

where in the source we just typed the dot below (char U0323) after the glyph. This feature is supported for the 4th bce and 6th bce Greek in Sans:

Γ̣ Ε̣ Ω̣ Μ̣ Ε̣ Τ̣ Ρ̣ Ι̣ Α̣ Γ̣ Ε̣ Ω̣ Μ̣ Ε̣ Τ̣ Ρ̣ Ι̣ Α̣

4.5 Support for Chemistry

It happens often that Greek upright characters are needed in Chemistry. People often have trouble with this (and this is why packages such as `chemgreek` exist). If Greek keyboard is available then it is easy; you just type in Greek, say `β-glucan` to get “β-glucan”. But many writers do not have the Greek keyboard enabled, and they do not need to. Usually they type `β-glucan` but the result “β-glucan” is not satisfying. One can use the “up” versions typing `β̣-glucan` but still the result “β̣-glucan” looks more Math than Chemistry. To help with this, the `fontsetup` package provides commands such as `\chemAlpha`, `\chemalpha`, `\chemBeta`, `\chembeta`, etc. So this information essentially would only belong to the `fontsetup` documentation if it was not for kappa and rho. If we type in Greek `κ-compound` we get “κ-compound” which is not satisfying, as kappa is too cursive for this use. So the NewCM family provides an alternative kappa for this reason and this is how `\chemkappa` is defined in `fontsetup`:

```
\newcommand{\chemkappa}{\textrm{\char"03F0}}:
```

We write `\chemkappa-compound` and now get “κ-compound”.

(The `\textrm` command in the above definition is there to make the command work in math mode too.) Similar is the situation for `\chemrho` (ρ) and `\chemrhoalt` (ϱ).

5 Russian

Russian is supported using the glyphs from the `cmu` package but it has considerable improvements (for example, the quality of the bold sans (see below)).

Я помню чудное мгновенье:
 Передо мной явилась ты,
 Как мимолетное виденье,
 Как гений чистой красоты.
 (Пушкинъ)

Again, as in Greek there is a different kind of guillemots for Russian which are available in `CharacterVariant 3` (`cv03`). Compare:

Defaults guillemots: «» Russian guillemots: «» Greek guillemots: «»

Same is the situation with Russian emdash which is shorter than the default:

Default emdash: —
 Russian emdash: —

6 Hebrew

The Hebrew blocks U0590–U05FF and Hebrew Presentation forms UFB1D–UFB4F are fully covered. and A few letters from Hebrew:

צֵלָה שִׁשְׁמִינִי אֶבְרָהָם

7 Coptic and E pact Numbers

The Coptic language is fully supported. This covers the Coptic blocks in the Greek and Coptic Unicode block (U03E2–U03EF), the full Coptic Unicode block (U2C80–U2CFF) and the Coptic E pact Numbers (U102E0–U102FF). A few letters from Coptic and E pact numbers follow:

ΑΟΓΟϢ ΝΑΙΡΥΠΠΙΟϢ ϣ ω ϛ ϣ ε

8 Cherokee

Both Unicode blocks U13A0–13FF and UAB70–UABBF for Cherokee are supported. A few letters are: ᏍᏏᏉᏚᏏ ᏍᏏᏉᏚᏏ

9 Devanagari

Devanagari script is supported for the serified font in Regular (10pt/8pt), Book (10pt/8pt), and Bold (10pt). The fonts support Hindi (as the default), Sanskrit, Marathi and Nepali Languages. The optional arguments for the `fontspec` font-selection mechanism must include

`Script=Devanagari`, `Language=XXXX` where `XXXX` must be replaced with one of `Hindi`, `Sanskrit`, `Marathi`, `Nepali`. If the `Language` parameter is not set then the default is `Hindi`. For `LuaATEX` the parameter `Renderer=Harfbuzz` must also be included.

So if say Marathi is needed as the default font document then one can use the following:

```
\usepackage{fontspec}
\setmainfont[Script=Devanagari, Language=Marathi,%
Renderer=Harfbuzz]{NewCM10Devanagari-Book.otf}
```

The Devanagari fonts were developed with the help of निरंजन (Niranjan) whose name appears in the copyright section of the fonts and I also thank him for providing the samples below.

