Mathematical Abstract Document

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Introduction

MAD (*Mathematical Abstract Document*) is a document preparation system integrated with MAPLE. MAD provides a simplified model for describing a collection of logically structured documents with mathematical content. MAD also provides routines for manipulating the data structure that represents such documents and for exporting this data structure into standard formats, such as LaTeX, PostScript, PDF and HTML.

Integrating MAD into a computer algebra system such as MAPLE brings the following original features:

- the *automation* of the computation and of the typesetting of mathematical formulæ, graphs and tables;
- the *automation* of the building of documents thanks to the underlying programming language.

Example: orthogonal polynomials

This example illustrates how to use MAD to *build* documents on the orthogonal polynomials. This example produces 7 files; these documents list the N first polynomials for each family of orthogonal polynomials.

```
N := 10;
polylist := map(op,[indices(orthopoly)]);# list of polynomials
for i in polylist do
lnames := [op(1,eval(orthopoly[i]))];# list of names of variables
polyname := &mathseq(&operatorname(i),&superscript(&sepsequence(comma,op(2..-2,
lnames))),&subscript(lnames[1]),&()(lnames[-1]));# math mode name
link[i] := &link([i],&imath(polyname));# link to a document
# one document per othogonal family
doc[i] := Document(Section(&seq("Orthogonal polynomial",&imath(polyname)),label=[i],
Section(&seq("First",&imath(N),"polynomials"),seq(Equation(subs(lnames[1]=j,polyname)
=eval(orthopoly[i](j,op(2..-1,lnames)))),j=0..N)),
Section("Navigation",&link(nextpoly(i),"Next"),&link([main],"Up"),
&link(backpoly(i),"Back"))));
od;
# main document
Doc := Document(file=[orthopoly],Chapter("Orthogonal polynomials",label=[main],
Paragraph(seq(link[i],i=polylist)),seq(doc[i],i=polylist)));
```

Translators

A translator to a target format allows to translate the MAD format into the target format. A translator is an *independent* piece of software that *only* provides the format-specific pieces of code. The design of splitting the implementation between generic code and format-specific code makes the entire system MAD easily maintainable and also extendable, since the development of new translators requires relatively little work.

The way the documents look (*i.e.* their *styles*) is to be set at translator level. Two translators are currently available.

– *Translator to LaTeX*. In order to have more control over spacing and line-breaking, this translator produces AMS-LaTeX. The most important part of the translator lies in its implementation of the mathematical format. A recursive computation of approximate widths and heights of TeX boxes determines the appropriate sizes for parentheses and brackets, as well as the appropriate locations of line-breaks. The formats PostScript and PDF are produced from the LaTeX source by standard tools (`dvips` and `pdflatex` respectively).

– *Translator to* HTML. This translator produces HTML 4.0. Mathematical formulæ are displayed as GIF or PNG pictures, which are produced by the script **`htmx`** from the output of the previous translator. Note that, instead of pictures, mathematical formulæ could be rendered in other formats (*e.g.* MathML). Note that HTML could also be produced directly from the LaTeX output by tools, such as `hevea` and `latex2html`.

Abstract document

MAD allows to concentrate on the semantics of the content and its logical architecture within the document.

An abstract document is represented by a recursive data structure of documents, chapters, sections and paragraphs. The paragraphs are the leaves of the data structure and they are meant to hold the content of the document. This content is made up of plain text, mathematical formulæ (inline and 2D), graphs, cross-references, lists, tables, ...

Allowing the nesting of sectioning descriptors into each other simplifies the syntax. For instance, the single MAD command `Section` is mapped to the LaTeX counterparts `\section`, `\subsection`, `\subsubsection`, ... according to the nesting depth of the descriptor. Allowing nested documents is another facility for expressing a *collection* of abstract documents that are actually spread over several physical files as a single data structure. Note here that the physical mapping onto files and the logical structure of a collection of documents are totally independent.

MAD also supports cross-references (hyperlinks). The system of cross-references can be incrementally updated, which allows to refer to documents that are generated in different MAPLE sessions.

Mathematical formulæ

The semantics of a mathematical object is kept in the MAPLE format, from which other formats, such as MathML and OpenMath can be derived. The display, however, is encoded in a simple pretty printing format that describes the relative positioning of the operands within the mathematical expression. This format supports the automatic line-breaking of large expressions and the adjustment of the height of sized symbols (*e.g.* parenthesis). This format involves a reduced set of 14 primitive instructions and it is easily mapped to LaTeX.

Example: orthogonal polynomials (continued)

The main abstract document that has been built in the first part of this example can now be exported into several output formats using *translators*, by invoking the command

```
Export(Doc,LaTeX,format=[dvi,ps,pdf]);# produce dvi, PostScript, PDF
Export(Doc,HTMX,format=[html]);# produce HTML 4.0
```

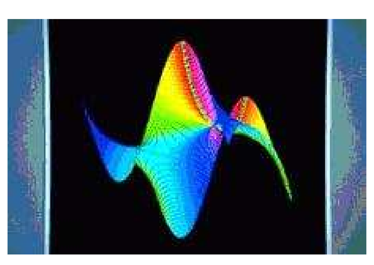
A portion of compiled LaTeX output is shown here in order to demonstrate the automatic line breaking algorithm.

$$G_5^a(x) = \frac{4a(a+1)(a+2)(a+3)(a+4)x^5}{15} - \frac{16a(a+1)(a+2)(a+3)(a+4)x^3}{48+12a} + \\ \frac{32a(a+1)(a+2)(a+3)(a+4)x}{32(a+4)(a+3)}$$

Availability

- The system MAD is used to generate the interface of the Encyclopedia of Special Functions [1], which can be seen at `http://algo.inria.fr/esf`.
- The system MAD is implemented in MAPLE and forms a standalone software that is distributed under GNU Lesser General Public Licence (LGPL) and is available at `http://algo.inria.fr/meunier`.
- The software has been designed to be easily customized (several options and parameters are available) and extended (new translators can be added).

[1] Ludovic Meunier and Bruno Salvy. ESF: An automatically generated Encyclopedia of Special Functions. In *ISSAC'03*, 2003.



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