

Tools For Creating Accessible Documents

L^AT_EX, TeX4ht, and MathML

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Outline

- 1 Motivation
- 2 Rendering math content
 - The old ways of doing it
 - And the present
- 3 The tools
 - \LaTeX
 - MathML
 - TeX4ht
- 4 How to do it?
 - converters to MathML
 - MathML editors and viewers

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What is accessible ?

An *accessible* document is understood here in the same way [W3C Accessibility Initiative](#) understands it [1].

Roughly speaking, a web document is *accessible*, if there exists an alternative way to convey some (if not most) of its content to visually and/or hearing impaired users. Although rarely those alternative ways preserve the quality/fidelity of the original content, this happens to be the case for documents with mathematics, physics, chemistry, or engineering notations.

In this talk, I will describe some of the tools for creating such accessible documents.

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Rendering math content

The tools

How to do it?

Summary

First, text (ascii) is accessible,

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unless one tries very hard to make it inaccessible.

So, text is accessible and thus, the following content:

The old river in its broad reach rested unruffled at the decline of day, after ages of good service done to the race that peopled its banks, spread out in the tranquil dignity of a waterway leading to the uttermost ends of the earth.

- Joseph Conrad, Heart of Darkness, Part 1

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Indeed, there are many screen readers that speak the text. [Fire Vox](#) is an Open Source, freely available talking browser extension for Firefox web browser created and maintained by Charles Chen. You can think of it as a screen reader that is designed especially for Firefox and is available for Linux/Mac/Windows platforms.

And here is *Fire Vox* in action.

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Let us take an extreme case of the classic drip painting by Jackson Pollock (1948), No.5 (sold in 2006 for \$140 million):

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Let us take an extreme case of the classic drip painting by Jackson Pollock (1948), No.5 (sold in 2006 for \$140 million):



And other, not so extreme, cases . . .

from Symphony No. 9, by Dvorak

And what about this?

What about math?

Nowadays, making the mathematics notation accessible to visually impaired is rather easy, including the expression below,

$$\int \frac{mv}{mg - kv^2} dv = \int dy \implies -\frac{m}{2k} \ln |mg - kv^2| = y + d_1 \implies$$

$$mg - kv^2 = d_2 \exp\left(-\frac{2ky}{m}\right) \implies v^2 = \frac{mg}{k} \left[1 - d_3 \exp\left(-\frac{2ky}{m}\right)\right]$$

or this diagram,

$$\begin{array}{ccccc} \mathbb{C} & \xrightarrow{H_1} & \mathbb{C} & \xrightarrow{H_2} & \mathbb{C} \\ P_{c,3} \downarrow & & P_{\bar{c},3} \downarrow & & \downarrow P_{-c,3} \\ \mathbb{C} & \xrightarrow{H_1} & \mathbb{C} & \xrightarrow{H_2} & \mathbb{C} \end{array}$$

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First, there were images . . .

In hypertext (html or xml) documents, each of the following mathematical expressions:

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \int_{-\infty}^x e^{-\frac{(t-\mu)^2}{2\sigma^2}} dt$$

$$f(\epsilon, \delta s) \approx \frac{1}{\xi\sqrt{\frac{2\pi}{\kappa}(1-\beta^2/2)}} \exp\left[\frac{(\epsilon - \hat{\epsilon})^2}{2} \frac{\kappa}{\xi^2(1-\beta^2/2)}\right]$$

$$\frac{d^2x}{dt^2} + \sin(x) = \sin^{10}\left(\frac{t^2}{1+t^2}\right), x(0) = 0, \frac{dx}{dt}(0) = 1$$

was represented as graphics (gif, or png) images.

And here is an example of how it worked.

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Now, mathematics/scientific content can be rendered natively in browsers.

Indeed, almost all mathematical expressions can be now represented as the hypertext content, i.e., without resorting to the use of graphics images.

Next, I will describe what is involved.

