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The New Computer Modern FontFamily

version 5.02

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1 Introduction

The NewComputerModern FontFamily is a huge extension (“huge” in terms of the number of additional glyphs) of the `lm` fonts. It is not just a family adding random missing glyphs but it adds support for several more languages and shapes needed for academic (and not only) work. Currently it supports among others, Greek¹, Cyrillic², Hebrew, Cherokee and Coptic. Since it supports diacritics stacking the number of languages that use the Latin alphabet is greatly expanded. Diacritics stacking is also needed for Greek for papyrological work and this is also supported.

Version 4.0 adds to the classic design of computer modern new shapes for Latin and Greek, in particular it adds families for Medieval Latin and Uncial Greek matching in style to the main family.

In terms of weights and sizes, all of its shapes come in Regular, Book weights at 10 and 8 point sizes and in Bold at 10 points.

Mathematics is also supported in Regular and Book weights, currently providing a full coverage of the Unicode Math blocks (with a few more glyphs needed for Mathematics that Unicode has forgotten to encode).

What follows is a sequence of commands and results so as to show how to access all features of the fonts. Character tables are also included.

2 How to load the fonts

The simpler way to load the fonts is through the `fontsetup` package. The command

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

will load the Book weight of the NewCM family, and

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

will load the Regular weight.

Also notice that the fonts support the microtype package for fine typographic tuning. See the documentation of microtype for this.

¹from Claudio Beccari’s Greek.

²from the `cmu` package.

3 The Latin alphabet

3.1 Ligatures and stylistic alternatives in Latin

The Serif font includes additional ligatures fb ffb ffh ffj ffk ffl fh fj ft fk and the same with longs instead of f in the default liga table (in addition to the default fi fl ffi ffl ff). It also includes an alternative k (in the cv01 table) and sp ch ck ct st in the dlig table. Finally it also includes “end” versions for the letters a, e, m, n and r in the cv02 table. To access the alternative k load the relative font (here the Book weight) with

`\setmainfont[CharacterVariant=1]{NewCM10-Book.otf}`

To load the same font with the dlig table enabled use

$$\setmainfont[RawFeature=+dlig]{NewCM10-Book.otf}$$

and to load the font with endings variations use

8


```
\setmainfont[CharacterVariant=2]{NewCM10-Regular.otf}
```

Of course the above can be mixed separating the optional arguments with comma, or one can define a custom font say by using

`\newfontfamily\myfont[<options to enable>]{NewCM10-Regular.otf}`

Regular	k	a e m n r	sp ch ck ct st
cv01	k		
cv02		a e m n r	
dlig			sp ch ck ct st

3.2 Old Italic

The fonts also fully support the Old Italic Unicode block (U10300–U1032F) in the Sans font. For example, the slots U10307, U10310, U10312, U10314, U1031F and U1032F are .

3.3 Diacritics Stacking

Diacritics—the full block U+0300 to U+036F—and diacritics stacking is supported. In the margin you can see an example of stacking on the letter “x” in Roman, Sans and Mono. If you need to enter these accents you can use the `\char` command or just copy-paste from the following line (from this pdf file or the provided source \TeX file):

