Unicode mathematics with LaTeX

Will Robertson

June 28, 2010

Unicode mathematics with LaTeX

Will Robertson

School of Mechanical Engineering
University of Adelaide
Australia

June 28, 2010

Unicode mathematics with LaTeX

Will Robertson

LaTeX3 Project

June 28, 2010

Acknowledgements

— The TEX Users Group for their very generous support
— Barbara Beeton for her work on the STIX fonts
— Jonathan Kew, Taco Hoekwater for XƎTEX, LuaTEX

Outline

Origins of unicode maths

Ad hoc math font encodings:

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

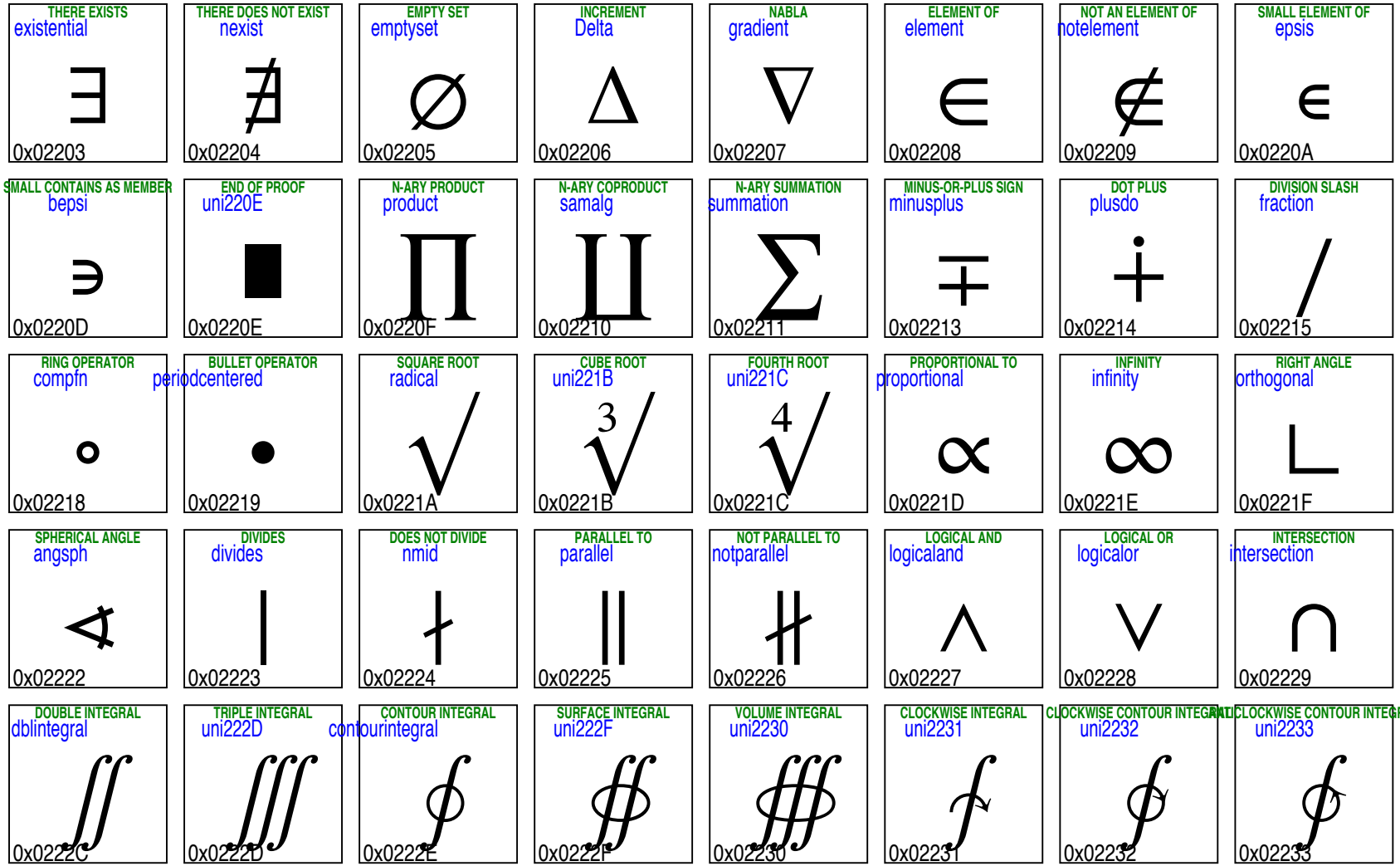
And of course other non-TEX fonts such as ‘Symbol’ and those used for Mathematica.