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The theme... , \LaTeX and \TeX

- What is \LaTeX ? What is \TeX ?
 - \LaTeX is a markup language (as `groff/troff` and `html` are) for representing structured documents.
 - \TeX is a high quality typesetting program offering extensive desktop publishing features and automation, such as numbering and cross-referencing, tables and figures, detailed page layout, bibliographies, and indexing. Also, \TeX/\LaTeX is the only **VIABLE** tool for creating high quality documents that contain math/physics/chemistry/biology/engineering notations. In contrast to most word processors, where one sees the document more or less as it will look when printed, \LaTeX focuses on the meaning of what is being written without distractions by the visual presentation of the information.
- Very simple examples of \LaTeX and `html` source codes:
 - Side by side source codes for `\LaTeX` and `html`

The theme... , L^AT_EX and T_EX

- What is L^AT_EX? What is T_EX?
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 - T_EX is a high quality typesetting program offering extensive desktop publishing features and automation, such as numbering and cross-referencing, tables and figures, detailed page layout, bibliographies, and indexing. Also, T_EX/L^AT_EX is the only **VIABLE** tool for creating high quality documents that contain math/physics/chemistry/biology/engineering notations. In contrast to most word processors, where one sees the document more or less as it will look when printed, L^AT_EX focuses on the meaning of what is being written without distractions by the visual presentation of the information.
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What is document markup ?

- In a word processor, one sees the document more or less as it will look when printed;
- Working with a *markup language* is different. For example, to emphasize the phrase `detailed description` in LaTeX source code, one has to type: `\emph{detailed description}`;
- Markup languages have always dominated typographic work of high quality;
- LaTeX is a markup language designed and implemented by Leslie Lamport (1994) in *A document Preparation System*, based on Donald E. Knuth's (1984) *The TeXbook*.

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- What is MathML?

- **MathML** is an application of **XML** for describing mathematical notations and capturing both its structure and content. It aims at integrating mathematical notation into World Wide Web documents so they can be accessible to the visually impaired
- As \LaTeX , XML is a markup language for representing structured documents. However, in contrast to \LaTeX , XML is **NOT** page layout language. Also XML is an interchange and manipulation interface designed for machine.

- Very simple examples of \LaTeX and *MathML* codes:

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Note: In the interest of brevity, a preamble part of the XML/MathML document is omitted.

- **Presentation and Content MathML.**

Below, I focus only on *Presentation MathML*.

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MathML (as an application) of XML also handles pictures.



Two examples of MathML use.

First a simple example of MathML rendering (with \LaTeX as the original source code):

- [Firefox and Opera browsers.](#)
- [Internet Explorer browser.](#)

And here is a rather complicated and real life document; the original (unchanged \LaTeX source code) solutions to Assignment 2 (Applied Differential Equations, Math 280), given to my students in the Spring of 2008:

- [Math280, Spring 2008, Homework 2, MathML version](#)

and for comparison, a pdf version of the same assignment,

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Note: *Internet Explorer without installed MathPlayer will not properly render MathML code, or may even refuse to open a file and may display an error message.*

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The theme, . . . TeX4ht

TeX4ht is a system that converts \TeX/\LaTeX inputs into various hypertext documents: HTML or XML/MathML:

\LaTeX input \implies TeX4ht \implies HTML/XML/MathML output

TeX4ht has been designed and maintained by Eitan M. Gurari [3] and [4] (see also [5]). First, a \LaTeX source code is compiled by \TeX/\LaTeX program together with loading of the additional macros for creating hooks in the output. Next, this output is post-processed by the program `tex4ht` to produce hypertext. Additional files, such as `.css` and, if needed, image files are created by the program `t4ht`.

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Theme, . . . and the packages

This talk is supplemented with ready to download and use complete $\text{T}_\text{E}\text{X}/\text{L}\text{A}\text{T}_\text{E}\text{X}/\text{TeX4ht}$ packages for Mac and Windows platforms. Linux packages are not included since the vast majority of Linux users have them already installed on their systems; however, just in case, I also provide Linux installation instructions. In addition to the full TeX/LaTeX system, the packages also include additional tools like Ghostscript, Ghostview, dvips, image converters, as well as [Firefox](#) browser extensions: fonts package for better MathML rendering and Open Source [Fire Vox](#) screen reader (all platforms).