$$\begin{aligned} \textcircled{1} & \text{C} \rightarrow \text{E} \rightarrow \text{G} \rightarrow \text{H} \text{ see } \rightarrow \parallel \text{K} \rightarrow \text{N} \rightarrow \text{P} \rightarrow \text{Q} \rightarrow \text{R} \rightarrow \text{S} \rightarrow \text{T} \rightarrow \text{U} \rightarrow \text{V} \rightarrow \text{W} \rightarrow \text{X} \rightarrow \text{Y} \rightarrow \text{Z} \rightarrow \text{AA} \rightarrow \text{AB} \rightarrow \text{AC} \rightarrow \text{AD} \rightarrow \text{AE} \rightarrow \text{AF} \\ \textcircled{2} & \text{E} \rightarrow \text{G} \rightarrow \text{H} \rightarrow \text{I} \rightarrow \text{J} \rightarrow \text{K} \rightarrow \text{L} \rightarrow \text{M} \rightarrow \text{N} \rightarrow \text{O} \rightarrow \text{P} \rightarrow \text{Q} \rightarrow \text{R} \rightarrow \text{S} \rightarrow \text{T} \rightarrow \text{U} \rightarrow \text{V} \rightarrow \text{W} \rightarrow \text{X} \rightarrow \text{Y} \rightarrow \text{Z} \rightarrow \text{AA} \rightarrow \text{AB} \rightarrow \text{AC} \rightarrow \text{AD} \rightarrow \text{AE} \rightarrow \text{AF} \\ \textcircled{3} & \text{E} \rightarrow \text{G} \rightarrow \text{H} \rightarrow \text{I} \rightarrow \text{J} \rightarrow \text{K} \rightarrow \text{L} \rightarrow \text{M} \rightarrow \text{N} \rightarrow \text{O} \rightarrow \text{P} \rightarrow \text{Q} \rightarrow \text{R} \rightarrow \text{S} \rightarrow \text{T} \rightarrow \text{U} \rightarrow \text{V} \rightarrow \text{W} \rightarrow \text{X} \rightarrow \text{Y} \rightarrow \text{Z} \rightarrow \text{AA} \rightarrow \text{AB} \rightarrow \text{AC} \rightarrow \text{AD} \rightarrow \text{AE} \rightarrow \text{AF} \\ \textcircled{4} & \text{E} \rightarrow \text{G} \rightarrow \text{H} \rightarrow \text{I} \rightarrow \text{J} \rightarrow \text{K} \rightarrow \text{L} \rightarrow \text{M} \rightarrow \text{N} \rightarrow \text{O} \rightarrow \text{P} \rightarrow \text{Q} \rightarrow \text{R} \rightarrow \text{S} \rightarrow \text{T} \rightarrow \text{U} \rightarrow \text{V} \rightarrow \text{W} \rightarrow \text{X} \rightarrow \text{Y} \rightarrow \text{Z} \rightarrow \text{AA} \rightarrow \text{AB} \rightarrow \text{AC} \rightarrow \text{AD} \rightarrow \text{AE} \rightarrow \text{AF} \end{aligned}$$

Some of the upper accents

\ / ^ ~ - — ∪ • ∴ ? ○ ∥
 ∨ ! || ≡ ∩ ∪ ε × { } [] ⊂ ⊃ ≈ ∞

Some of the lower accents

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292 293 294 295 296 297 298 299 300 301 302 303 304 305 306 307 308 309 310 311 312 313 314 315 316 317 318 319 320 321 322 323 324 325 326 327 328 329 330 331 332 333 334 335 336 337 338 339 340 341 342 343 344 345 346 347 348 349 350 351 352 353 354 355 356 357 358 359 360 361 362 363 364 365 366 367 368 369 370 371 372 373 374 375 376 377 378 379 380 381 382 383 384 385 386 387 388 389 390 391 392 393 394 395 396 397 398 399 400 401 402 403 404 405 406 407 408 409 410 411 412 413 414 415 416 417 418 419 420 421 422 423 424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456 457 458 459 460 461 462 463 464 465 466 467 468 469 470 471 472 473 474 475 476 477 478 479 480 481 482 483 484 485 486 487 488 489 490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511 512 513 514 515 516 517 518 519 520 521 522 523 524 525 526 527 528 529 530 531 532 533 534 535 536 537 538 539 540 541 542 543 544 545 546 547 548 549 550 551 552 553 554 555 556 557 558 559 560 561 562 563 564 565 566 567 568 569 570 571 572 573 574 575 576 577 578 579 580 581 582 583 584 585 586 587 588 589 590 591 592 593 594 595 596 597 598 599 600 601 602 603 604 605 606 607 608 609 610 611 612 613 614 615 616 617 618 619 620 621 622 623 624 625 626 627 628 629 630 631 632 633 634 635 636 637 638 639 640 641 642 643 644 645 646 647 648 649 650 651 652 653 654 655 656 657 658 659 660 661 662 663 664 665 666 667 668 669 670 671 672 673 674 675 676 677 678 679 680 681 682 683 684 685 686 687 688 689 690 691 692 693 694 695 696 697 698 699 700 701 702 703 704 705 706 707 708 709 710 711 712 713 714 715 716 717 718 719 720 721 722 723 724 725 726 727 728 729 730 731 732 733 734 735 736 737 738 739 740 741 742 743 744 745 746 747 748 749 750 751 752 753 754 755 756 757 758 759 760 761 762 763 764 765 766 767 768 769 770 771 772 773 774 775 776 777 778 779 780 781 782 783 784 785 786 787 788 789 790 791 792 793 794 795 796 797 798 799 800 801 802 803 804 805 806 807 808 809 810 811 812 813 814 815 816 817 818 819 820 821 822 823 824 825 826 827 828 829 830 831 832 833 834 835 836 837 838 839 840 841 842 843 844 845 846 847 848 849 850 851 852 853 854 855 856 857 858 859 860 861 862 863 864 865 866 867 868 869 870 871 872 873 874 875 876 877 878 879 880 881 882 883 884 885 886 887 888 889 890 891 892 893 894 895 896 897 898 899 900 901 902 903 904 905 906 907 908 909 910 911 912 913 914 915 916 917 918 919 920 921 922 923 924 925 926 927 928 929 930 931 932 933 934 935 936 937 938 939 940 941 942 943 944 945 946 947 948 949 950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970 971 972 973 974 975 976 977 978 979 980 981 982 983 984 985 986 987 988 989 990 991 992 993 994 995 996 997 998 999 1000 1001 1002 1003 1004 1005 1006 1007 1008 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 1019 1020 1021 1022 1023 1024 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 1035 1036 1037 1038 1039 1040 1041

