Linear Access to Mathematics for Braille Device and Audio synthesis

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Introduction

„In a knowledge society, democracy requires citizens to have a certain scientific and technical knowledge as part of their basic skills“

European Community Commission (COM 2001 714)

Introduction (2)

The Lambda Project

„Lambda aims at solving the problem of mathematics text management by blind users of secondary schools and universities, as well as that of fruition of science texts, in digital formats and through Braille print.“

Outline

- The Lambda Project
- The Lambda Code
- The Mathematical Editor
- Lambda and DAISYScience

Lambda Project

- EU-Project (IST-Programme)
  - Information Society Technologies
    - Research towards a user-friendly Information Society.
- 15 European partners
  - 8 different European countries
- Begin 2002 – End 2006
  - User studies
  - Definition of Lambda linear code
  - Editor function specification
  - Editor development
  - System validation

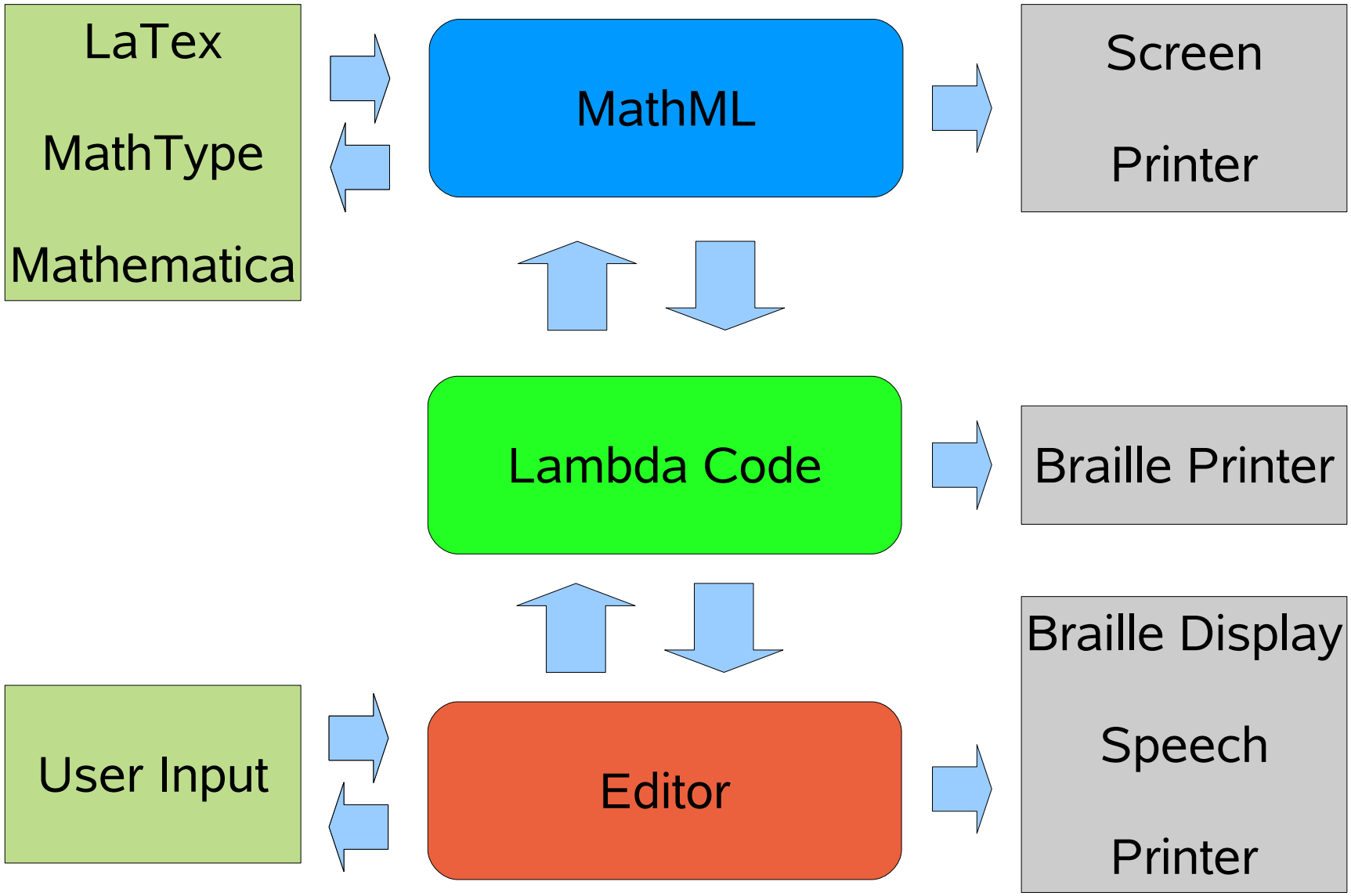
Lambda Project (2)

- Arca Progetti SRL - Verona
- EBU – Paris
- ONCE – Madrid
- ACAP – Lisbon
- Dodecanese Ass. - Rhodes
- LOGOS – Moscow
- National Library f. Blind – Monza
- Uni. Paul Sabatier – Toulouse
- University of York
- RNIB – London
- Unione Italiana Ciechi – Verona
- University of Milano
- Veia Progetti
- CSA di Vicenza
- University of Stuttgart

Lambda Project (3)

