1 Introduction

We will show how to semantically mark up mathematics in the sTeX format [**Kohlhase:ulsmf08**] and how to convert it into OMDoc [**Kohlhase:OMDoc1.3**].

We have some mathematical material in Subsection 2.2 which will serve as example content. In the rest of this section we will explain the setup of the example and present an approach to automation of the OMDoc conversion via Unix Makefiles.

1.1 The Setup

The source of this note is contained in the file `paper.tex`. We call it the **target**, since formatting it with LaTeX will generate the main document. The content in Subsubsection 2.1.1 and Subsubsection 2.1.2 comes from included files `continuous.tex` and `differentiable.tex`, we will call them **module** s, since they may be used (i.e. included) by other target documents as well.

As the modules are built for inclusion into other documents, they are not self-contained:

1. they do not contain a LaTeX preamble and `\begin`/`\end{document}`, and
2. they may depend on other modules, whose semantic macros they need to include,
3. to facilitate this a module file `modf.tex` comes with a "semantic macro short form" `modf.sms` that can be included without generating output in the PDF.

This will have consequences for the automation. Concretely, the module on differentiable functions in Subsubsection 2.1.2 depends on that for continuous functions in Subsubsection 2.1.1. Both of them depend on modules for real numbers, sets and functions that we do not want to cover in this note. We assume that they have already been marked up with the same methods as we describe here and are accessible to us and call them **background module** s. In our setup we keep them in the subdirectory `background`.

1.2 Formatting and OMDoc conversion

To format an sTeX document — i.e. to produce a PDF file from the sTeX marked-up sources — we only need to run the `pdflatex` program over the target document — assuming that all modules (regular or background) have semantic macro short forms.

To convert an sTeX document to OMDoc, we need to run `latexml` over it, post-process the result by `latexmlpost`, and finally massage away all remaining LaTeXML islands with a stylesheet, see [**Kohlhase:ssmtl***] for details.

1.3 Makefile-based Automation

As the conversion to OMDoc is rather complex (the programs in the three steps take a variety of options), we support an automation by Unix Makefiles. There are three main `make` targets.

`make omdoc` will trigger the OMDoc transformation of the target document.

`make mods` will trigger the OMDoc transformation of the modules.

`make pdf` will trigger the LaTeX formatting the target

`make mpdf` will trigger the LaTeX formatting the modules

`make sms` will trigger the re-generation of all semantic macro short forms of modules (this is implicitly called in all the other `make` targets)

To use this, we need to set up a `Makefile` of the following form:

```
STEXDIR = ../..
TARGET = paper.tex
MODSLIBDIR = ../background
BIBINPUTS = $(PREFIX)/lib/bib:

include $(STEXDIR)/lib/make/Makefile.vars
 all : pdf mpdf
include $(STEXDIR)/lib/make/Makefile.in
```

The variable STEXDIR has to be set to the main directory of the sTeX distribution. The variable TARGET specifies the target document (all other `*.tex` files that are not excluded in the BUTFILES variables are considered as modules). Here, the `background` directory for convenience. The MODSLIBDIR specifies the location of the prefix and postfix files `pre.tex` and `post.tex` that will be prepended and appended to the modules to make them into complete files TeX files that can be converted. The last three lines just include the Makefiles from the sTeX distribution and configure the default make target (`make all`) to be produce the pdf version

Note that in the directory `background` we have a very similar Makefile as above. The only differences are that the variable STEXDIR is adapted and that the BUTFILE variable is set to `pre.tex` and `post.tex`, so that they are not converted. In the directory `background` we have followed good practice by establishing a phony

2 Mathematical Content

2.1 Calculus

We present some standard mathematical definitions, here from calculus.

2.1.1 Continuous Functions

Definition 2.4 A function $f\colon \mathbb{R} \to \mathbb{R}$ is called **continuous** at $x \in \mathbb{R}$, iff for all $\epsilon > 0$ there is a $\delta > 0$, such that $|f(x) - f(y)| < \epsilon$ for all $|x - y| < \delta$. It is called **continuous on** a set $S \subseteq \mathbb{R}$, iff is is continous at all $x \in S$, the set of all such functions is denoted with $\mathcal{C}^0(S, T)$, if $f(S) \subseteq T$.

2.1.2 Differentiable Functions

Definition 2.6 A function $f\colon \mathbb{R} \to \mathbb{R}$ is called **differentiable** at $x \in \mathbb{R}$, iff for all $\epsilon > 0$ there is a $\delta > 0$, such that $\frac{|f(x)-f(y)|}{|x-y|} < \epsilon$ for all $|x - y| < \delta$.

2.2 A Theory Graph for Elementary Algebra

Here we show an example for more advanced theory graph manipulations, in particular imports via morphisms.

Definition 2.7 A **magma** is a structure $\langle G, \circ \rangle$, such that G is closed under the operation $\circ\colon G \times G \to G$.

Definition 2.8 A magma $\langle G, \circ \rangle$, is called a **semigroup**, iff $\circ$ is associative.

Definition 2.9 A **monoid** is a structure $\langle G, \circ, e \rangle$, such that $\langle G, \circ \rangle$ is a semigroup and e is a **neutral element**, i.e. that $(x \circ e) = x$ for all $x \in G$.

Definition 2.10 In a monoid $\langle G, \circ, e \rangle$, we use denote the set $\{x \in S \mid x \neq e\}$ with S^*.

Definition 2.11 A **group** is a structure $\langle G, \circ, e, i \rangle$, such that $\langle G, \circ, e \rangle$ is a monoid and i acts as a **inverse**, i.e. that $(x \circ i(x)) = e$ for all $x \in G$.

Definition 2.12 We call a group $\langle G, \circ, e, i \rangle$ a **commutative group**, iff $\circ$ is commutative.

Definition 2.13 A **ring** is a structure $\langle R, +, 0, \cdot, 1, - \rangle$, such that $\langle R^*, \cdot, 1 \rangle$ is a monoid and $\langle R, +, 0, - \rangle$ is a commutative group.

3 Conclusion

In this note we have given an example of standard mathematical markup and shown how a a sTEX collection can be set up for automation.