Please note that stacking is by default supported with xetex. With luatex you have to add the option `Renderer=Harfbuzz`, say by

```
\addfontfeature{Renderer=Harfbuzz}
```

Also notice that your text editor may not support stacking. The editor may show the accents one after the other, but the pdf produced by xetex or luatex will have the accents stacked.

3.3.1 Coloring diacritics

If one wants to use color for diacritics, different from the color of the base character this does not work with Xe_{La}T_EX (the commands of the `color` package break the stacking mechanism). It works though with Lua_{La}T_EX using the `luacolor` package. However, there is a problem when the base glyph and the first diacritic above exist in the font as a precomposed character. For example, this is the case with aacute (á) (U+00E1). Such characters are treated as one by Lua and they can not be colorized with different colors. A work around is to place the empty character U+034F between “a” and acute (U+0301). So the following minimal example produces the result below:

```
\documentclass{article}
\usepackage[olddefault]{fontsetup}
\usepackage{luacolor}
\pagestyle{empty}
\newfontfamily{\ncmtest}[Renderer=Harfbuzz]{NewCM10-Regular.otf}
\definecolor{orange}{RGB}{255,191,0}
\definecolor{colorone}{RGB}{91,0,250}
\definecolor{colortwo}{RGB}{250,0,121}
\definecolor{colorthree}{RGB}{0,204,250}
\definecolor{colorfour}{RGB}{14,250,0}
\definecolor{colorfive}{RGB}{255,150,0}
\definecolor{colorgray}{gray}{0.8}
\newcommand{\emptydiacritic}{\char"034F}
\begin{document}
\Huge
{\ncmtest \color{colorgray}a\color{colorfour}\color{colortwo}%
\emptydiacritic\color{colorthree}\color{colorone}\color{colorfive}~}
\end{document}
```



4 Greek

The full Unicode Greek block is supported, which is

- U0370–U03FF for monotonic, where missing glyphs, such as Heta (Ϟ), Pamphilian digamma (ϙ) etc, have been added. For example, it is now possible to write

βιβλίο instead of βιβλίο.

- U1F00–U1FFF for polytonic, and
- U10140–U1018F for ancient Greek numbers.

Θεώρημα 4.1 (Πυθαγόρειον) *Ἐν τοῖς ὀρθογωνίοις τριγώνοις τὸ ἀπὸ τῆς τῆν ὀρθὴν γωνίαν ὑποτείνουσας πλευρᾶς τετράγωνον ἴσον ἐστὶ τοῖς ἀπὸ τῶν τῆν ὀρθὴν γωνίαν περιεχουσῶν πλευρῶν τετραγώνοις.*

Small Caps is included (in Mono font too) and all polytonic accents of Greek. Ypogegrammeni is the default for all characters including Small Caps and prosigrammeni is offered as an alternative shape in the `ss01` lookup table:

	ypogegrammeni	prosigrammeni
regular	Ͱ ͱ Ͳ ͳ ʹ ͵	Ͱͱ ͱͲ Ͳͳ ͳʹ ʹ͵
sans	Ͱͱ ͱͲ Ͳͳ ͳʹ ʹ͵	Ͱͱ ͱͲ Ͳͳ ͳʹ ʹ͵
mono	Ͱͱ ͱͲ Ͳͳ ͳʹ ʹ͵	ͰͱͲͳʹ͵ ͱͲͳʹ͵

The prosigrammeni alternates can be accessed with

`\textprosigrammeni{<text>}`

or the

`{\prosigrammeni <text>}`

of the `fontsetup` package.