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

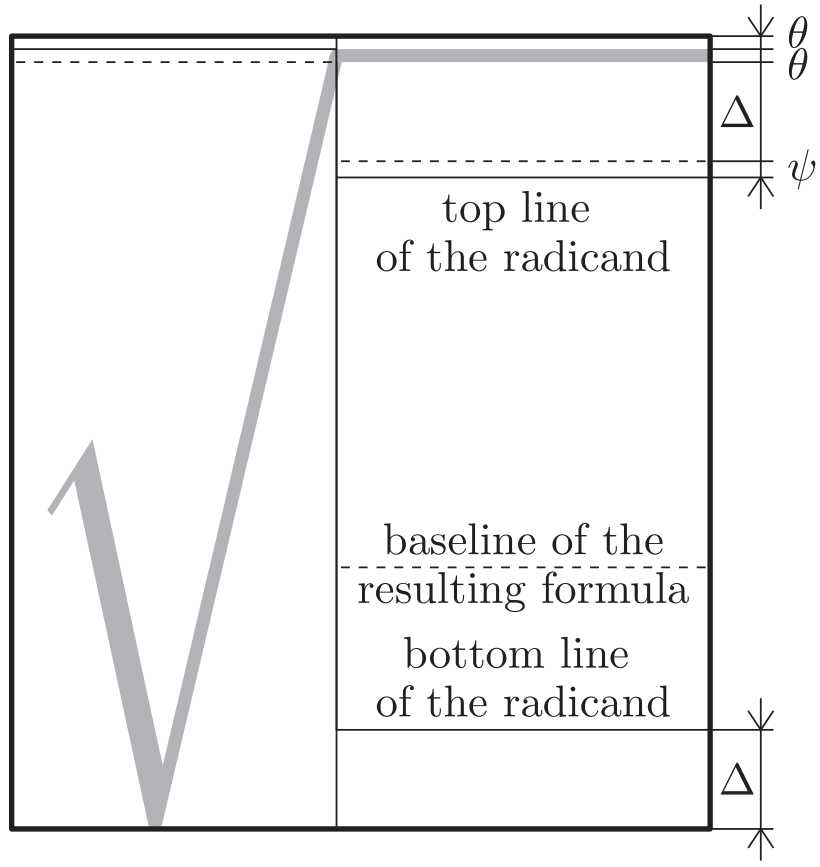


From the STIX fonts documentation.

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 XƎLATEX
- LuaLATEX support imminent

OpenType Maths Fonts

Cambria Math

Microsoft

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

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

Asana Math

Apostolos Syropoulos

$$F(s) = \mathscr{L}\{f(t)\} = \int_0^\infty \mathrm{e}^{-st} f(t)\,\mathrm{d}t$$

```
\setmathfont{Asana Math}
```

XITS Math

Khaled Hosny

$$F(s) = \mathscr{L}\{f(t)\} = \int_0^\infty \mathrm{e}^{-st} f(t)\,\mathrm{d}t$$