A Sanskrit sample from बृहदारण्यकोपनिषद् (brhadāraṇyakopaniṣad) follows:

ॐ पूर्णमदः पूर्णमिदं, पूर्णात्पूर्णमुदच्यते।
पूर्णस्य पूर्णमादाय पूर्णमेवावशिष्यते॥

That^a is complete;
this^b too is complete.
From one complete comes the other. Taking out
one complete from the other too results in a complete.

^athe outer world

^bthe inner world

Next is a beautiful part of a poem in Marathi by तुकाराम (Tukaram) and its translation:

जें कां रंजलें गांजलें
त्यांसि म्हणे जो आपुलें॥ १ ॥
तो चि साधु ओळखावा।
देव तेथें चि जाणावा॥

Only the one who treats the downtrodden people equally is a sage^a.
One may sense the essence of god there.

^a “The wise” of course, not the plant.

Devanagari Unicode letters (range U0900–U097F) are also available as variables (letters) and numbers in the Regular and Book Math fonts. They are available as usually in three weights in the Math fonts so that the color is balanced when in script size (eg in exponents or indices). For this to work a version of `fontsetup` package greater or equal to 1.8 with options `default` or `olddefault` loaded is needed. This is because Devanagari letters are not Math variables in Unicode standard and hence not supported currently as such by the unicode-math package. To show this possibility next is a theorem in Hindi (mixing with Greek):

प्रमेय (Πυθαγόρας (पिथागोरास)) अगर समकोण त्रिभुज के कर्ण की लंबाई को ‘अ’ और अन्य दो भुजाओं की लंबाई को ‘क’ और ‘ख’ कहते हैं, तो भुजाओं की लंबाई के वर्गों की जोड़, कर्ण के वर्ग जितनी होती है, अर्थात् $अ^2 = क^2 + ख^2$ ।

However, if only Devanagari numbers are needed with the source using arabic numerals then one can use the Stylistic Set 04 of the Math font. So the command `\setmathfont[StylisticSet=4]{NewCMMath-Regular.otf}` with source:

```


$$\sum_{n=0}^{\infty} \frac{x^n}{n!} = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots = e^x.$$


$$9! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 9.$$


$$2^{2^2}$$


```

will have the following effect:

$$\sum_{n=0}^{\infty} \frac{x^n}{n!} = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \dots = e^x.$$

$$9! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 9.$$

۲۳²

which when the math font is reset to use Arabic numbers with `\setmathfont{NewCMMath-Book.otf}` it gives:

$$\sum_{n=0}^{\infty} \frac{1}{n!} x^n = 1 + x + \frac{1}{2!} x^2 + \frac{1}{3!} x^3 + \frac{1}{4!} x^4 + \dots = e^x.$$

$$9! = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 \cdot 6 \cdot 7 \cdot 8 \cdot 9.$$

$$2^{2^2}$$

10 Medieval Latin and Uncial Greek

The family includes new shapes for medieval and uncial Greek. The `fontsetup` package provides `\textuncial{<text>}` and `{\uncial text}` to use this shape. Let us write a sentence in this shape:

ΤΗΕ ΠΥΘΑΓΟΡΕΑΝ ΤΗΕΟΡΗΜ ΙΣ ΟΝΕ ΟΥ ΤΗΕ ΜΟΣΤ ΙΜΠΟΡΤΑΝΤ
ΤΗΕΟΡΗΜΣ ΙΝ ΜΑΤΗΕΜΑΤΙΣ.

ΤΟ ΠΥΘΑΓΟΡΕΙΟ ΘΕΩΡΗΜΑ ΕΙΝΑΙ ΑΠΟ ΤΑ ΣΗΜΑΝΤΙΚΟΤΕΡΑ ΘΕ-
ΩΡΗΜΑΤΑ ΤΩΝ ΜΑΘΗΜΑΤΙΚΩΝ.

11 Braille

Braille, both 6dot (uni2801–uni283F) as well as 8dit (uni2840–uni28FF) patterns are included in two versions. The Regular font provides the characters for sighted persons (such as teachers) so they can easily see which dots are on and which off. The Sans font contains the true Braille characters. I decided to have the sighted version in the Regular font since a blind person does not need the real Braille pattern, as those are produced by embossers. The Braille patterns here are meant as fonts to typeset text mainly for sighted persons.