4.1 Other character variants

Guillemots (left and right) have a different shape for Greek. For this to work the fonts must be loaded with the `cv04` character variant.

Compare the default guillemots: «» with Greek guillemots: «».

There is a serious problem with Unicode and the Greek anoteleia (U0387); the Greek semicolon. Unicode “thinks” that this character is the same with periodcentered (U00B7). This influences the way keyboards are configured by several vendors such as xorg. Anoteleia is a dot written at x-height and not at 1/2 the x-height as the periodcentered. Although Unicode recognizes the problem³, although they recognize that with their current standard you can not correctly write the Greek language, they refuse to fix it, justifying it by saying the magical words “backwards compatibility” (to a ...mistake, one could add).

NewComputerModern can not allow this, as it defies the purpose of its existence, which is to properly write every supported language. So enabling the CharacterVariant 04 (`cv04`) in addition to correct guillemots for Greek it maps periodcentered (produced by the keyboards (in Greek Linux keyboards by `AltGr+q`) to proper anoteleia.

³personal communication

It also fixes a long standing issue with the Greek apostrophe (') (U1FBD) which is not the same with quoteright (') (U2019). U1FBD named as “Greek Koronis” by Unicode is the proper character.

Another problem that has to do with quotes inside quotes. The internal quotes in Greek should be written with the characters `quotedblleft` and `quotedblbase`⁴. For example, this is correct for Greek

«άλφα “βήτα»,»

But the keyboards only produce `quotesingle` which is already mapped to apostrophe and it is difficult to remember the names “`quotedblleft`” and “`quotedblbase`”. So when enabling `cv04` one can define the commands

`\newcommand\leftgrquotes{\char"201C}`

and

`\newcommand\rightgrquotes{\char"201E}`

for the rare case one needs quotes inside quotes. The `fontsetup` package does this automatically for Greek if the `xgreek` package has been loaded *before* the `fontsetup` package or when the language is set to Greek by, say, the Babel package. Otherwise, for non-Greek documents with small passages of Greek, the author may enable `cv04` by creating a custom command such as

`\newcommand\propergreek[CharacterVariant=4]{NewCM10-Book.otf}`

A phrase with Greek quotes inside quotes, proper anoteleia, and proper apostrophe is

«φώναζε: “απ’ έξω την προπαίδεια»,»· σαν εκδίχηση ακουγόταν...

4.2 Prosodic symbols

In Greek philology and in linguistics it is often needed to stack accent-type symbols above letters, even if they are not vowels. Although rare in writings, it is for example valid to place dieresis over the consonants π , τ and χ of the nasal complexes $\mu\pi$, $\nu\tau$, $\gamma\chi$ when it is necessary to show that these are pronounced, as written, voiceless, and not voiced. For example,

κομῆρέσα, αντιανῖτανῖτικός, ελεγχῆτης

(see previous footnote). The fonts support this writing if a combining dieresis is placed after the letter to receive it. The combining dieresis is the character U0308. On Linux desktops this is easily entered pressing `Alt+Control+u`, release them, and type the sequence 0308 and space.

More than that, in linguistics, they need to combine several accents above Greek letters. All this stacking of accents is supported by the fonts. For example, one can write

ῶ ῑ ῖ Ῑ Ὶ Ί Ῐ Ῑ Ὶ Ί

⁴Μανόλης Τριανταφυλλίδης, *Νεοελληνική Γραμματική της δημοτικής*, Ανατύπωση της έκδοσης του ΟΕΕΒ 1941 με διορθώσεις, Θεσσαλονίκη 2002, σελ. 66, ενότητα 133.

by placing the combining accents from the Unicode block U0300–U0362 plus the usual Greek accents *after* the letter. So the above was typed as

$$\alpha^{-\tau} \quad \varepsilon' \sim \quad \Lambda^- \quad \gamma \Lambda^- \quad \Omega' \sim \quad \alpha^- \quad X^- \quad \psi^- \quad \dots$$

