New TX font package

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1   Introduction

This package is meant to be a replacement for Young Ryu's `txfonts`. It is a complete text (`newtxtext`) and math (`newtxmath`) package with roman text font provided by a Times clone, sans serif based on a Helvetica clone, typewriter faces, plus math symbol fonts whose math italic letters are from a Times Italic clone. As of version 1.4, `newtxtext` no longer depends on `txfonts` but is based on the richer source TeXGyre Termes, but `newtxmath` continues to use the `txfonts` math glyphs with many metric adjustments and some wholesale modifications.

VERY IMPORTANT: The math package changed substantially as of version 1.5, changing a number of glyphs, adding an option to reduce the sizes of large operators, and changing the integral signs to a choice of upright and slanted forms, each available in twelve variants. The new options are `upint` (upright integrals) and `smallerops` (smaller large operators.) Some previously available options may no longer have any effect. The changes are described in detail in the section on math mode options. A summary of the changes in version 1.5 is given in the Appendix.

This math package works, after possibly replacing its math Roman and Greek letters, with fonts other than Times that are intermediate in weight between Computer Modern and Times. The free font Linux Libertine is one particular target—it is of nearly the same x-height as Computer Modern, but, not being a *modern* font, does not have a high contrast ratio, and so appears denser than Computer Modern but not as much so as Times. It is meant as a replacement for Times, but differs from it in many characteristics, more similar to MinionPro than Times, and provides a better range of variants than Times—three weights (regular, semi-bold and bold) rather than just two, and has expert features in all weights: old-style figures, more extensive and more interesting ligatures, and small caps. In my opinion, material typeset in Linux Libertine looks better than the corresponding material typeset in Times. This seems especially true on the screen. As of version 1.0, the package also offers support for MinionPro as a math font, but with limitations described in detail below. More recently, an option to provide math support for the `garamondx` text font package was added. Version 1.55 adds support for the SticksToo text fonts, a reworking of the newly released STIX2 text fonts.

The `newtx` package differs from `txfonts` in the following ways:

- the new package is split into separate text and math packages that do not need to be used in conjunction;

- both text and math packages offer options not present in the original package, described below, including the option to use libertine Latin and Greek letters to replace Times, as well as a similar option minion;

- wide accent glyphs have been corrected (they should have zero depth) so that they no longer collide with the underlying glyph;

- for those who do not like the integral in txfonts, an emboldened version of the Computer Modern integral is made available, matching the weight of the txfonts symbols;

- an upright partial derivative symbol has been added, named \uppartial;

- there is now an option to get braces more pleasing to older eyes;

- macros have been added to bring the calls to Greek symbols more into conformity with PSNFSS and Mathtime Pro 2;

- problems using AMS macro packages before txfonts are settled;

- \coloneq and \eqcolon now point to the correct glyphs;

- The problem with the ogonek accent and tabular environments (bad definition of \k) is fixed;

- The default encoding for newtxtext is now T1, but support is offered also for OT1 and LY1. As some add-on packages are available only in T1, that seems the best current choice.

- Sans serif is by default taken from TeXGyreHeros, and by default at 90% of the scale factor (set by scaled, default value 1). The option helvratio=.98 will change that to 98%.

- \varkappa $\varkappa$ has been moved from AMSb to lettersA, and is now accompanied by an upright form \upvarkappa $\varkappa$ which behaves as it should when using the frenchmath option.

2   Text mode options

Beginning with version 1.4, the text font component of newtx is no longer dependent on the txfonts, and is constructed entirely from TeXGyre Termes and some modifications thereof.

The text mode environment invoked by

\usepackage{newtxtext}

has several options, a number new to version 1.4: you may write

\usepackage[scaled=.93]{newtxtext}

to load the roman and typewriter text fonts at 93% of normal size, and the sans serif (Helvetica clone) at scale $0.9 * 0.93$. This is not of much utility if the package is used with the math package newtxmath to which it is already matched, but may be with other math packages. The options

\usepackage[scaled=.95,helvratio=.96]{newtxtext}

load roman and typewriter text fonts at 95% of normal size, and the sans serif (Helvetica clone) at scale $0.95 * 0.96$.