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

OpenType Maths Fonts

STIX

$$F(s) = \mathscr{L}\{f(t)\} = \int_0^\infty \mathrm{e}^{-st} f(t)\,\mathrm{d}t$$

```
\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)
- Inputing symbols and characters:

Symbols in the source

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

ascii	w
unicode	w
	(U+1D464)

Symbols in the source

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

name	`\circledast`
char	⊛
	(U+229B)

Symbols in the source

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

name	\mbfx
alphabet	\mathbf{x}
char	$\mathbf{x}$

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathup`	•	•	•
`\mathit`	•	•	
`\mathbfup`	•	•	•
`\mathbfit`	•	•	

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

αβγδεϵζηθϑικϰλμνξοπϖρϱσστυφϕχψω

ΑΒΓΔΕΖΗΘΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ

0123456789

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathup`	•	•	•
`\mathit`	•	•	
`\mathbfup`	•	•	•
`\mathbfit`	•	•	

$$abcdefghijklmnopqrstuvwxyz$$

$$ABCDEFGHIJKLMNOPQRSTUVWXYZ$$

$$\alpha\beta\gamma\delta\varepsilon\epsilon\zeta\eta\theta\vartheta\iota\kappa\varkappa\lambda\mu\nu\xi o\pi\varpi\rho\varrho\varsigma\sigma\tau\upsilon\varphi\phi\chi\psi\omega$$

$$A B \Gamma \Delta E Z H \Theta \varTheta I K \Lambda M N \Xi O \Pi P \Sigma T \Upsilon \Phi X \Psi \Omega$$

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathup`	•	•	•
`\mathit`	•	•	
`\mathbfup`	•	•	•
`\mathbfit`	•	•	

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

αβγδεεζηθϑικκλμνξοπϖρϱςστυφϕχψω

ΑΒΓΔΕΖΗΘΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ

0123456789

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathup`	•	•	•
`\mathit`	•	•	
`\mathbfup`	•	•	•
`\mathbfit`	•	•	

$$\mathit{abcdefghijklmnopqrstuvwxyz}$$

$$\mathit{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$$

$$\mathit{\alpha\beta\gamma\delta\epsilon\varepsilon\zeta\eta\theta\vartheta\iota\kappa\varkappa\lambda\mu\nu\xi o\pi\varpi\rho\varrho\varsigma\sigma\tau\upsilon\varphi\phi\chi\psi\omega}$$

$$\mathit{A B \Gamma \Delta E Z H \Theta \varTheta I K \Lambda M N \Xi O \Pi P \Sigma T \Upsilon \Phi X \Psi \Omega}$$

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`	•		•
`\mathsfit`	•		
`\mathbfsfup`	•	•	•
`\mathbfsfit`	•	•	

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

0123456789

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`	•		•
`\mathsfit`	•		
`\mathbfsfup`	•	•	•
`\mathbfsfit`	•	•	

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`	•		•
`\mathsfit`	•		
`\mathbfsfup`	•	•	•
`\mathbfsfit`	•	•	

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

αβγδεεζηθϑικϰλμνξοπϖρϱσστυφϕχψω

ΑΒΓΔΕΖΗΘΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ

0123456789

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`	•		•
`\mathsfit`	•		
`\mathbfsfup`	•	•	•
`\mathbfsfit`	•	•	

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

αβγδεεζηθϑικϰλμνξοπϖρϱσστυφϕχψω

ΑΒΓΔΕΖΗΘΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathtt`	•		•
`\mathbb`	•		•
`\mathscr`	•		
`\mathbfscr`	•		
`\mathfrak`	•		
`\mathbffrak`	•		

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

0123456789

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathtt`	•		•
