

Unicode mathematics with L^AT_EX

Will Robertson

June 28, 2010

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\LaTeX 3 Project

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Acknowledgements

- The T_EX Users Group for their very generous support
- Barbara Beeton for her work on the STIX fonts
- Jonathan Kew, Taco Hoekwater for X_YT_EX, LuaT_EX

Outline

What is unicode mathematics?

What fonts are available?

Using symbols and alphabets

How alphabets behave

Future

Origins of unicode maths

Ad hoc math font encodings:

- Computer Modern Math + AMS additions
- Euler
- Lucida Math
- MathTime Pro

And of course other non- \TeX fonts such as ‘Symbol’ and those used for Mathematica.

Origins of unicode maths

Math Font Group, <http://tug.org/twg/mfg/>

- Aim: as easy to switch maths fonts as text fonts
- Implemented but not adopted
- Designed for \TeX 's constraints:
256 glyphs in 16 maths fonts
- Project stalled because Unicode was the future

Which future we're now participating in

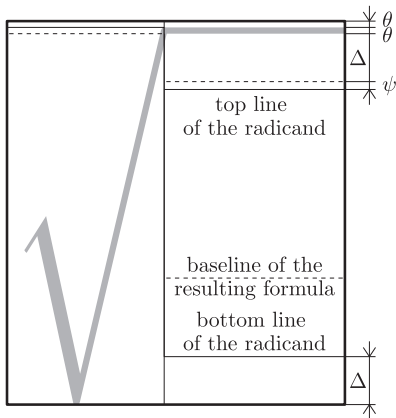
<p>THERE EXISTS existential</p> \exists <p>0x02203</p>	<p>THERE DOES NOT EXIST nexist</p> \nexists <p>0x02204</p>	<p>EMPTY SET emptyset</p> \emptyset <p>0x02205</p>	<p>INCREMENT Delta</p> Δ <p>0x02206</p>	<p>NABLA gradient</p> ∇ <p>0x02207</p>	<p>ELEMENT OF element</p> \in <p>0x02208</p>	<p>NOT AN ELEMENT OF notelement</p> \notin <p>0x02209</p>	<p>SMALL ELEMENT OF epsis</p> ϵ <p>0x0220A</p>
<p>SMALL CONTAINS AS MEMBER bepsi</p> \ni <p>0x0220D</p>	<p>END OF PROOF uni220E</p> \blacksquare <p>0x0220E</p>	<p>N-ARY PRODUCT product</p> \prod <p>0x0220F</p>	<p>N-ARY COPRODUCT samalg</p> \amalg <p>0x02210</p>	<p>N-ARY SUMMATION summation</p> \sum <p>0x02211</p>	<p>MINUS-OR-PLUS SIGN minusplus</p> \mp <p>0x02213</p>	<p>DOT PLUS plusdo</p> $\dot{+}$ <p>0x02214</p>	<p>DIVISION SLASH fraction</p> $/$ <p>0x02215</p>
<p>RING OPERATOR comprn</p> \circ <p>0x02218</p>	<p>BULLET OPERATOR periodcentered</p> \bullet <p>0x02219</p>	<p>SQUARE ROOT radical</p> $\sqrt{\quad}$ <p>0x0221A</p>	<p>CUBE ROOT uni221B</p> $\sqrt[3]{\quad}$ <p>0x0221B</p>	<p>FOURTH ROOT uni221C</p> $\sqrt[4]{\quad}$ <p>0x0221C</p>	<p>PROPORTIONAL TO proportional</p> \propto <p>0x0221D</p>	<p>INFINITY infinity</p> ∞ <p>0x0221E</p>	<p>RIGHT ANGLE orthogonal</p> \perp <p>0x0221F</p>
<p>SPHERICAL ANGLE angsph</p> \sphericalangle <p>0x02222</p>	<p>DIVIDES divides</p> \mid <p>0x02223</p>	<p>DOES NOT DIVIDE nmid</p> \nmid <p>0x02224</p>	<p>PARALLEL TO parallel</p> \parallel <p>0x02225</p>	<p>NOT PARALLEL TO notparallel</p> \nparallel <p>0x02226</p>	<p>LOGICAL AND logicaland</p> \wedge <p>0x02227</p>	<p>LOGICAL OR logicalor</p> \vee <p>0x02228</p>	<p>INTERSECTION intersection</p> \cap <p>0x02229</p>
<p>DOUBLE INTEGRAL dblintegral</p> \iint <p>0x0222C</p>	<p>TRIPLE INTEGRAL uni222D</p> \iiint <p>0x0222D</p>	<p>CONTOUR INTEGRAL contourintegral</p> \oint <p>0x0222E</p>	<p>SURFACE INTEGRAL uni222F</p> \oiint <p>0x0222F</p>	<p>VOLUME INTEGRAL uni2230</p> \oiint <p>0x02230</p>	<p>CLOCKWISE INTEGRAL uni2231</p> $\int\limits_{\curvearrowright}$ <p>0x02231</p>	<p>CLOCKWISE CONTOUR INTEGRAL uni2232</p> $\oint\limits_{\curvearrowright}$ <p>0x02232</p>	<p>CLOCKWISE CONTOUR INTEGRAL uni2233</p> $\oint\limits_{\curvearrowright}$ <p>0x02233</p>

