Automated production of Braille textbooks

organized by
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Workshop Summary

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Overview

The purpose of the workshop was to extend the availability of mathematics textbooks in Braille to students and professionals who are visually impaired. The goal is to produce mathematical text accurately, inexpensively, and in a timely manner by developing a user-friendly software workflow using open-source software to automatically, or nearly automatically, translate mathematical text to Braille ready for embossing.

This was the first AIM workshop to run virtually, after the closure necessitated by COVID-19. The organizers are grateful to AIM staff for thinking through the logistics of such meetings. Due to difference in time zones (the participants on the West Coast of the United States were separated by 9 time zones from the participants in Europe), the daily meeting period of the workshop was somewhat reduced compared to the usual AIM workshop.

Progress in our work can be highlighted by the following feedback from a Nemeth transcriber. The transcriber received an automatically translated—with the tools that were improved during the workshhop—Calculus textbook. She reported, in part:

> Also- the [automatically produced] files are saving A TON OF MONEY & TIME! I was able to get [Section] 5.1 done in 6 hours. It would have taken more than 20 in traditional brailling!
>
> So- This is all FREAKING AMAZING! please don't lose sight of the things we are accomplishing for all braille readers!

The activities during the workshop and the follow-up work aim to further reduce the time needed by transcribers to produce ready-to-use Braille version of the text for blind students.

Activities during the workshop can be organized into two main groups. The first focuses on improving transcription tools and on production of raised graphics. The second group of activities involved gathering information about available technologies, advice for authors, and policy recommendations. Documentation about transcription rules and information about available and emerging accessibility tools can be difficult to find. A valuable part of the workshop was a number of demonstrations of the available technology.

Transcription and raised graphics tools

Mathematical Braille text has two parts, each covered by a separate set of rules: literary text and mathematics expressions. The set of rules for transcribing mathematics is called Nemeth Braille (or simply Nemeth), named after American mathematician Abraham Nemeth who designed the set.

A key tool allowing transcription of mathematics into Nemeth Braille is Speech Rule Engine (SRE) developed by Volker Sorge. SRE is able to processes a LaTeX expression into a variety of outputs, including speech and Nemeth. In preliminary testing, a number of bugs were identified. Working groups during the workshop were able to do additional proof-reading; bugs were identified and fixed. The work is ongoing to produce a way to systematically test the ability of software to correctly convert from LaTeX to Nemeth.

PreTeXt is a mark-up vocabulary that allows to write mathematics documents and compile the same source document into a variety of formats: html, PDF, EPUB, etc. One of the directions of work during the workshop was to improve the ability of PreTeXt to compile a source document into a Braille output. Rob Beezer integrated latest Speech Rule Engine into PreTeXt production script.

A "pipeline" to convert HTML documents to BRF (file format understood by every Braille embosser) was built by Peter Krautzberger. It is available in https://github.com/pkra/aim-workshop-braille-2020/tree/master/puppeteer.

Most, if not all, mathematics textbooks have accompanying graphics. Producing raised print versions of the graphs and diagrams is a difficult problem, in particular because tactile legibility is different from the visual one. A way to convert a diagram written in LaTeX package `tikz` to a PDF file with Braille labels was known before the workshop. The conversion had a number of shortcomings. During the workshop, a very successful working group managed to come up with a way to produce an SVG file with Braille labels from a `tikz` file. The SVG file was successfully tested on an embosser.

This capability was further improved by the ability to produce navigable SVG from a `tikz` file. The navigation can allow a user interacting with an image on a computer screen to move between different components of the image, as these components are described by a screen reader. This technology can further be integrated with audio-tactile graphics software IVEO.

Ability to produce navigable and audio-enhanced SVG from computing software was also explored. A good number of images in textbooks are generated by scientific graphing tools. First steps were taken to produce navigable SVG from a Matplotlib output.

Information, policy, and technology demonstrations

Information and policy. The following git repository was created together with the associated wiki as a long-term home for related accessibility information: https://github.com/PreTeXtBook The repository will contain the advice documents, as well as information related to raised print in mathematics.

During the workshop, the participants had a session with Susan Osterhaus, a Statewide Mathematics Consultant and a long-time teacher at Texas School for the Blind and Visually Impaired. She welcomed a set of recommendations and questions for Braille Authority of North America (BANA) related to Nemeth Braille. Our work on proof-reading the output of SRE revealed that some of the common mathematics symbols are missing in Nemeth

(notably, the blackboard-bold and calligraphic fonts, as well as symbols such as $\models$, $\vdash$, $\rtimes$, and).

Nemeth rules describe how to transcribe complicated fractions and large matrices. Similar guidelines are needed for other 2-dimensional mathematical expressions that frequently occur in some undergraduate texts: commutative diagrams and logical inference rules. A document started during the workshop will be shared with BANA.

Advice for authors. A group of participants was meeting to discuss advice for graphics authors, how to make mathematical graphics effective for the Blind. A document that was compiled will be posted on the Accessibility Wiki referenced above. The group has compiled a list of previously developed documents with graphics guidelines. The advice for mathematical graphics includes both general design principles, as well as specifics, such as spacing guidelines for graphics elements.

Demostrations. The workshop featured a number of technology demonstrations, both during plenary talks and during the working group meetings. These included:

- IVEO: audio-tactile graphics developed by ViewPlus. Enriched SVG files can be embossed, placed on top of a touch-screen and after simple calibration read out loud as the user touches the graphics.
- Accessible chemistry diagrams developed by Progressive Accessibility Solutions. Navigation-enriched SVG files that allow the user to navigate around the skeletal formulas of molecules, from group level to individual atoms and bonds between them. Similar technology is available for navigating complex mathematics formulas.
- `brailleR` package for statistical software R, developed by Jonathan Godfrey. The tools were demonstrated by Volker Sorge. Jonathan Godfrey was able to join one of the sessions of the workshop to discuss the details. This discussion served as the basis for developing navigation-enriched diagrams for files produced by other scientific software.

Al Maneki, one of the organizers of the workshop, will inform the National Federation of the Blind about the workshop activities.