The option osf instructs the text fonts to use old-style figures 1234567890 rather than the default lining figures 1234567890. As of version 1.23, newtxtext loads initially with lining figures so the math package uses lining figures in math mode. The option osf changes the default to old-style figures in text at the very end of the preamble, forcing the use of old-style figures in text, but not math. In earlier versions, it was necessary to run \useosf after loading newtxmath. This is no longer required.

If you use the babel package, you should load it before newtxtext—for example:

```
\usepackage[<babel options>]{babel}
\usepackage[osf]{newtxtext}
```

More generally, the pattern of the preamble should be:

```
<encoding options>
[optional] \usepackage{substitutefont} % so you can change babel's fonts
[optional] \usepackage[<babel options>]{babel}
\usepackage[p,osf]{newtxtext}% osf in text, lining figures in math
[optional] redefine the plain theorem style if necessary
<other font loading commands>
\usepackage{newtxmath}
<substitutefont commands>
```

As an example of a `theoremstyle` definition,

```
\usepackage[theoremfont]{newtxtext}
%%% modify the default definition of plain to reduce spacing above and below
\newtheoremstyle{plain}
{0pt}   % ABOVESPACE, extra space above
{0pt}   % BELOWSPACE, extra space below
{\slshape}  % BODYFONT, italic with upright figures and punctuation
{}        % INDENT (empty value is the same as 0pt)
{\bfseries} % HEADFONT
{.}          % HEADPUNCT
{5pt plus 1pt minus 1pt} % HEADSPACE
{}           % CUSTOM-HEAD-SPEC\newtheorem{thm}{Theorem}[section]
```

Here is a specific example following this pattern, but without `theoremfont`.

```
\usepackage[LGR,T1]{fontenc} % spell out all text encodings used
\usepackage[utf8]{inputenc} %
\usepackage{substitutefont} % so we can use fonts other than those in babel
\usepackage[greek.polutoniko,english]{babel}
\usepackage[largesc,osf]{newtxtext} %
\usepackage[varqu,varl]{zi4}% inconsolata
\usepackage{cabin}% sans serif
\usepackage[vvarbb]{newtxmath}
\useosf % use oldstyle figures except in math
\substitutefont{LGR}{\rmdefault}{Tempora} % use Tempora to render Greek text
```

As of version 1.4, there are four normal figure styles: tabular lining, tabular oldstyle, proportional lining and proportional oldstyle, the default figure alignment being `tabular`. To make `proportional` the default, use the option p or `proportional`.

Option `defaultsups` (same effect as `defaultsups=true`) forces the package to use the LaTeX default footnote markers (or, at least, those in force when the package is loaded) instead of those preferred by the package—Times Roman superior figures instead of spindly ordinary Times lining figures reduced to about 70%. (Footnote markers in minipages use the default lowercase italic alphabetic characters, unless otherwise specified by redefining \thempfootnote.) For better control over position and size of footnote markers, use the `superiors` package after loading `newtxtext`. The \sustyle font switch and its related \textsu macro

know not only about figures, but also the lower case letters, including egrave, so that traditional French expressions like 1$^{\text{ière}}$ may be typeset correctly.

Option largesc changes the small cap glyphs from the default petite caps defined in TeXGyre Termes (same size as in txfonts) to a larger size that, in upright shapes, is metrically compatible with Adobe's small caps. These are about 10% larger than petite caps. For a comparison, SMALL CAPS, PETITE CAPS, and *ITALIC SMALL CAPS*, *ITALIC PETITE CAPS*.

Option adobesc is only for those who own licenses for Adobe Times Small Caps and install them into the ptmsc package downloaded from CTAN. This option loads largesc and substitutes the Adobe glyphs, where available, including their larger Regular and Bold tabular oldstyle figures.

The theoremfont option changes the default font used for the plain theoremstyle of amsthm, keeping italic text but substituting upright figures and punctuation, and, provided you have loaded amsthm before newtxtext, it will redefine the plain theoremstyle. For example, with this option, you get theorem statements like this:

Theorem 2.1. *This is Theorem Italic*: *text numbers are upright*—12345; *punctuation is in many cases upright* (*also, parens, braces {} and brackets* []). *What about question marks and exclamations*? *Also upright*! [*These fit better with math mode punctuation and figures, like*: *for all* $x \in [0, 1]$, *let* $f(x) := \exp(\alpha x)$].