- Mathematics text management by blind users
  - Secondary schools and universities
  - Scientific texts, in digital formats and Braille print
- Linear maths code
  - Textual and sequential
  - Directly derived from MathML of W3C
- Editor including a series of tools
  - Easy and fast entry and changing of maths texts
  - Help understand both structure and internal relations of formulas
- Import and export texts
  - Most popular formats (MathML, LaTex, MathType, Mathematica)
  - Print both conventionally and in Braille

Lambda Project (4)



The Lambda Code

- Common Markup-Language
  - Linearly represent mathematical expressions
- Full Braille output of mathematic formulas
- Preserves peculiarities of national Braille
- Leading Principles
  - Explicit meaning of linearly represented notation
    - No ambiguities
  - Compact linear representation
    - Minimize movement on Braille display
  - Preserve national dot configurations
  - Intuitive rules and dot configurations
    - Symetric dot combinations for corresponding tags
  - No exploitation of the blank character
  - Context-free Notation

The Lambda Code (2)

- Contains about 290 Elements
  - Digits, Symbols, Operators, Functions, ...
- Atomic Elements
  - Single Elements like ∅ or ∞
  - <X>
  - a+b ([obj1]<X>[obj2]), n! ([obj]<X>), ...
- Composit Elements
  - Elements like $\int$ dx, or /
  - <open><close>
  - <open><int><close>
  - $\frac{a+b}{a-b}$, $\int x^2 dx$, ...

The Lambda Code (3)

- Content vs. Presentation
  - Semantic information of formulas are preserved whereas the visual description is discarded

$$\sum_{i=1}^{n} a_i$$

- Content oriented description
  - Summ over all a_i with i going from 1 to n
- Presentation oriented description
  - Capital Letter Sigma with subscript i=1 and superscript n followed by an a subscript i

The Lambda Code (4)

- Lambda for Blind and Sighted
  - Lambda should be intuitive and easy to understand

$$\sqrt{\frac{(x+1)^2}{(x+1)*(x-1)}+\frac{x^2}{x-1}}$$

```
√⁄(x+1)^2⁄(x+1)*(x-1)\\+⁄x^2⁄x-1\\⟩
```

- Alternatives (OpenOffice or LaTex)

```
sqrt{{(x+1)^2}over{(x+1)*(x-1)}+{x^2}over{x-1}}
```

```
\sqrt{\frac{(x+1)^2}{(x+1)*(x-1)}+\frac{x^2}{x-1}}
```

The Lambda Code (5)

- Lambda and Braille

x^{a+1} $\sqrt[3]{x+y}$

x⇑a+1⇓ √(3√(x+y)⟩

  - German Braille

  - Italian Braille

The Lambda Code (6)

- Mathematics evolves
  - New Notations introduced constantly in active research areas
- Lambda Code extensibility
  - New Tags can be introduced
  - Dot combinations and speech output can be adapted

The Mathematical Editor

- Lambda Editor
  - Text editor to read and write Lambda Code
  - Code is displayed on the screen
  - ... output on the Braille display
  - ... and spoken by Speech Synthesis
- Easy input
  - Short-cut keys
  - Automatic completion
  - Context based input
- Block-Structure handling
  - Mathematical elements are grouped into Blocks
  - Blocks can be collapsed or expanded for easier reading

The Mathematical Editor (2)

- Block-structuers in Lambda

$$\sqrt{\frac{(x+1)^2}{(x+1)*(x-1)}+\frac{x^2}{x-1}}$$

```
√//(x+1)^2⁄(x+1)*(x-1)\\+//x^2⁄x-1\\/

√                                   /
√//         ⁄               \\+//    ⁄    \\/
√//(    )^2⁄(    )*(    )\\+//x^2⁄x-1\\/
√//(x+1)^2⁄(x+1)*(x-1)\\+//x^2⁄x-1\\/
```

The Mathematical Editor (3)

- Speech and Braille output
  - The editor can be used with speech output, Braille output and both together
- Speech synthesis
  - Lambda speech synthesis helps explore block structure
  - Lambda editor provides different speech output options
- Short output
  - Shortend tag names „braces open“
- Verbose output
  - Full tag names „round braces open“
- Speech speed and breaks are further used to communicate information „*x+1 div. x-1*“ vs. „*x+ … 1 div. x-1*“

The Mathematical Editor (4)

- Flexibility
  - The Lambda editor is designed with different users in mind
  - Students from Primary School, Secondary School or University
  - Teachers and Lecturers
  - Researchers
- Adabtability
  - The editor needs to adapt to the users needs
- Novice user
  - Just basic menu options and simple commands are available
  - Most detail is hidden
- Advanced user
  - All menu options and commands, scripting, extensibility, ...

Lambda and DAISYScience

- DAISYScience
  - Accessible Scientific Documents through Automated Conversion into Advanced DAISYBooks and Reader-tailored Presentation
- Accessible Scientific Documents
  - Text (summarized and simplified)
  - Scientifc formulas (linearized and verbalized)
  - Graphics (linearized and verbalized)
- DAISY Talking Books
  - **D**igital **A**ccessible **I**nformation **SY**stem
  - Digital Talking Book are accessible and navigable
  - Multimedia documents
  - www.daisy.org

Lambda and DAISYScience (2)

- Formulas and Lambda
  - Development of new notations
    - The lambda notation will be extended and adabted to new notations
  - Mathematics, Physics, Chemistry, ...
  - Adoption of national Braille standards
  - Abbrevations of constants and units of measurement
  - Formula exploration

Closing (Lambda and DAISYScience)

„Lambda and DAISYScience will be solving the problem of scientific text management by blind users of secondary schools and universities, as well as that of presentation of science texts, in digital formats and through Braille print.“