`\mathbb`	•		•
`\mathscr`	•		
`\mathbfscr`	•		
`\mathfrak`	•		
`\mathbffrak`	•		

abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

0123456789

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathtt`	•		•
`\mathbb`	•		•
`\mathscr`	•		
`\mathbfscr`	•		
`\mathfrak`	•		
`\mathbffrak`	•		

$\mathscr{abcdefghijklmnopqrstuvwxyz}$

$\mathscr{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathtt`	•		•
`\mathbb`	•		•
`\mathscr`	•		
`\mathbfscr`	•		
`\mathfrak`	•		
`\mathbffrak`	•		

$\mathscr{a b c d e f g h i j k l m n o p q r s t u v w x y z}$

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

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathtt`	•		•
`\mathbb`	•		•
`\mathscr`	•		
`\mathbfscr`	•		
`\mathfrak`	•		
`\mathbffrak`	•		

$$\mathfrak{abcdefghijklmnopqrstuvwxyz}$$

$$\mathfrak{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$$

Fourteen alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathtt`	•		•
`\mathbb`	•		•
`\mathscr`	•		
`\mathbfscr`	•		
`\mathfrak`	•		
`\mathbffrak`	•		

$\mathfrak{abcdefghijklmnopqrstuvwxyz}$

$\mathfrak{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`		•	
`\mathsfit`		•	•
`\mathbfsfit`			•

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`		•	
`\mathsfit`		•	•
`\mathbfsfit`			•
`\mathbbit`	•		
`\mathbfbb`	•		•
`\mathbfbbit`	•		

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`		•	
`\mathsfit`		•	•
`\mathbfsfit`			•
`\mathbbit`	•		
`\mathbfbb`	•		•
`\mathbfbbit`	•		
`\mathcal`	•		•
`\mathbfcal`	•		

Eight extra STIX alphabets

Alphabet switch	Latin	Greek	Numerals
`\mathsfup`		•	
`\mathsfit`		•	•
`\mathbfsfit`			•
`\mathbbit`	•		
`\mathbfbb`	•		•
`\mathbfbbit`	•		
`\mathcal`	•		•
`\mathbfcal`	•		

$\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$

$\boldsymbol{\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}}$

Styles of maths

Separation between content and form:

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

TEX $a\ A\ \gamma\ \Gamma$ French $a\ \mathrm{A}\ \gamma\ \Gamma$

ISO $a\ A\ \gamma\ \Gamma$ Upright $\mathrm{a}\ \mathrm{A}\ \gamma\ \Gamma$

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

Styles of maths

Separation between content and form:

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

TEX $a\ A\ \gamma\ \Gamma$ French $a\ \mathrm{A}\ \gamma\ \Gamma$

ISO $a\ A\ \gamma\ \mathit{\Gamma}$ Upright $\mathrm{a}\ \mathrm{A}\ \gamma\ \Gamma$

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

Styles of maths

Separation between content and form:

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

TEX $a\ A\ \gamma\ \Gamma$ French $a\ A\ \gamma\ \Gamma$

ISO $a\ A\ \gamma\ \Gamma$ Upright $\mathrm{a}\ \mathrm{A}\ \gamma\ \Gamma$

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

Styles of maths

Separation between content and form:

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

TEX $a\ A\ \gamma\ \Gamma$ French $a\ \mathrm{A}\ \gamma\ \Gamma$

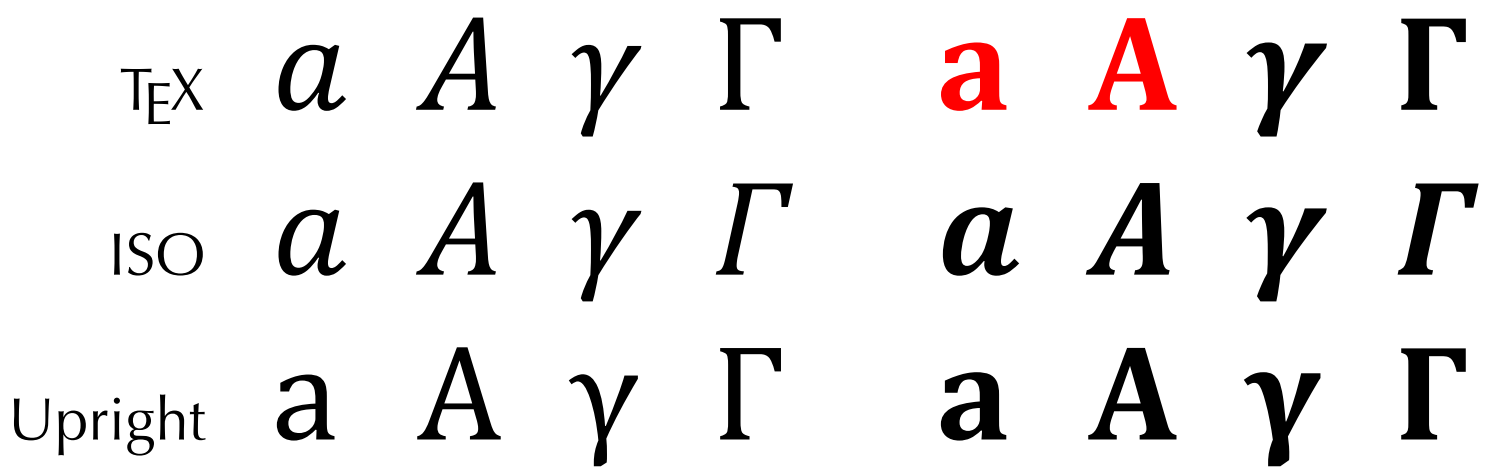
ISO $a\ A\ \gamma\ \Gamma$ Upright $\mathrm{a}\ \mathrm{A}\ \gamma\ \Gamma$

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

Styles of bold maths

Separation between content and form:

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

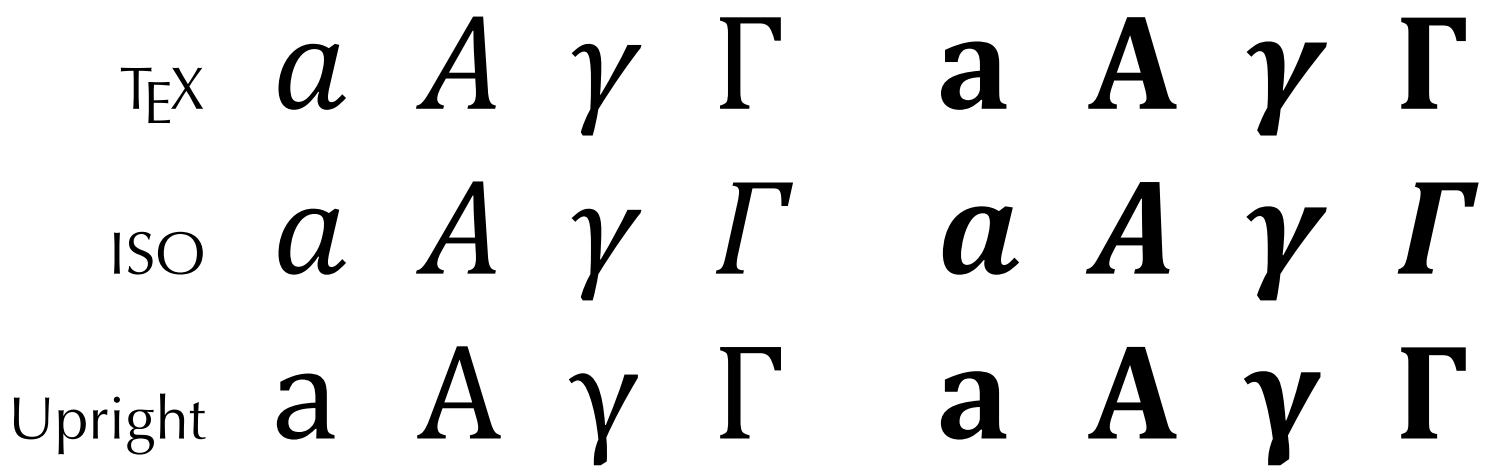



