# **Accessible Open Textbooks in Math-Heavy Disciplines**

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#### The challenge

The authoring platform of choice in many math-heavy disciplines is LaTeX. It produces typeset documents of excellent quality and handles formulas and mathematical diagrams extremely well.

Unfortunately, it only produces PDF output. To produce accessible OER from LaTeX, the content must either be converted into a format that can produce both PDF output for printing and accessible HTML for readers with accessibility requirements, or tools to produce HTML from LaTeX directly must be used. The choice of tools is restricted, and any conversion is requires extensive work.

Mathematical formulas and diagrams raise special issues. While diagrams can typically be provided with text descriptions, formulas must be presented in a way that is accessible to assistive technology such as screen readers.

## **Accessible representation of formal proofs in logic**

Formal proofs use vertical lines to indicate where subp and end. Such vertical lines extend from the assumption subproof to its last line and are displayed between the numbers and the formulas in any given line. This make special challenge for users with low vision or complete vision.

To make these proofs accessible in this HTML version, coded as tables. Each table line has four columns: the a subproof level indicator, a formula, and a justification subproof level indicator is a number recording how ma subproofs the current line is contained in. The table he and subproof level indicators are hidden so that proofs appear as in the printed text.

For instance, the subproof beginning on line 5 ends at line 7 starts another subproof. A screen reader should approximately as: "7, close subproof, 2, open subproof AS.'



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### **Avoiding LaTeX**

Two good options to convert math-heavy LaTeX projects to HTML are:

- PreTeXt: A more established solution and popular inmathematics. Source code is XML.
- R Markdown/Quarto: A newer solution popular in the social sciences (economics, psychology). Source code is Markdown, converts to PDF via LaTeX, and to HTML (Bookdown). Uses pandoc.

Conversion from LaTeX to either PreTeXt or Markdown is laborious. The American Institute of Mathematics, which develops PreTeXt, offers a free conversion service for OER. Partially automated conversion is possible (pandoc).

Other platforms (e.g., Pressbooks) are dispreferred as conversion is more difficult, not autoatizable, and support for mathematical content is limited.

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proofs start on line of the e line es proofs a e loss of	1	$(W \lor X) \lor (Y \lor Z)$
	2	X  o Y
	3	$\neg Z$
	4	$W \lor X$
	5	W
	6	$W \lor Y$
proofs are line number, n. The any nested eader rows s visually	7	X
	8	Y
	9	$W \lor Y$
	10	$W \lor Y$
	11	$Y \lor Z$
	12	Y
i line 6, and read line 7 of, upper X,	13	$W \lor Y$
	14	$W \lor Y$



PR
PR
PR
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AS
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AS
$\rightarrow E 2, 7$
VI 8
∨E 4, 5–6, 7–9
AS
DS 11, 3
VI 12
∨E 1, 4–10, 11–13

#### **Converting LaTeX to HTML: LaTeXML + BookML**

An option requiring less setup and investment is to convert LaTeX projects directly to HTML. There are few good conversion utilities, but LaTeXML is an emerging preferred option. . It is a reimplementation of LaTeX, but outputs to XML instead of to PDF, and can compile mathematical formulas to MathML.

MathML is not universally supported by web browsers. Webpagescan use the browser extension MathJax which displays MathML to the user and converts semantic formula information to content accessible to assistive technologies. This option is used by PreTeXt, R Bookdown, and LaTeXML.

BookML uses LaTeXML to produce webpages that use a style modified from that used by Bookdown. LaTeXML and provides additional features to authors to provide different code depending on whether LaTeX is used to produce a PDF, or LaTeXML to produce HTML.

As a case study, we have converted the open textbook forall x: Calgary to a responsive, accessible website using BookML. This included:

PreTeXt: A more established solution and popular inmathematics. Source code is XML.

- Fine tuning of HTML output and CSS
- ALT text for images and diagrams
- Alternative content for some textual elements
- An accessible representation of formal proofs Because LaTeXML reimplements LaTeX, its extensible scripting

require separate detailed descriptions.

# **READ MORE:**





- capabilities can be used to generate accessible output
- automatically, including accessible versions of complex
- mathematical content, including diagrams that would otherwise