4.3 Archaic Greek writing

The Sans Serif Regular font provides access to 6th century bce and 4th century bce Greek capitals in ss04 and ss03 lookups. The `fontsetup` package provides commands such as

`\textivbce{}`, `\ivbce`, `\textvibce{}` and `\vibce`

6th century bce:

ΜΕΘΕΙΣ ΑΓΕΩΜΕΤΡΕΤΟΣ ΕΙΣΙΤΩ

4th century bce:

ΜΗΔΕΙΞ ΑΓΕΩΜΕΤΡΗΤΟΣ ΕΙΞΙΤΩ

Moreover, all fonts (except Mono & Math) support Ancient Greek Numerals (the full Unicode block of Greek digits U10140–U1018E is supported), with most symbols designed from scratch (and did not exist in C. Beccari’s original fonts). A few of the new symbols:

$$\mathrm{H}\overline{\mathrm{H}}\chi\Sigma^+\Gamma^0\overline{\Delta}^M q$$

The four numerals that already existed in this range (that is U10144–U10147) in Beccari’s fonts have been altered to a new design matching the style of cm but also provide some Ancient Greek flair. The new designs in Serifed and SansSerifed are:

ΔΗΧΜ ΔΗΧΜ

The `fontsetup` package provides commands for all of the above symbols. The commands follow the Unicode name of each slot (minus the “Greek Acrophonic”). So the Unicode slot U1014F named “Greek Acrophonic Attic Five Staters” can be accessed with the command `\atticfivestaters` and it gives Ɱ ; and the slot u10182 named “Greek Kyathos Base Sign” can be accessed with the command `\greekkyathosbasesign` and it gives Ɱ .

4.4 Support for Papyrology

Papyrology needs to declare that a glyph is missing from the papyrus or the papyrus is worn at this point and the papyrologist adds the missing glyph but it is not clear from the papyrus. This is done by adding a dot below the glyph and it is supported for all Greek glyphs in the upright fonts `monotonic` or `polytonic`:

À Á Â Ã Ä Å Æ Ç È É

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 `\upbeta-glucan` but still the result “β-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:

אבגדהושש'לצ

7 Coptic and Epact 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 Epact Numbers (U102E0–U102FF). A few letters from Coptic and Epact numbers follow:

ΛΟΓΟΣ ΝΑΙΓΥΠΤΙΟΣ ၁ ၁ ၁ ၁ ၁

8 Cherokee

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

9 Devanagari

Devanagari script is supported for the serifed 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 Lua_{TEX} 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 (brhadāranyakopanisad) 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 लम्बाई के वर्गों की जोड़, कर्ण के वर्ग जितनी होती है, अर्थात् $अ^२ = क^२ + ख^२$ ।

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:

```


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


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


$$2^{2^2}$$


```

will have the following effect:

$$\sum_{n=0}^{\infty} \frac{१}{n!} x^n = १ + x + \frac{१}{२!} x^2 + \frac{१}{३!} x^3 + \frac{१}{४!} x^4 + \dots = e^x.$$

$$१! = १ \cdot २ \cdot ३ \cdot ४ \cdot ५ \cdot ६ \cdot ७ \cdot ८ \cdot ९.$$

$$2^{2^2}$$

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:

Τῆς ΠΥΘΑΓΟΡΕΑΝ ΤῆΟΡΕΜ ΕΙΣ ΟΝ Τῆ ΜΟΣΤ ΙΜΠΟΡΤΑΝΤ
 ΤῆΟΡΕΜΣ ΙΝ ΜΑΤῆΜΑΤΙΣ.
 Το ΠῤῆΑΓΟΡΕΙΟ ΘΕΩΡῤῤΑ ΕΙΝΑΙ ΑΠΟ ΤΑ ΣΗΜΑΝΤΙΚΟΤΕΡΑ ΘΕ-
 ΩΡῤῤΑΤΑ ΤΩΝ ΜΑΘῤῤΑΤΙΚΩΝ.

