

Navigating Mathematics

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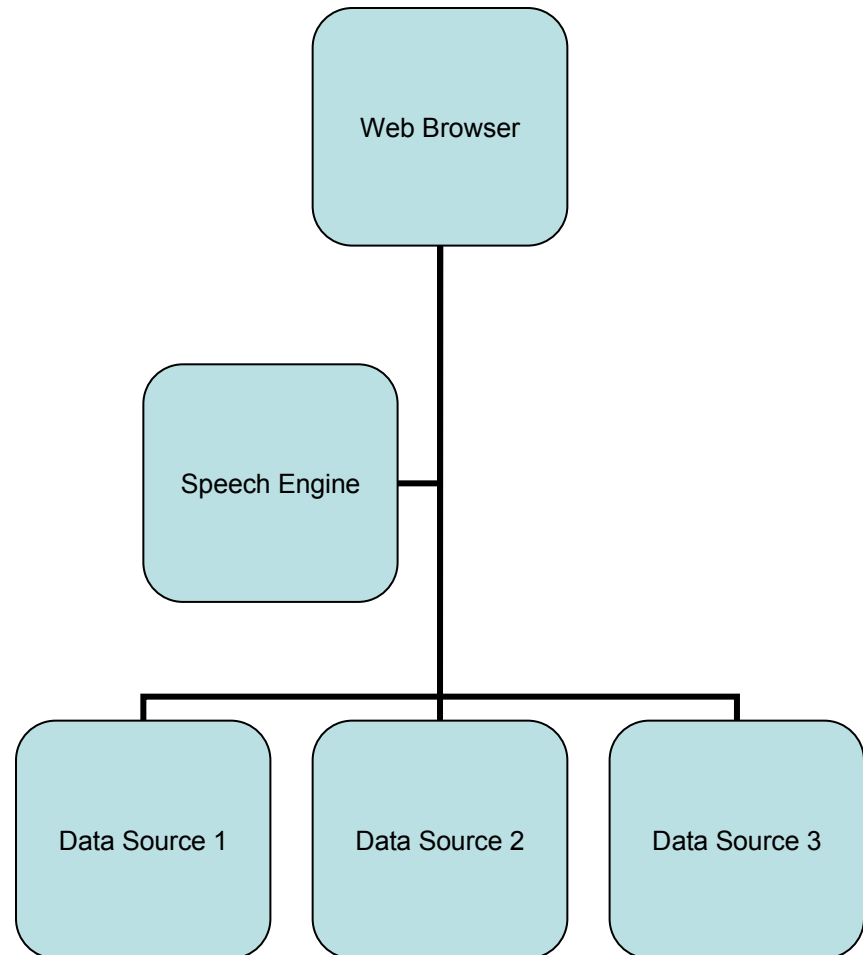
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Purpose

- Mathematics is used throughout advanced education
 - Someone currently has to prepare the mathematics
 - An added difficulty on the blind and visually impaired
 - Want to eliminate the middle man

Quick Overview

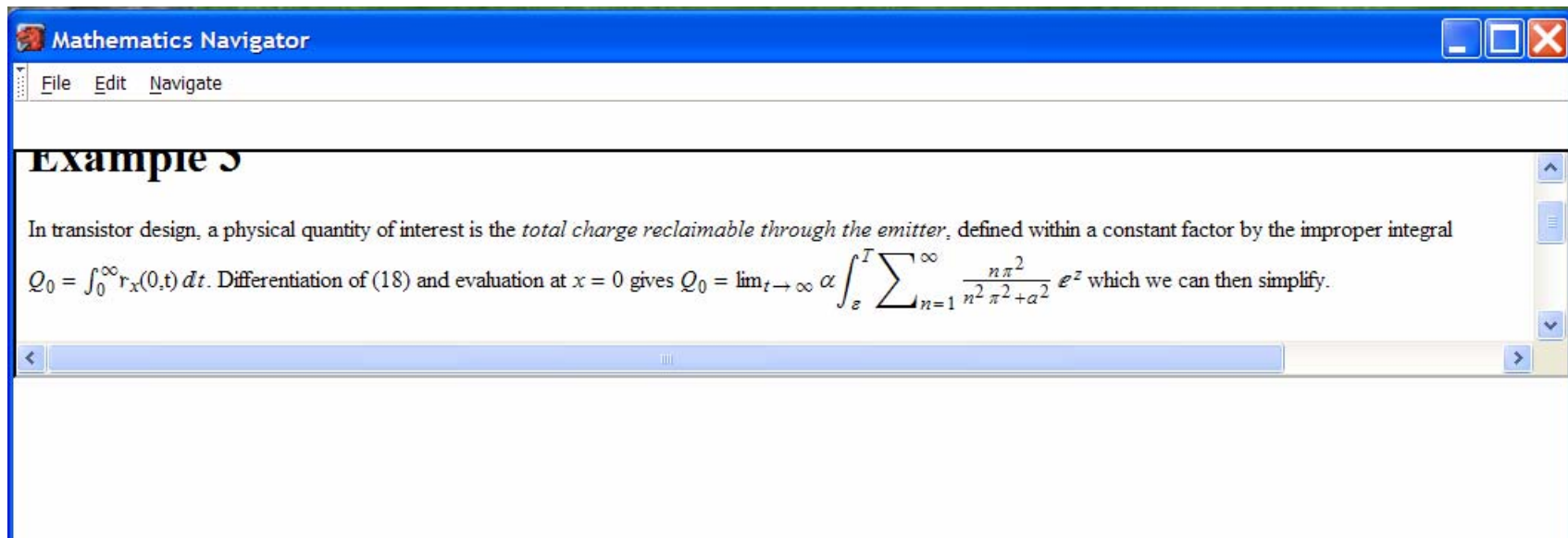
- Mozilla extension
 - Mozilla handles displaying Presentation MathML
 - Is the viewer in the MVC architecture
- Java engine
 - Speaks it aloud
 - Translates from LaTeX, MathML, OpenMath
 - Focus is on LaTeX
 - The model in the MVC architecture