Compare this to traditional plain theoremstyle with the same text:

Theorem 2.1. *This is Theorem Italic: text numbers are upright—12345; punctuation is in many cases upright (also, parens, braces {} and brackets []). What about question marks and exclamations? Also upright! [These fit better with math mode punctuation and figures, like: for all* $x \in [0, 1]$, *let* $f(x) := \exp(\alpha x)$].*

If you are using another theorem package (e.g., ntheorem, theorem) you will have to add your own descriptors as specified in the its documentation and set the body font to \slshape.

3   Spacing issues

This new version of newtxtext has spacing that is a little different, in its default state, from that of the old newtxtext. In small part this is due to the finer kerning of TeXGyre Termes, but mostly because the three parameters that govern inter-word spacing are not the same.

	txfonts	Termes
fontdimen2 (interword space)	.25em	.25em
fontdimen3 (interword stretch)	.15em	.2em
fontdimen4 (interword shrink)	.06em	.1em

That is, Termes has the same normal spacing as txfonts but its spacing is more flexible in terms of both stretch and shrink. More frequently than not, a paragraph built with Termes will occupy more space than the same built with txfonts. For this reason, the package offers some ways to change the spacing parameters. This may be important if you are trying to imitate the pagination of a document built using txfonts.

Option tighter sets the three fontdimen values to those of txfonts.

Option looser sets the three fontdimen values to {.3em,.2em,.1em} respectively.

If you want full control, the options spacing, stretch, shrink allow you to modify one or more of the above fontdimens. For example,

```
\usepackage[stretch=.15em,shrink=.095em]{newtxtext}
```

4   Math mode options

The package invoked by

`\usepackage{newtxmath}`

loads the math part of the `txfonts` (with revised metrics and additional glyphs) and should be loaded *after* the text font and its encoding have been specified, as it uses the text font settings to define how operators, numbers, math accents, `\mathrm`, `\mathbf` etc. are rendered. You should also load a Typewriter font so as not to generate mysterious error messages about metafont trying to generate `ectt10`. The package offers a number of options.

- `upint` (new as of version 1.5) selects upright integrals—the default shape is slanted. Each shape/size of integral takes one of twelve form, illustrated below in the case of display size slanted integrals.

$$\int \quad \oint \quad \iint \quad \iiint \quad \iiiint \quad \oiint \quad \oiiint \quad \varointclockwise \quad \ointctrclockwise \quad \fint \quad \sumint \quad \sqint$$

named respectively

```
\int \oint \iint \iiint \iiiint \oiint
\oiiint \varointclockwise \ointctrclockwise \fint \sumint \sqint
```

The three sizes of the upright integrals look like:

Glyph	Command
$\int$	`\smallint[up]`
$\int$	`\int[up]`
$\int$	`\displaystyle{\int[up]}`

Note that the suffix up is not required unless the document's integral style is slanted. You may find the `\smallint` is useful for inline math mode when it is important not to change the line spacing.

- `smallerops` (new as of version 1.5) causes big operators other than integrals to render up to 20% less tall, so that displayed formulas may occupy less vertical space. For example, in the following display, the first operator is the usual `\sum`, the second is what you would get with `smallerops`, the third is `\sum` and the fourth is `\smallsum`, the latter being used mainly with inline math.

$$\sum \sum \sum \Sigma$$

Similarly, there are `\smallprod` and `\smallcoprod` which, along with `\smallsum`, are of class `mathop`, unlike their Greek letter equivalents.

- (New as of version 1.5.) Two macros allow you to change `fontdimen` values in math mode: `\setSYdimens` and `\setEXdimens`, which allow you to change the `fontdimen` parameters for the `symbol` and `extension` fonts respectively. They may be used only in your preamble. Their arguments can be any valid TeX commands to change `fontdimen` values. For example:

`\def\setSYdimens{\fontdimen16\font=2pt\fontdimen17\font=1.15\fontdimen17\font }`

Don't use these unless you know what you're doing.