From the STIX fonts documentation.

OpenType mathematics

The unicode maths encoding saw the inception of the STIX fonts

- Which have now been released! (Good timing.)
- We now had the means to typeset any known maths glyph
- But maths needs more than glyphs for proper typesetting



Bogusław Jackowski. "Appendix G illuminated". In: *TUGboat* 27.1 (2006), pp. 83–90

Microsoft Word 2007

Murray Sargeant and others:

- from the unicode maths encoding,
- extended OpenType,
- implemented a unicode maths typesetting engine for Microsoft Word (and now Office).

OpenType fonts can now contain the necessary information for typesetting maths.

The package

`\usepackage{unicode-math}`

- Requires a 32-bit unicode-aware \TeX variant
- Written for $X_{\text{Y}}\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$
- Lua $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ support imminent

Cambria Math Microsoft

$$F(s) = \mathcal{L}\{f(t)\} = \int_0^{\infty} e^{-st} f(t) dt$$

```
\setmathfont{Cambria Math}
```

Asana Math

Apostolos Syropoulos

$$F(s) = \mathcal{L}\{f(t)\} = \int_0^{\infty} e^{-st} f(t) dt$$

`\setmathfont{Asana Math}`

XITS Math

Khaled Hosny

$$F(s) = \mathcal{L} \{ f(t) \} = \int_0^{\infty} e^{-st} f(t) dt$$

```
\setmathfont{XITS Math}
```

STIX

$$F(s) = \mathcal{L} \{ f(t) \} = \int_0^{\infty} e^{-st} f(t) dt$$

```
\setmathfont{STIXGeneral}
```


Neo Euler Khaled Hosny

$$F(s) = \mathcal{L}\{f(t)\} = \int_0^{\infty} e^{-st} f(t) dt$$

```
\setmathfont[math-style=upright]{Neo Euler}
```

Symbols in the source

- Backwards compatibility is paramount
- Existing maths document *should* work (modulo edge cases)
- Inputting symbols and characters:

Symbols in the source

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- Existing maths document *should* work (modulo edge cases)
- Inputing symbols and characters:

name	<code>\circledast</code>
char	⊛
	(U+229B)

Symbols in the source

- Backwards compatibility is paramount
- Existing maths document *should* work (modulo edge cases)
- Inputing symbols and characters:

name	<code>\mbfx</code>
alphabet	<code>\mathbf{x}</code>
char	x

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
<code>\mathup</code>	•	•	•
<code>\mathit</code>	•	•	
<code>\mathbfup</code>	•	•	•
<code>\mathbfit</code>	•	•	

abcdefghijklmnopqrstvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

αβγδεεζηθθικκλμνξοππρρςστυφφχψω

ΑΒΓΔΕΖΗΘΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ

0123456789

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<code>\mathsfit</code>	•		
<code>\mathbfsfup</code>	•	•	•
<code>\mathbfsfit</code>	•	•	

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<code>\mathscr</code>	•		
<code>\mathbfscr</code>	•		
<code>\mathfrak</code>	•		
<code>\mathbffrak</code>	•		

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<code>\mathbfscr</code>	•		
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<code>\mathbffrak</code>	•		

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A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
<code>\mathsfup</code>		•	
<code>\mathsfit</code>		•	•
<code>\mathbfsfit</code>			•

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
<code>\mathsfup</code>		•	
<code>\mathsfit</code>		•	•
<code>\mathbfsfit</code>			•
<code>\mathbbit</code>	•		
<code>\mathbfbb</code>	•		•
<code>\mathbfbbbit</code>	•		

