# Tools For Creating Accessible Documents LATEX, TeX4ht, and MathML

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# Outline



#### Motivation

- Rendering math content
  - The old ways of doing it
  - And the present
- 3 The tool
  - lat<mark>e</mark>x
  - 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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### First, text (ascii) is accessible,

Jacek Polewczak Accessible documents

#### First, text (ascii) is accessible, 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.

### Now, are there alternative ways to present Pollock?

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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):



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#### And other, not so extreme, cases...

(from Symphony No. 9, by Dvorak)

And what about this?

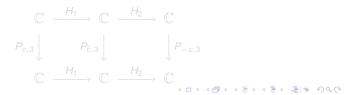
Jacek Polewczak Accessible documents

### What about math?

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

$$\int \frac{mv}{mg - kv^2} \, dv = \int dy \implies -\frac{m}{2k} \ln|mg - kv^2| = y + d_1 \implies$$
$$mg - kv^2 = d_2 \exp\left(-\frac{2ky}{m}\right) \implies v^2 = \frac{mg}{k} \left[1 - d_3 \exp\left(-\frac{2ky}{m}\right)\right]$$

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or this diagram,

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

The old ways of doing it And the present

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The old ways of doing it And the present

### 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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The old ways of doing it And the present

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.

<mark>l4T<sub>E</sub>X</mark> MathML TeX4ht

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LAT<sub>E</sub>X MathML TeX4ht

# The theme..., $\[Mathbb{E}T_EX\]$ and $\[T_EX\]$

#### • What is <a>Left</a> What is <a>TeX</a>? What is <a>TeX</a>?

- LATEX is a markup language (as groff/troff and html are) for representing structured documents.
- T<sub>E</sub>Xis 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<sub>E</sub>X/L<sup>A</sup>T<sub>E</sub>X 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<sup>A</sup>T<sub>E</sub>X 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 • 의논X and html

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**L₄T<sub>E</sub>X** MathML TeX4ht

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- 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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  - Below, I focus only on Presentation MathML.

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## Prose and graphics in MathML

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#### LAT<sub>E</sub>X MathML TeX4ht

# Prose and graphics in MathML

In addition to mathematical expressions, MathML (as an application of XML) provides all the needed support for prose documents:

- Sectional units;
- Lists;
- Tables, etc.

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Here is an example of such (browser) output, or its pdf version.

#### LATEX MathML TeX4ht

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



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LAT<sub>E</sub>X MathML TeX4ht

## 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,

Math280, Spring 2008, Homework 2, pdf version

Note:Internet Explorer without installed MathPlayer will not properlyrender MathML code, or may even refuse to open a file and may displayan error message.(1)

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## The theme,... TeX4ht

TeX4ht is a system that converts T<sub>E</sub>X/L<sup>A</sup>T<sub>E</sub>X inputs into various hypertext documents: HTML or XML/MathML:

TeX4ht has been designed and maintained by Eitan M. Gurari [3] and [4] (see also [5]). First, a  $\square T_EX$  source code is compiled by  $T_EX/\square T_EX$  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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 $\text{LAT}_{EX}$  input  $\implies$  TeX4ht  $\implies$  HTML/XML/MathML output

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### Theme,... and the packages

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### Theme,... and the packages

This talk is supplemented with ready to download and use complete  $T_EX/IaT_EX/TeX4ht$  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.
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converters to MathML MathML editors and viewers

## 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;
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## Outline



- 2 Rendering math content
  - The old ways of doing it
  - And the present
- 3 The tools
  - LATEX
  - MathML
  - TeX4ht

#### How to do it?

- converters to MathML
- MathML editors and viewers

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.
- Commercial WebEQ<sup>TM</sup> Developers Suite is a toolkit for creating web pages that include interactive math. WebEQ<sup>TM</sup> is based on Java and has embedded MathML. It is platform and browser independent. Available for Linux/Mac/Windows.

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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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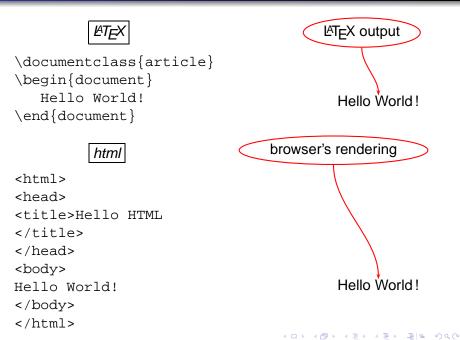
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### Important qualifications

- T<sub>E</sub>X/L<sup>A</sup>T<sub>E</sub>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])

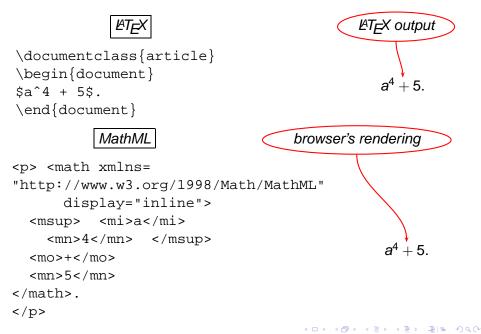
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## Source codes for LATEX and html



## Codes for LaTEX and MathML

Return





- [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