```
[bold-style=TeX]
```

Styles of bold maths

Separation between content and form:

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




```
[bold-style=ISO]
```

Styles of bold maths

Separation between content and form:

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

TEX	$\boldsymbol{a}$	$\boldsymbol{A}$	$\boldsymbol{\gamma}$	$\boldsymbol{\Gamma}$	$\mathbf{a}$	$\mathbf{A}$	$\boldsymbol{\gamma}$	$\boldsymbol{\Gamma}$
ISO	$\boldsymbol{a}$	$\boldsymbol{A}$	$\boldsymbol{\gamma}$	$\boldsymbol{\Gamma}$	$\boldsymbol{a}$	$\boldsymbol{A}$	$\boldsymbol{\gamma}$	$\boldsymbol{\Gamma}$
Upright	$\mathbf{a}$	$\mathbf{A}$	$\boldsymbol{\gamma}$	$\boldsymbol{\Gamma}$	$\mathbf{a}$	$\mathbf{A}$	$\boldsymbol{\gamma}$	$\boldsymbol{\Gamma}$

```
[bold-style=upright]
```

DEMO

Silly example

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

```
\setmathfont [
                                    ...
                                                ]{Cambria Math}
```

Silly example

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

```
\setmathfont [
              range={\equal }, Colour=009922
                                          ]{Cambria Math}
```

Silly example

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

```
\setmathfont [
        range={\mathop ,\mathscr }, Colour=red
                                        ]{Cambria Math}
```

Outline

Who knows?

What next?

- Proper LuaLaTeX support
- LaTeX's 'mathversion' not supported: what is '`\boldmath`'?
- Generalising the database for maths glyphs:
  Collaboration with ConTeXt

What else?

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