Structure of Mathematics

- The mathematics documents we focus on conform to a rough structure
 - Emphasis is on the mathematical text
 - Images and diagrams are a totally separate issue
 - Different types of mathematics
 - Traditional inline vs display
 - Terms versus structure

Structure of a mathematical document



Mathematics Navigator

File Edit Navigate

Example 3

In transistor design, a physical quantity of interest is the *total charge reclaimable through the emitter*, defined within a constant factor by the improper integral

$$Q_0 = \int_0^\infty r_x(0,t) dt. \text{ Differentiation of (18) and evaluation at } x = 0 \text{ gives } Q_0 = \lim_{t \rightarrow \infty} \alpha \int_\varepsilon^T \sum_{n=1}^{\infty} \frac{n\pi^2}{n^2\pi^2 + \alpha^2} e^z \text{ which we can then simplify.}$$

Breaking It Down

- When we generate MathML, we annotate it with details to help us navigate
 - Prolific use of ids so that we can tag location
 - Semantic preserving documentation
- Emphasis on semantic-preserving information
 - But not everything. No comments, no original source

Phrasebook

- Every mathematical expression has a default phrase

$$A \oplus B$$

- Read that as A plus B regardless of what A and B are
 - But we can provide more refined queries

Similarities to Parsing

- When parsing, context is used to derive a concrete production
 - $A \leftarrow BcD$
- When producing to text, we want to take a concrete production and add context
 - The integral of $f(x)$ from 0 to π with respect to x
 - We want to place $f(x)$ in context with the rest of the document

Components

- FreeTTS system from Sun Microsystems
 - Implements a useful subset of the JSAPI
 - Based on Festival and Flite
- Present as a signed Java applet as an XUL extension to the Mozilla browser suite
 - Allows access to local files
 - XUL provides a richer application experience than HTML

Location

- One big challenge is keeping track of the source material
 - We convert math like $\int_a^b f(x)dx$ into a bit of text like “the contour integral of $f(x)$ with respect to x from a to b ”
 - But if we stop after “of $f(x)$ ”, where are we in the document?
 - If the user clicks ‘play’ , where should it restart?
 - The speech synthesizer knows only the translated form, which may be significantly transformed
 - Where are the significant end points?

Location 2

- Compiler warning similarities
 - Approach #1: Store lots of metadata to reverse the mapping
 - Approach #2: Try to go for significant markers
- We take approach #2
 - When transforming super/subscripts, we always go back to the base
 - This has the disadvantage in deeply nested expressions
 - But they're problematic anyways

Location 3

- Take advantage of authorial conventions
- Divide mathematics into three parts
 - Normal text doesn't need special support.
 - The user has other navigation tools to go back to the beginning of a sentence or section or so on.
 - Inline mathematics is marked so that it always begins at beginning of it
 - Display mathematics uses heuristics
 - Groups are sequence point

Mozilla/XUL integration

- Initial version was a Javascript-enabled web page
 - User could not change document location except with the navigator tools
- But Mozilla / Netscape offers a richer interface possibilities
 - The Mozilla browser is itself written in a combination of XUL and XBL
- Use CVS Mozilla with minor patches
 - To make the cursor position available

Testing

- Testing the effectiveness of the navigator
 - Using sighted students
 - In conjunction with Professor Gillan of Psychology
- Usability of the navigator
- Retention and comprehension of mathematics

Products

- Translator from LaTeX to MathML
 - Updated since initial release
 - Now consists of a separate lexer and parser suitable for running separately from the project
 - Refactored out, freely available to download
 - Still limitations on the TeX parser, but less so than the ad hoc parser

Products

- Mozilla Math Navigator Extension
 - Java applet source code
 - XUL and javascript interface code
 - Minor patch to the Mozilla source code
 - Licensed for free distribution
 - In the process of gaining a sourceforge platform for it

Summary

- LaTeX documents can be read aloud and navigated
 - Improved design over previous version
 - Open-source and publicly available
- Testing is underway to test efficacy