MathDox editor

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Abstract. We describe the MathDox Editor, a web based editor for easy creation of semantically rich mathematical documents, enriched with services for computations and translation to various formats.

1 Introduction

For several decades TEX and LATEX have been the de facto standards for authoring mathematical and technical documents. However, as the Web is increasingly important for all kind of purposes, including scientific communication and education, new forms of mathematical markup are gaining importance. Indeed, MathML [17], both presentation and content, and OpenMath [23] are relatively new markup languages for mathematical expressions that get more and more attention. These new standards offer new posiblities. In particular, the semanticaly rich presentation of mathematics with content MathML and OpenMath make it possible to easily connect to mathematical services, like computer algebra systems, or to translate the mathematics to other formats. However, putting mathematical expressions and documents on the Web is still difficult.

In the past decade, several companies and research institutes have developed mathematical expression/formula editors. These editors usually aim to describe the visual appearance. The Amaya [1], LyX [13], TeXmacs [29] and MathType [18] editors are using MathML Presentation, LATEX, or native formats to store expressions for describing the expression appearance. Only a few formula editors like MathEX [8], Sentido [27] and Wiris [31] use MathML Content or OpenMath to capture the meaning of expressions. (For a larger list of formula editors, see [5].)

These editors can often be integrated as a plugin with Web-based (X)HTML-editors, like FCKeditor [12] or tinyMCE [30], that run in a browser. Usually these editors are then opened in a seperate window or frame and the user has to create a formula inside this seperate window and paste it in to the document.

We report on a new Web-based tool under development at the TU/e, called *MathDox Editor*, for the interactive entering and editing of *semantically rich* mathematical documents and expressions. The (envisoned) features of the MathDox editor are:

- Rich mathematical document structure (theorem, lemma, proof etc).
- Inline editing of mathematical formulas;

– Semantic presentation of mathematics in OpenMath;
– Basic output format MathDox (an extension of DocBook with OpenMath) [14];
– Various output formats through XSL-transformation: XHTML-MathML 2.0 and 3.0, ODF-MathML, LaTeX;
– Access to computational back engines (e.g. Computer Algebra Systems, like Mathematica, Maple and Maxima, GAP, or other OpenMath enabled mathematical software).

This online editor is envisioned to be used inside (mathematical) e-learning tools, such as learning and content management systems, forums, (mathematical) assessment systems etc., but also for writing short notes and mathematical webpages. Using XSL Transformations the MathDox Editor can be adapted to create and modify a (subset) of various document formats.

The MathDox Editor targets at researchers, educators and students in all fields of science, math and technology, both at high school and university level.

The MathDox Editor and its components will be made available as open source software.

2 MathDox Editor and its Components

The MathDox Editor consists of four components: a text editor, a formula editor, XSL transformation services, and computational services. The heart of the system consists of the text editor with integrated formula editor. This part is developed in JavaScript. XSL transformations and computational services are offered as add-ons to the system.

For each of the components of the MathDox Editor we have developed a proof of concept. These can be found at

`http://www.mathdox.org/MathDoxEditor/`

We give a short description of the components and indicate the plans for further development within the project.

Mathematical Text Editor. This text editor is a web based editor for creating MathDox source code. The editor uses similar techniques as in popular (X)HTML editors like tinyMCE [30] or FCKeditor [12], or the editor WYMEditor [32], which is more oriented towards semantics. A proof of concept of a Text Editor has been set up. To extend the text editor to a mathematical text editor, the following four tasks can be distinguished:

– To make inline editing of mathematical formulas possible we will integrate formula editors (see below) in the text editor. Therefore JavaScript functions have to be developed to add, check, enable usability and remove these formula editors within the Text Editor.

Because the MathDox Formula Editor is an inline editor and is written in Javascript it is well suited for use inside the MathDox Editor. As it is being actively developed by the same group, it is easy to extend this Formula Editor where needed.
- After deciding which (mathematical) structures are desirable in a document, restrictions have to be build using JavaScript to filter and check the structure of the edited text (theorem, lemma, proof, etc.)
- On finishing the editing of a document, the contained formula of each inline Formula Editor has to be embedded in the (mathematical) structured (X)HTML document using JavaScript. This has to be done in such a way that reloading this document in the editor wil give a user the same visible result.
- The (X)HTML structure of the document created by the text editor has to be transformed into proper MathDox source, that might also be used as input for the text editor.