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 ɳ β ʈ χ	ð ɳ β θ χ
Sans	ð ɳ β θ χ	ð ɳ 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} , $\widehat{tʃ}$ 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 $\widehat{tʃ}$ and $\underline{dʒ}$ the fonts have a contextual chaining substitution table that uses a tie which prints lower so it does not touch ʃ and ʒ. In cases that one wants to show the tie as $x\underset{\sim}{y}z$ 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, tʃ}` produces \underline{ts} , $\widehat{tʃ}$.

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

$p̣$, $'$, $ɿ$, l , d , j , $ʂ$, e , k , m , $ṭ$, $ʈ$, etc.

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

\underline{ts} $\widehat{tʃ}$ $\underline{ʈ}$ \underline{p} $'$ $ɿ$ l d j $ʂ$ e k m $ṭ$ $ʈ$

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 [ɨ], 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 [ɹ]. 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:

LM	NewCM
XΞ	XΞЯДЛ

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 , $\dot{+}$ etc are now provided in optical sizes, so that expressions such as

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

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

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

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

produces

ABCDEFGHIJKLMNOPQRSTUVWXYZ
ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
ABCDEFGHIJKLMNOPQRSTUVWXYZ

14.3 Blackboard Bold

In version 5.0 of the fonts a new NewCM blackboard bold was introduced in the place of the AMS blackboard bold letters. There were many complains from Mathematicians for this choice. I have to make a statement here: it seems that although AMS blackboard bold are not matching with the computer modern design the long time Mathematicians use them had its effect. People (including myself) got used to it and find it difficult to feel their non-matching design. Moreover, the new design can not be metrically equivalent with the past so there will be slight changes in the older documents if re-run. With this in mind and the fact that the new design should be considered “beta”, as there are characters that need improvement, I decided bring back to default the AMS design and keep the new design for new documents for the StylisticSet 3.

The AMS blackboard bold are:

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz

0123456789 $\pi\gamma\Gamma\Pi\Sigma Ddeij$

To access the new ones 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 $\pi\gamma\Gamma\Pi\Sigma Ddeij$

If using the latest `fontsetup` (to be released soon) then you can choose the NewCM blackboard bold with the option `newcmbb`.

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 `LuaLaTeX`. 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																
U+0020–002F		!	"	#	\$	%	&	'	()	*	+	,	-	.	-
U+0030–003F	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	-
U+0040–004F	Ⓐ	Ⓐ	Ⓑ	Ⓒ	Ⓓ	Ⓔ	Ⓕ	Ⓖ	Ⓗ	Ⓘ	Ⓢ	Ⓚ	Ⓛ	Ⓜ	Ⓝ	Ⓞ
U+0050–005F	Ⓟ	Ⓠ	Ⓡ	Ⓢ	Ⓣ	Ⓤ	Ⓥ	Ⓦ	Ⓧ	Ⓨ	Ⓩ	-	-	-	-	-
U+0060–006F	-	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ	ⓕ	ⓖ	ⓗ	ⓘ	Ⓤ	Ⓚ	Ⓛ	Ⓜ	Ⓝ	Ⓞ
U+0070–007F	Ⓟ	Ⓠ	Ⓡ	Ⓢ	Ⓣ	Ⓤ	Ⓥ	Ⓦ	Ⓧ	Ⓨ	Ⓩ	-	-	-	-	-
Latin-1 Supplement																
U+00A0–00AF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U+00B0–00BF	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Greek and Coptic																
U+0370–037F	-	-	-	-	´	˘	-	-	-	-	-	-	-	-	;	-
U+0380–038F	-	-	-	-	´	˘	Ⲁ	ⲁ	Ⲃ	ⲃ	Ⲅ	ⲅ	Ⲇ	ⲇ	Ⲉ	ⲉ
	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+0390–039F	İ	Λ	Β	Γ	Δ	Ε	Ζ	Η	Θ	Ι	Κ	Λ	Μ	Ν	Ξ	Ο
U+03A0–03AF	Π	Ρ	-	ϸ	Τ	Υ	Φ	Χ	Ψ	Ω	İ	Ț	λ	ε	η	ι
U+03B0–03BF	Ț	λ	β	γ	Δ	ε	ζ	Η	Θ	Ι	Κ	Λ	μ	Ν	Ξ	Ο
U+03C0–03CF	Π	Ρ	ϸ	ϸ	Τ	Υ	Φ	Χ	Ψ	Ω	İ	Ț	ο	τ	ω	-
	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.
- [IPAre] 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.