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
<code>\mathsfup</code>		•	
<code>\mathsfit</code>		•	•
<code>\mathbfsfit</code>			•
<code>\mathbbit</code>	•		
<code>\mathbfbb</code>	•		•
<code>\mathbfbbit</code>	•		
<code>\mathcal</code>	•		•
<code>\mathbfcal</code>	•		

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
<code>\mathsfup</code>		●	
<code>\mathsfit</code>		●	●
<code>\mathbfsfit</code>			●
<code>\mathbbit</code>	●		
<code>\mathbfbb</code>	●		●
<code>\mathbfbbit</code>	●		
<code>\mathcal</code>	●		●
<code>\mathbfcal</code>	●		

ABCDEFGHIJKLMNOPQRSTUVWXYZ

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Styles of maths

Separation between content and form:

```
\[ a A \gamma \Gamma \]
```

\TeX *a A γ Γ*

\French *a A γ Γ*

\ISO *a A γ Γ*

\Upright a A γ Γ

```
[math-style=TeX]
```


Styles of maths

Separation between content and form:

```
\[ a A \gamma \Gamma \]
```

\TeX *a A γ Γ* \French *a A γ Γ*

\ISO *a A γ Γ* \Upright *a A γ Γ*

```
[math-style=ISO]
```

Styles of maths

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```
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```

\TeX $a A \gamma \Gamma$

\French $a A \gamma \Gamma$

\ISO $a A \gamma \Gamma$

\Upright $a A \gamma \Gamma$

```
[math-style=french]
```

Styles of maths

Separation between content and form:

```
\[ a A \gamma \Gamma \]
```

\TeX *a A γ Γ* \French *a A γ Γ*

\ISO *a A γ Γ* \Upright **a** A γ Γ

```
[math-style=upright]
```

Styles of bold maths

Separation between content and form:

```
\[ \mathbf {a A \gamma \Gamma } \]
```

TeX	a	A	γ	Γ	a	A	γ	Γ
ISO	a	A	γ	Γ	a	A	γ	Γ
Upright	a	A	γ	Γ	a	A	γ	Γ

[bold-style=TeX]

Styles of bold maths

Separation between content and form:

```
\[ \mathbf {a A \gamma \Gamma } \]
```

TeX	<i>a</i>	<i>A</i>	<i>γ</i>	<i>Γ</i>	a	A	γ	Γ
ISO	<i>a</i>	<i>A</i>	<i>γ</i>	<i>Γ</i>	a	A	γ	Γ
Upright	a	A	γ	Γ	a	A	γ	Γ

[bold-style=ISO]

Styles of bold maths

Separation between content and form:

```
\[ \mathbf {a A \gamma \Gamma } \]
```

TeX	<i>a</i>	<i>A</i>	<i>γ</i>	<i>Γ</i>	a	A	γ	Γ
ISO	<i>a</i>	<i>A</i>	<i>γ</i>	<i>Γ</i>	a	A	γ	Γ
Upright	a	A	γ	Γ	a	A	γ	Γ

[bold-style=upright]

DEMO

Silly example

$$F(s) = \mathcal{L}\{f(t)\} = \int_0^{\infty} e^{-st} f(t) dt$$

`\setmathfont [`

`...`

`]{Cambria Math}`

Silly example

$$F(s) = \mathcal{L}\{f(t)\} = \int_0^{\infty} e^{-st} f(t) dt$$

```
\setmathfont [
```

```
range={\equal }, Colour=009922
```

```
]{Cambria Math}
```

Silly example

$$F(s) = \mathcal{L}\{f(t)\} = \int_0^{\infty} e^{-st} f(t) dt$$

```
\setmathfont [
```

```
range={\mathop ,\mathscr }, Colour=red
```

```
]{Cambria Math}
```

Outline

What is unicode mathematics?

What fonts are available?

Using symbols and alphabets

How alphabets behave

Future

Who
knows?

What next?

- Proper Lua \LaTeX support
- \LaTeX 's 'mathversion' not supported: what is ' $\backslash\text{boldmath}$ '?
- Generalising the database for maths glyphs:
Collaboration with Con \TeX t

What else?

- Integration with breqn
(‘beyond amsmath’)
- ‘Semantic’ maths, analogous to Content MathML
 - ▣ the cool package
 - ▣ the sTeX package