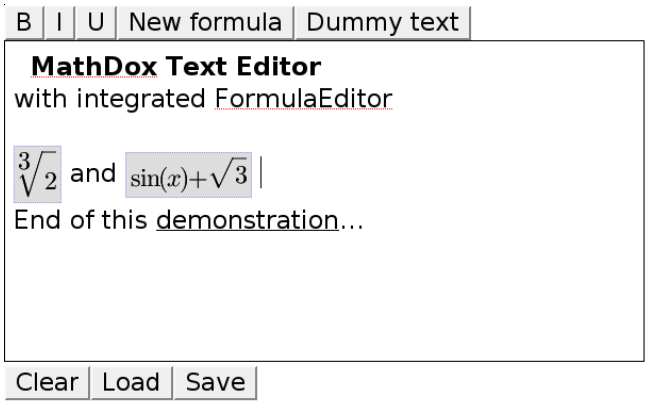

Fig. 1. MathDox Editor with inline math editing

MathDox Formula Editor. The MathDox formula editor is a web-based editor for mathematical formulas. It is currently being developed at the Technische Universiteit Eindhoven as a means for students to enter formulas in an e-learning environment. Its main features include:

- It has a two-dimensional WYSIWYM (what you see is what you mean) interface.
- It allows for editing with help of a palette but also *inline linear input*.
- The input field for a formula automatically resizes to the right size.
- It can produce a semantic representation of the formula in OpenMath.

– No plugins need to be installed in the browser to use the editor.
– It can be easily integrated into existing HTML pages.
– It is available under an open source license.

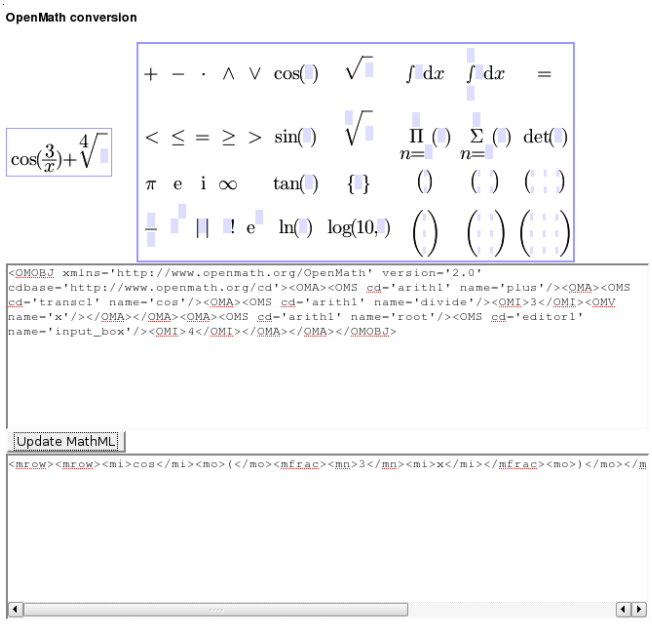

Fig. 2. MathDox Formula Editor

The editor is written in Javascript and uses the HTML5 canvas element in combination with jsMath sprite fonts to render mathematics.

The MathDox Formula Editor functions by adding a Canvas for an HTML TextArea (with the class mathdoxformulaeditor), and rendering the HTML TextArea invisible. On this Canvas the formula is then drawn. After a click on the Canvas it gains focus and the user can enter formulas. It is also possible to enter (complicated) symbols, like matrices or roots, from a palette. When the formula changes, the TextArea is updated. In this way the MathDox Formula Editor can be used in an HTML Form, and the produced input will be an OpenMath string.

Currently this editor has only been tested in Mozilla Firefox (v2 and v3) and Microsoft Internet Explorer (v6 and v7).

The planned extensions to the formula editor include

– Extend with new symbols;
– Make selection, copy and paste of subformulas possible;
– Add computational services (see below);

– Adapt to other browsers supporting the HTML canvas element;
– Provide plugin for other web based editors like tinyMCE and FCKeditor.

XSLT services. XML is designed so that it can be transformed easily. A way of doing this is by using XSLT stylesheets. To transform OpenMath to a native language of a computer algebra system (CAS) we have written several, so called, *phrasebooks*. Some of these are implemented in Java, others in XSLT. It is possible to use this functionality as a web service. On submitting OpenMath input, the resulting native language is returned. The services are designed in a way that it is easy to add new services for XSLT stylesheets (including version 2.0). They can therefore be easily extended to convert XHTML+OpenMath to MathDox, and from there into other formats. The MathDox Editor output is an XML document in MathDox source, that can be transformed by the use of appropriate XSL transformations. MathDox will allow us to use the open source stylesheets already available for DocBook translation.

We want to provide XSLT services that translate MathDox output into

– XHTML-MathML;
– ODF-MathML;
– LaTeX.

We have set up a default service that with the appropriate XSL stylesheet will perform the required transformations.

Computational Services. Translation services are nice, but it would be much nicer to have services that do computations and return the result (preferably in OpenMath). It is possible to use libraries for this, like the ones already developed by us, or the libraries under development for SCIENCE [26]. However, various security problems arise (denial of service, some computer algebra systems allow to read files, or start shells), that should be looked after before these services can be offered.

We will offer computational services to

– Mathematica [16];
– Maxima [19];
– GAP [4].

Another thing that would be nice to have is a services that converts LaTeX (which can be created from MathDox) into PDF. It should be possible in Java to allow LaTeX to only be able to read its input and library files. This possiblity will be investigated.