	6dot	8dot
Regular version	⠠⠠⠠⠠⠠⠠	⠠⠠⠠⠠⠠⠠⠠⠠
Sans version	⠠⠠⠠⠠⠠⠠	⠠⠠⠠⠠⠠⠠

12 Ipa symbols

IPA symbols are included and following a suggestion of Huanyu Liu the kerning found in `tipa` package has been added here and further improved. Moreover the letters eth, eng, beta, theta and chi exists in IPA-style in the fonts and are accessible in the `ss05` lookup table since they are in a different design from the Latin and Greek letters. You can access this lookup table using the `\textipa` command of the `fontsetup` package.

	Non-IPA	IPA
Regular	ð ŋ β θ χ	ð ŋ β θ χ
Sans	ð ŋ β θ χ	ð ŋ β θ χ

I am grateful to निरंजन (Niranjan) for suggesting and testing all the IPA improvements that follow:

The joining of two characters such as \underline{ts} , \underline{dz} , \widehat{kp} , \widehat{tj} etc is also supported. The low tie is the character U035C and the upper tie is U0361. The \underline{ts} is produced by typing the sequence t then the low tie and then s. Similarly \widehat{kp} is produced by typing the sequence k then the upper tie and then p. For \widehat{tj} and \underline{dz} the fonts have a contextual chaining substitution table that uses a tie which prints lower so it does not touch j and z. In cases that one wants to show the tie as $x\underset{y}{\frown}z$ then one needs to enable the cv5 character variant since the tie characters (U035C and U0361) are marks and not base glyphs. One can do that with a command such as

```
\newfontfamily{\showtie}[CharacterVariant=5]{NewCM10-Book.otf}
```

There is also an older practice that such sequences are joint into a ligature. This is not the modern way of writing but it seems than many people in the linguistics still prefer it. The fonts support this, if one enables the `lipa` table (local ipa) of the fonts. This can be done by adding the `RawFeature+=lipa` to the font specs when loading it and it is done automatically with the commands `\textoldipa{arg}` and `\oldipatext arg` of the `fontsetup` package.

For example, `\textoldipa{ts, tj}` produces \underline{ts} , \widehat{tj} .

All other symbols of the `tipa` package are supported. Some examples are:

$p̣$, $'$, $ɿ$, l , d , j , $ʒ$, e , $ḳ$, $ṃ$, $ṭ$, $ʈ$, etc.

It is worth noting that all of the above is also available in the Mono family:

| \underline{ts} | \widehat{tj} | \underline{ts} | $p̣$ | $'$ | $ɿ$ | l | d | j | $ʒ$ | e | $ḳ$ | $ṃ$ | $ṭ$ | $ʈ$ |

Another issue is that IPA used to use the Italic alternation of “g” even in the upright design. This restriction was lifted in 1949 as can be seen on page 3 in [IPAreview].

Even though the normal upright shape is accepted as an alternation, there are linguists who prefer the older (Italic) shape “g” and hence we are making it the default in the stylistic set dedicated for IPA (ss05).

Another such case is with the “a” shape. It has a different visual form in Italics “a” which resembles to a distinct symbol of IPA leading to a wrong transcription. In order to avoid this confusion, we have used the slanted version “a” of “a” in ss05. The other vowel symbol (ie, α (U0251)) is also available in the fonts.

Next we give a real example of using IPA symbols. The quote below is from *A course in phonetics*, Ladefoged, Peter and Johnson, Keith, (2014), Cengage learning, pp. 285–286, and the `StylisticSet=05` has been enabled:

Other examples of this phenomenon have also been mentioned. We saw that before [ɪ], English does not distinguish between tense and lax vowels. Consequently, the vowel that occurs in, for example, sing has a quality between that of [i] and [ɪ]. Similarly, there is no distinction between tense and lax vowels before [ɪ]. The vowel in here in most forms of American English is also intermediate between [i] and [ɪ]. The principle of maximum perceptual separation also accounts for some of the differences between languages. French has two high rounded vowels, [u] as in *tout* [tu] “all,” and [y] as in *tu* [ty] “you.”

