicate/object triples where the components are URI references to web resources. The subjects are usually text fragments,

the objects are as well (for relational annotations) or alternatively are concepts from an annotation ontology (for classificational annotations). The predicates are always properties and relations defined in the annotation ontology.

The KAT system itself is realized as a JavaScript library which instruments an XHTML5 document in a browser. To simplify the URI-based referencing of text ranges (node-sets in the HTML document object model) KAT assumes that the document has been word- and sentence-tokenized; the tokens are wrapped in HTML `span` elements that carry unique `id` attributes corresponding to the TEI guidelines. The annotation workflow itself is form-based as shown in Figure 2: the annotator selects a text range, and is then given a modal form to fill classifications and relations as required by the annotation ontology. The annotations are stored as RDF triples in the browser’s local storage and can be visualized by special pop-ups and arrows (see Figure 2).

KAT is not tied to a particular annotation ontology (or ontology format). At startup, the system is reads a set of **KAT bindings** – custom XML files that

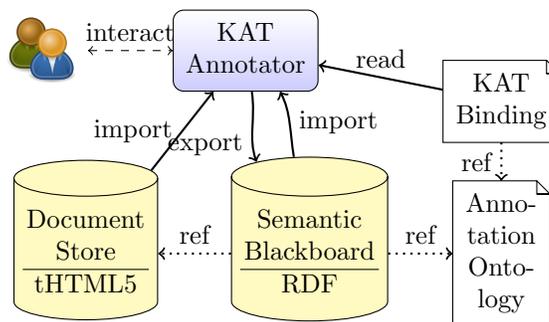
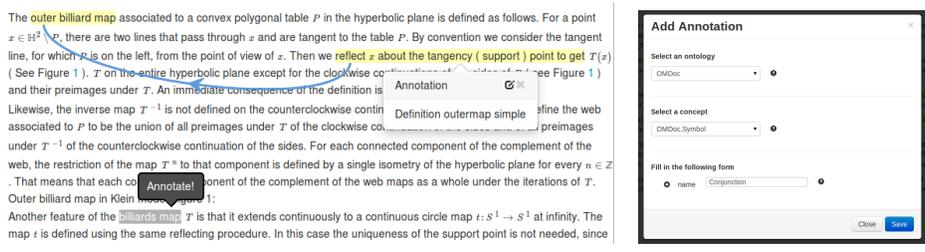


Fig. 1. The KAT System Architecture



**Fig. 2.** Annotating in KAT: Selection and Form-Filling

describe the annotation interface, the constraints between the components of an annotation frame, and the RDF to be produced. The frame of OMDoc symbols used in Figure 2, is given by the fragment of a KAT binding in Listing 1.1. It specifies *i)* the fields of the annotation form, their values and validation constraints, *ii)* their display, and *iii)* the RDF subgraph for the frame via a templating mechanism. Note that this frame classifies the annotated word as an OMDoc symbol (via the `rdf:type` predicate) and relates it to its name via the `o:symbolname` relation from the OMDoc ontology.

**Listing 1.1.** A KAT Frame Specification for OMDoc Symbols

```

<frame name="Symbol" >
  <help>An OpenMath/OMDoc Symbol</help>
  <fields>
    <field name="name" type="text" >
      <help>The name of the symbol defines it in a theory</help>
      <value>Name</value>
      <default>Symbol</default>
      <validation>[A-Z][a-z]*</validation>
    </field>
  </fields>
  <display> ... </display>
  <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
    <rdf:Description xmlns:o="http://omdoc.org/ontology#" >
      <rdf:type rdf:resource="http://omdoc.org/ontology#Symbol" />
      <o:symbolname>{name}</o:symbolname>
    </rdf:Description>
  </rdf:RDF>
</frame>

```

Even though KAT can work as a standalone library that can be added to any STEM document in HTML5, it is best used as a component of a corpus management system, such as the CorTEX system [CT] developed by the second author. In this situation the annotator requests an annotation task from CorTEX, which serves the TEI-tokenized document with KAT and a set of bindings for the intended annotation ontologies. When the annotation is complete, the generated RDF is exported to the semantic blackboard – an RDF triple store maintained by CorTEX. When combined with CorTEX, KAT can be used by multiple annotators; and can be used to review existing annotations, by importing them from the triple store. KAT also has experimental support for inter-annotator agreement reviews via a side-by-side view of the various annotations.

### 3 Conclusion & Future Work

We have presented the KAT system, an open, parametric, and browser-based annotation system for STEM documents encoded in HTML5. The code base is released under the Gnu Public License and is available at [KG]. The system is in an early state of development, but can already be used for practical annotation and annotation review work. The user interface both needs and is yet to undergo serious usability testing and polish, to both improve productivity and also to fully stabilize it for production use. The next steps will be to refine our annotation ontologies and integrate more linguistic ontologies to get more coverage. Also we want to start work on preparing a small annotated corpus of mathematical documents.

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