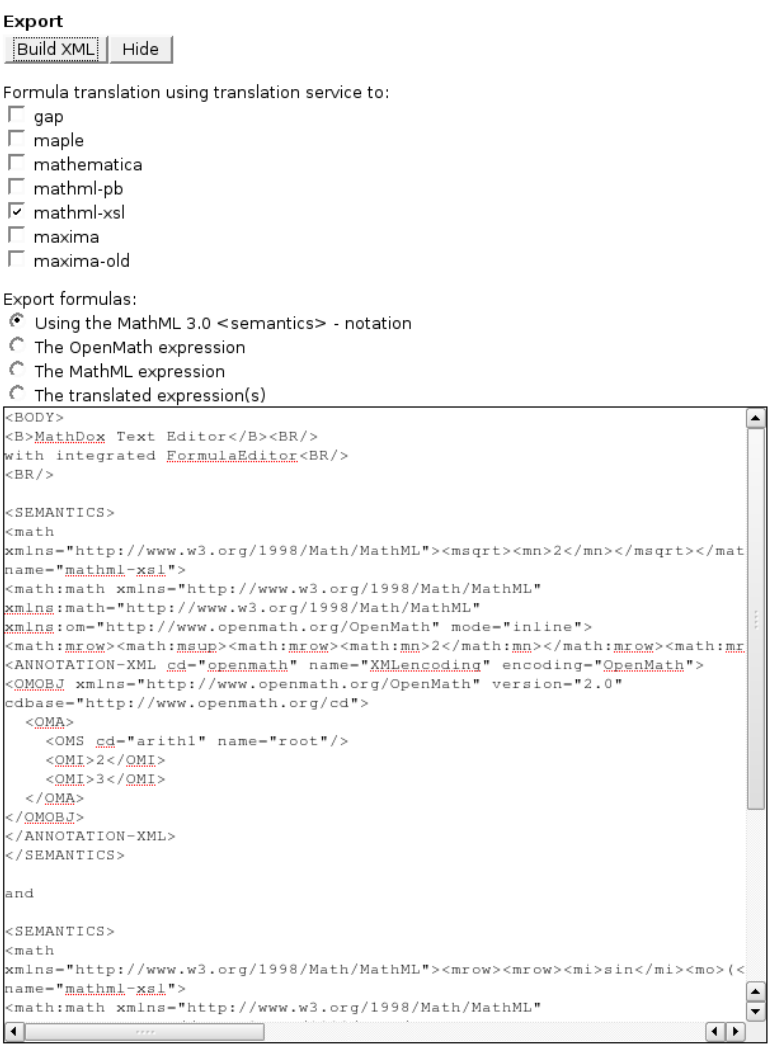

Fig. 3. XML output with MathML and OpenMath encoding of math, obtained by XSL transformations

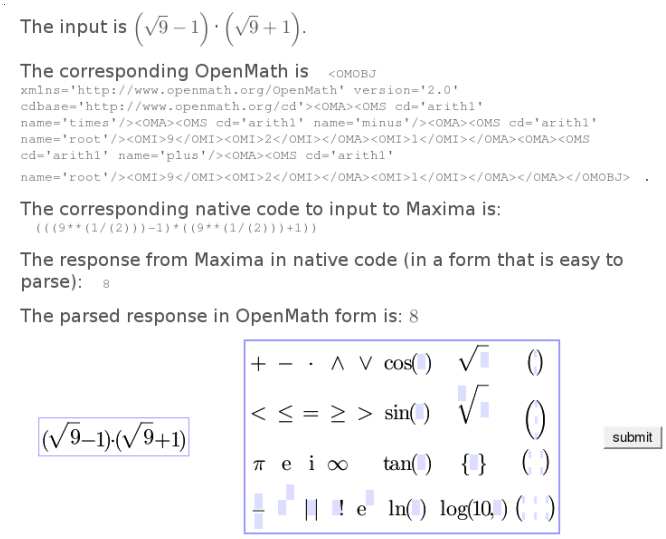

Fig. 4. Communication with a CAS

3 Future Plans

We list some future plans:

- Extend the text editing functionalities in various ways to make the Mathdox editor a complete mathematical document editor.
- Add interactive graphics to the editor, e.g. via JSXGraph [11].
- Provide the MathDox editor as a browser plugin, e.g. for Firefox.
- Provide the MathDox editor as plugin for some Learning Managment Systems like Moodle [21] or Sakai [25] and Content Management Systems like Drupal [3] or Joomla [10].
- Make the contents created by the MathDox Editor available to the visually impaired by adding XSL transformations to various forms of mathematical Braille and by transformations to VoiceXML and SSML for automatic speech generation.
- Embed the MathDox editor in the MathDox Exercise Editor [15].
- Add translations to other formats, like OMDOC [22], TBook [28] or DITA [2].

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