13 Bold Sans

lm fonts and cmu fonts do not contain a properly made BoldSans. Their BoldSans is a stroke-extension of the Sans with rounded corners. NewCM fixes that and provides a true BoldSans:



14 Unicode Math coverage and options

NewCM provides full Unicode math support, that is all Mathematics Unicode Slots presented in <http://www.unicode.org/charts/> in both Math weights, Regular and Book. These blocks are:

Mathematical Symbols

- Arrows (uni2190–uni21FF)
- Supplemental Arrows-A (uni27F0–uni27FF)
- Supplemental Arrows-B (uni2900–uni297F)
- Supplemental Arrows-C (u1F800–u1F8FF)
- Additional Arrows (uni2B00–uni2BFF)
- Miscellaneous Symbols and Arrows (uni2B00–uni2BFF)

Mathematical Alphanumeric Symbols

- (u1D400–u1D7FF)
- Arabic Mathematical Alphabetic Symbols (u1EE00–u1EEFF)
- Letterlike Symbols (uni2100–uni214F)

Mathematical Operators

- (uni2200–uni22FF)

Basic operators: Plus, Factorial
 (uni0000–uni007F)
 Division, Multiplication
 (uni0080–uni00FF)
 Supplemental Mathematical Operators
 (uni2A00–uni2AFF)
 Miscellaneous Mathematical Symbols-A
 (uni27C0–uni27EF)
 Miscellaneous Mathematical Symbols-B
 (uni2980–uni29FF)
 Floors and Ceilings (uni2308–uni230B)
 Invisible Operators (uni2061–uni2064)

Geometric Shapes (uni25A0–25FF)

Additional Shapes (uni2B00–uni2BFF)
 Box Drawing (uni2500–uni257F)
 Block Elements (uni2580–uni259F)
 Geometric Shapes Extended (u1F780–u1F7FF)

Unfortunately, the `unicode-math` package does not provide commands currently for the hundreds of extra glyphs that have been added in order to fully cover the above Unicode ranges. The user can consult the Unicode charts at the above link and access the required glyph with `\char"#` where `#` is the Unicode number of the slot the glyph belongs to.



For example, `\char"2BDA` will give the Hygeia symbol (uni2BDA) the Rod of Asclepius as shown above (grayed and scaled $\times 8$). The glyph that appeared in TUGboat (see [AT]), being more realistic will be moved to a new font in the future with ornaments.

14.1 Optical sizes for more glyphs

So far the fonts provided optical sizes for 1st and 2nd order exponents for letters. This was not true though for binary operators and some symbols commonly used in mathematics. For example, the `\perp` symbol (\perp) often appears in 2nd order exponents and then it appeared very thin. Some printers could even hardly print its thin lines. Now, such glyphs plus several binary operators, such as $+$, $-$, \pm , \dagger etc are now provided in optical sizes, so that expressions such as

$$+^{++} \perp^{\perp\perp} \ast^{\ast\ast} \frac{|P_{F^\perp}(K)|}{e^{(x+y)^\ast}}$$

appear on screen and print properly on printers. Zoom or print and compare with `latinmodern-math` font:

$$+^{++} \perp^{\perp\perp} \ast^{\ast\ast} \frac{|P_{F^\perp}(K)|}{e^{(x+y)^\ast}}$$

14.2 Math Script

Calligraphic letters are accessed as usual with `\mathcal` producing

ABCDEFGHIJKLMNOPQRSTUVWXYZ

However, mathematicians often need a second level of “scriptness”. The fonts provide an alternative calligraphic, a script design at StylisticSet 1. For this to work one has to re-set the math font using

```
\setmathfont[StylisticSet=1]{NewCMMath-Book.otf}
```

(or the Regular version). So the following code

```


$$\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$$

\setmathfont[StylisticSet=1]{NewCMMath-Book.otf}

$$\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$$


$$\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$$

\mscra\mscrb\mscrc\mscrd\mscre\mscrf\mscrg\mscrh\mscri\mscrj
\mscrk\mscrl\mscrn\mscro\mscrp\mscrq\mscrr\mscrs\mscrt
\mscru\mscrv\mscrw\mscrx\mscry\mscrz
\setmathfont{NewCMMath-Book.otf}

$$\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$$


```

produces

ABCDEFGHIJKLMNOPQRSTUVWXYZ
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ

14.3 Blackboard Bold

The Math fonts in the past used to have the AMS blackboard bold letters, which were accessed with the command `\mathbb`. These designs were not matching in style computer modern. Starting from version 5.0 of the fonts, they now contain a the full Unicode list of blackboard bold in cm-matching design. These are:

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
0123456789 πγΓΠΣDdeij

The old shapes, the ones of AMS, are also available for backwards compatibility. To access them one needs to load the math font enabling the `ss03` stylistic set using for example

```
\setmathfont[StylisticSet=3]{NewCMMath-Book.otf}
```

Then the above blackboard bold design changes to

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz
 0123456789 $\pi\sigma\Gamma\Pi\Sigma Ddeij$

If using `fontsetup` then you can choose the AMS blackboard bold with the option `amsbb`.

