Web accessibility of mathematics

organized by
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Workshop Summary

Goals and Focus

The goal of this workshop was to bring together a diverse group of specialists in the field of accessibility to address the barriers that impede development and adoption of accessible web content for mathematics, particularly math education. Our aim was to build better connections among existing assistive technologies, as well as identify potential improvements to the underlying standards and frameworks through informal presentations, brainstorming sessions, and focused coding efforts.

The main areas of focus of the workshop were the following:

- Improve interoperability among existing tools,
- Enhance tools to more consistently handle existing standards,
- Offer improvements or extensions to the current standards, and
- Refine authoring tools to support accessible math.

Daily Activities Summary

Each day of the workshop consisted of morning presentations, followed by more active sessions in the afternoons. Monday afternoon's activity was the most planned, in which groups examined some medium complex equation-like content and discussed the issues with making it web accessible. Some groups went so far as to attempt posting accessible versions. This session prepared the group for Tuesday which focused on screenreader technologies since their developers could not be present for the full week. For other afternoons, as many as six groups formed to discuss and work on topics of interest. Some groups continued to meet several days in a row (in particular, a group working on proof-of-concept applications for new ARIA proposals, and a group working on a new accessibility guide). Other topical groups convened for one afternoon only. Starting on Wednesday, the morning sessions allowed groups to present their work from the previous day (if they wished), and provided the opportunity for several participants to demonstrate their own software.

Some Concrete Accomplishments

Improved ARIA and Braille support in screen readers: Sina Bahram, Mick Curran, Reef Turner, Joanmarie Diggs, Sam Dooley, and Charles Lapierre worked on a number of improvements for the ARIA specification and for Braille standards that would allow screen readers enhanced support for voicing mathematics as well as outputting and entering Braille. Proof of concepts were prototyped in NVDA (Mick and Reef) and Orca (Joanmarie) assuming new ARIA tags that would have

to go into the next ARIA specification. Document samples are also available at sinabahram.github.io/aria-playground/, but require the NVDA prototype version created at the workshop to work. Some of the areas worked on were:

(1) ARIA live regions. The group worked to enhance the implementations of ARIA live regions by enabling complex markup such as SSML for speech or MathML for mathematics. While complex markup is technically allowed by the ARIA specification, screen readers simply never expected more than raw text. Mick and Reef implement support in NVDA during the workshop.

(2) Braille input on the web. Given the complexity of Braille input (from device to operating system to accessibility APIs to assistive technology to the browser), developers currently need a lot of hacking to access raw Braille input in HTML textarea or input elements. The group developed prototypes for a potential new ARIA attribute (aria-braille-input), including sample documents and support in NVDA.

(3) Braille alternatives. The group created prototypes for a potential new ARIA attributes for providing Braille-specific textual alternatives. This new attributes would allow authors to provide, e.g., Braille-specific contractions ("pln" for "planet", "p" for "people") or Nemeth Braille for equations, in addition to textual alternatives for voicing. The group developed sample documents and support in NVDA.

"Deep labeling" MathJax HTML output: The idea of deep labelling is to provide fully explorable voicing using deeply nested speech annotations alongside established ARIA exploration methodology via the aria-owns attribute in HTML content. Volker Sorge, David Tseng, and Peter Krautzberger implemented a prototype that enables server-side rendering of expressions with MathJax and client-side voicing with any screenreader. This method allows authors and publishers to replace running a very large and computationally heavy JavaScript application on the client by preprocessing alongside a very small, lightweight JavaScript programm. The code of the prototype is open source and available on GitHub.

"Deep labeling" MathJax SVG output: Joanmarie Diggs and Peter Krautzberger worked on the deep labeling approach for mathematics represented in SVG images. While the original sample was built by Peter in the Monday afternoon sessions, Joanie identified various bugs and limitations across the accessibility chain and modified the sample to enable navigation and voicing without any client-side JavaScript. While the result is only a single sample and a rapid prototype, it can serve as a good starting point for reporting bugs in web standards, browsers, and assistive technologies; more importantly the sample can inform equation rendering tools such as MathJax or MathLive on how to create working output automatically.

Math support in ChromeVox Next: ChromeVox is Google's screen reader for ChromeOS, the operating system of Chromebooks which are widely used in American high schools. David Tseng (Tech lead for ChromeVox Next at Google), Volker Sorge, and Peter Krautzberger worked to enable Mathematics support in ChromeVox Next by

(1) Identifying and removing the obstacle in Chrome that barred Math markup to be passed to ChromeVox,
(2) Integrating Speech Rule Engine (SRE) into ChromeVox Next,
(3) Enabling Math voicing and interactive exploration in ChromeVox Next.

Updating PCC's math accessibility guide: Alex Jordan, David Lowry-Duda, Sue-Ann Ma, Charles Lapierre, Phyllis Petteys, Angel Ray, Thomas Madsen, and Hwayeon Ryu laid the groundwork for an updated version of Portland Community College's (PCC) math accessibility guide for faculty. AIM volunteered to host the new version on their website. Alex is seeking support from PCC for someone to be lead organizer. Benetech is also interested in taking a lead role here.

Accessibility of PreTeXt: Rob Beezer, David Farmer, Alex Jordan, and Sina Bahram identified accessibility issues with PreTeXt HTML output. While they could address many of them already during the workshop, they are currently working to address more.

Context Semantics from PreTeXt: Rob Beezer introduced Volker Sorge to the concept and structure of PreTeXt documents, which will allow Volker to experiment with books written in PreTeXt in an ongoing MathJax project on harvesting the semantics of mathematical symbols and formulas from context information, such as definitions in text.

Digital and Nemeth Braille: Jason Merrill taught Rob Beezer and Alex Jordan the basics of digital Braille. Rob and Alex have a more clear outline now of achieving Braille output from PreTeXt. Rob Beezer and Volker Sorge also shared information and experiments on using the liblouis Braille library to translate documents into Braille and to harvest Nemeth Braille for mathematical symbols and expressions.

SRE Speech Support in MathLive: Arno Gourdol and Volker Sorge worked on integrating Speech Rule Engine (SRE) into MathLive, an online rendering and editing library for Mathematics. This now allows MathLive to voice mathematics with all the rule sets SRE offers as well as to exploit SRE's prosody markup for pausing, pitch and rate change. The work is currently being continued to obtain tighter integration of the two systems to also allow interactive exploration of mathematics in MathLive.

LaTeX package for semantic macros: David Farmer, Rob Beezer, Davide Cervone, Volker Sorge, and Alex Jordan brainstormed approaches to embed more semantic information into LaTeX that could be exploited for accessibility as well as by computational engines. In particular, they outlined a new macro package that would provide a number of convenient macros for commonly used mathematical constructs, where the semantic information would automatically be provided by the macro name. This would free authors from having to spend additional time on adding semantic information.

Future Plans

(1) We are looking into the possibilities for repeating this workshop on a regular basis, perhaps annually, perhaps biannually. Alex Jordan is researching Portland-area

facilities and expenses. We will follow up with researching Bay Area facilities and expenses. A follow-up workshop may not be a regular AIM funded workshop, and we are investigating different funding models and sources of funding.

(2) We will set up Google Group mailing lists for the participants to keep in touch as they work together to continue to pursue the issues they worked on.

(3) Alex Jordan, David Lowry-Duda, Sue-Ann Ma, Charles Lapierre, Phyllis Petteys, Angel Ray, Thomas Madsen, and Hwayeon Ryu will continue to collaborate on an updated version of PCC's math accessibility guide for faculty.

(4) David Farmer is working on developing the semantic macros whose framework was developed during the meeting.