The packages can be downloaded using interactive tutorial found at http://www.csun.edu/hcmth008/mathml/acc_tutorial.pdf (pdf format) or at http://www.csun.edu/hcmth008/mathml/acc_tutorial.html (html format).

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Creating MathML documents

There are several ways to create MathML documents. One can start from

- \LaTeX document and convert the \LaTeX source code to MathML using Open Source TeX4ht (already mentioned), TTH, Hermes, (online) ORCCA, or Tralics;
- one can use MathML authoring tools, for example, commercial applications like MathType and Scientific Word, or Open Source and full fledged word-processor OpenOffice;
- additionally, the commercial algebra systems and engineering software, e.g., *Maple*, *Mathematica*, *Matlab*, or *Mathcad*, allow saving worksheets (documents) in MathML format.

For more information on the above tools, look into my slide presentation on creating accessible documents at

http://www.csun.edu/hcmth008/mathml/converting_to_mathml.pdf

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For more information on the above tools, look into my slide presentation on creating accessible documents at

http://www.csun.edu/hcmth008/mathml/converting_to_mathml.pdf

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Outline

- 1 Motivation
- 2 Rendering math content
 - The old ways of doing it
 - And the present
- 3 The tools
 - \LaTeX
 - MathML
 - TeX4ht
- 4 How to do it?
 - converters to MathML
 - **MathML editors and viewers**

Selected MathML editors/viewers

- W3C's Editor/Browser (started in 1996), [Amaya](#) is a tool used to create and update documents directly on the Web, including an increasing number of XML applications, such as the XHTML family, MathML, and SVG. It allows all those vocabularies to be edited simultaneously in compound documents. Open Source *Amaya editor* is a freely available for all three platforms: Linux, Mac, and Windows. It does not require \LaTeX input.
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The things to remember:

- There **exist** tools for creating accessible documents with math/physics/chemistry/engineering content.
- The use **Open Formats documents** is preferred; it also helps greatly in creating such documents.
- **Open Source** (and not proprietary!) software packages lead in creating the most innovative tools.
- And finally, two more examples of MathML use:
 - [Math gallery](#)
 - [CSUN syllabus template with math formulas in MathML](#)

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Important qualifications

- $\text{T}_{\text{E}}\text{X}/\text{L}_{\text{A}}\text{T}_{\text{E}}\text{X}$ provides extremely detailed page layout. HTML/XML/MathML formats do not! They are *functional* mark-up languages and *NOT* page layout languages. Their exact rendering is not given by the document but decided by a browser, by windows size, resolution, and font selection. The results are good for browsing by not for printing.
- The only way to produce a precise page layouts is to represent documents in a page layout languages such as PDF, Postscript, or DVI.
- Furthermore, . . . *word processor formats are not suitable for transmitting printable copy, hopeless for browsing, and unreliable for archiving because of the instability of the formats.* (see, [2])

\LaTeX

```
\documentclass{article}
\begin{document}
  Hello World!
\end{document}
```

html

```
<html>
<head>
<title>Hello HTML
</title>
</head>
<body>
Hello World!
</body>
</html>
```

\LaTeX output

Hello World!

browser's rendering

Hello World!

\LaTeX

```
\documentclass{article}
\begin{document}
$a^4 + 5$.
\end{document}
```

MathML

```
<p> <math xmlns=
"http://www.w3.org/1998/Math/MathML"
  display="inline">
  <msup> <mi>a</mi>
    <mn>4</mn> </msup>
  <mo>+</mo>
  <mn>5</mn>
</math>.
</p>
```






 \LaTeX output

$$a^4 + 5.$$

browser's rendering

$$a^4 + 5.$$

References

-  [1] Section 508 software accessibility standards,
see also <http://www.section508.gov>
-  [2] I. Hutchinson TTH: the TEX to HTML translator
-  [3] E. M. Gurari, The authoritative documentation for TeX4ht
-  [4] E. M. Gurari, MathML via TeX4ht and other tools
-  [5] E. M. Gurari and S. Rathz,
From LaTeX to MathML and Back with TeX4ht and PassiveTeX