14.4 Upright and extensible integrals

The Math fonts (both Regular and Book weights) include upright integrals in the `ss02` StylisticSet. Use with

```
\setmathfont[StylisticSet=2]{NewCMMath-Book.otf}
or
\setmathfont[StylisticSet=2]{NewCMMath-Regular.otf}
```

or use the `upint` option of the `fontsetup` package with

```
\usepackage[upint,default]{fontsetup}
```

for the Book weight, or

```
\usepackage[upint,olddefault]{fontsetup}
```

for the regular weight.

Moreover, extensible integrals are supported by the fonts but *NOT* by the Unicode TeX engines. The following code is a trick so that extensible integrals can be constructed using Lua \LaTeX . The result is shown at the end of the article. What the code below does, is that it defines the slot `uni222B` (integral) as a delimiter. And then this is extended as a delimiter with the mechanism that the font provides.

```
\documentclass{article}
\usepackage[default]{fontsetup}
\begin{document}
$
\Uleft\Udelimiter 0 0 "222B
\begin{pmatrix}
  1\2\3\4\5\6\7\8\9
\end{pmatrix}
\Uright.
$
\end{document}
```

$$\int \begin{pmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \\ 8 \\ 9 \end{pmatrix}$$

14.5 Additional and alternative characters in Math

The Math fonts provide the character `\varnothing` (\emptyset), as an alternative to `\emptyset` (a slashed zero), through Character Variant `cv01`. The `fontsetup` package provides the option ‘`varnothing`’ to easily switch to the alternative character.

It also provides two more symbols that correspond to the commands

`\nrightrightarrows` (\rightrightarrows)

and

`\nleftleftarrows` (\nleftleftarrows)

and supported by the `default` and `olddefault` options of the `fontsetup` package. These symbols are not in the Unicode Standard and so they are added in the Private Area of the fonts.

15 The Medieval Latin and Uncial Greek glyph complement

Table 1: NewCMUncial10-Book.otf

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Basic Latin																
<code>U+0020-002F</code>		!	"	#	\$	%	&	'	()	*	+	,	-	.	-
<code>U+0030-003F</code>	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	-
<code>U+0040-004F</code>	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	Ⓖ	Ⓗ	Ⓘ	Ⓚ	Ⓛ	Ⓜ	Ⓝ	Ⓞ		
<code>U+0050-005F</code>	Ⓟ	Ⓠ	Ⓡ	Ⓢ	Ⓣ	Ⓤ	Ⓥ	Ⓦ	Ⓧ	Ⓨ	Ⓩ	-	-	-	-	-
<code>U+0060-006F</code>	-	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ
<code>U+0070-007F</code>	p	q	r	s	τ	u	v	ω	x	ϣ	z	-	-	-	-	-
Latin-1 Supplement																
<code>U+00A0-00AF</code>	-	-	-	-	-	-	-	-	-	¨	-	-	-	-	-	-
<code>U+00B0-00BF</code>	-	-	-	-	-	-	-	·	-	-	-	-	-	-	-	-
Greek and Coptic																
<code>U+0370-037F</code>	-	-	-	-	´	˘	-	-	-	-	-	-	-	-	-	;
<code>U+0380-038F</code>	-	-	-	-	´	˘	Ⓩ	·	Ⓩ	Ⓩ	Ⓩ	-	Ⓩ	-	Ⓩ	Ⓩ
<code>U+0390-039F</code>	ı	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ
<code>U+03A0-03AF</code>	Ⓩ	Ⓩ	-	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ
<code>U+03B0-03BF</code>	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ	Ⓩ
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Table 1: NewCMUncial10-Book.otf *cont.*

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
U+03C0–03CF	Π	Ρ	Ϙ	ϙ	Ϛ	ϛ	Ϝ	ϝ	Ϟ	ϟ	Ϡ	ϡ	Ϣ	ϣ	Ϥ	-
	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

Total number of glyphs in NewCMUncial10-Book.otf: 160

References

- [AT] Antonis Tsolomitis, *The NewComputerModern font family*, TUGboat Vol. 42, No. 1, 2021.
- [IPArevis] Council actions on revisions of the IPA, Phonetic Representation: b) Revision of the IPA, Journal of the International Phonetic Association, Volume 23, Issue 1, June 1993, pp. 32–34.