- `varg` causes the math italic letters `g,v,w,y` to be replaced by versions which are more distinctive—eg, useful for distinguishing math italic v from `\nu`;

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- `varvw` causes the math italic letters v,w to be replaced by versions which are more distinctive—eg, useful for distinguishing math italic v from \nu;

- `libertine` loads different versions of math italic and bold math italic based on Libertine rather than Times—the `varg` and `varvw` options are disabled in this case, as the equivalent variant forms are made available by default;

- (new in version 1.55) `stix2` loads different versions of math italic and bold math italic based on StixTwoMath rather than Times—the `varg` and `varvw` options are disabled in this case. See the documentation to the `SticksToo` package, which contains more details and some math samples.

- `minion` loads different versions of math italic and bold math italic based on MinionPro rather than Times—the `varg` and `varvw` options are disabled in this case, as the equivalent variant forms are made available by default—see the extended discussion below;

- `garamondx` loads different versions of math italic and bold math italic based on garamondx rather than Times—the `varg` and `varvw` options are disabled in this case, as the equivalent variant forms are made available by default.

- `baskervaldx` (or `Baskervaldx`) loads different versions of math italic and bold math italic based on Baskervaldx rather than Times—the `varg` and `varvw` options are disabled in this case, as the equivalent variant forms are made available by default.

- `baskerville` (or `Baskerville`, or `baskervillef` or `BaskervilleF`) loads different versions of math italic and bold math italic based on BaskervilleF rather than Times—the `varg` and `varvw` options are disabled in this case, as the equivalent variant forms are made available by default.

- `charter` (or `xcharter`) loads different versions of math italic and bold math italic based on XCharter rather than Times—the `varg` and `varvw` options are disabled in this case, as the equivalent variant forms are made available by default. **As of version 1.53, Greek letters in all styles are taken from new alphabets constructed to match the Charter style.**

- `noxchvw` (or `noXchvw` is new as of version 1.54, and applies only when math mode uses Charter alphabets. It causes math italic v and w to be rendered using Charter italic glyphs. Use this only if you don't care if math italic v is hard to distinguish from Greek \nu.

- `cochineal` loads different versions of math italic and bold math italic based on cochineal rather than Times—the `varg` and `varvw` options are disabled in this case.

- `utopia` (or `heuristica` or `erewhon`) loads different versions of math italic and bold math italic based on Utopia rather than Times—the `varg` and `varvw` options are disabled in this case, as the equivalent variant forms are made available by default. The Heuristica or Erewhon font package must be installed to use this option. (Erewhon is based on Heuristica, but is 6% smaller and has more complete figures styles and small cap styles, as well as a variety of smaller figures—superior, inferior, numerator, denominator.) For example:

```
\usepackage[osf]{erewhon} %extension of Utopia
\usepackage[varqu,varl]{inconsolata} % sans typewriter
\usepackage[scaled=.95]{cabin} % sans serif
\usepackage[utopia,vvarbb]{newtxmath}
```

- the `libertine` option also replaces both slanted and upright Greek symbols by the corresponding Libertine glyphs, and similarly for `minion`, `garamondx`, `stix2` and `cochineal`;

- `cmintegrals` instructs newtxmath to load a thicker version of the Computer Modern integral in place of the newtxmath default—the txfonts integral (identical to the integral in the Wolfram fonts), which is not to everyone's taste—a consequence is that none of the special forms of txfonts integrals are available; **as of version 1.5, this option does nothing, as the new default is slanted integrals.**

- the combination

  ```
  % The next line is no longer needed, as newtxmath Requires it
  %\usepackage{amsmath}% loads amstext, amsbsy, amsopn but not amssymb
  \usepackage{newtxmath}
  ```

  causes no error, unlike the same combination with txfonts, but does nothing significant. (Recall that amsmath is loaded automatically if you use an AMS document class such as amsart or amsbook, as is amsthm.)

- If you wish to use \usepackage{amsthm}, place it before loading newtxmath or the result will be

  ```
  ! LaTeX Error: Command \openbox already defined.
  ```

- `uprightGreek` and `slantedGreek` determine the form of Greek alphabet loaded—the default is uprightGreek, which loads upright uppercase and slanted lowercase Greek symbols, as is customary in Anglo-American mathematical typesetting. With the option slantedGreek, which you might want to use if you cared about ISO standards, all Greek symbols are slanted. No matter which is set, \Gammaup (or \upGamma) gives you upright \Gamma, etc, and \Deltait, \zetait give you italic (i.e., slanted) versions of those letters. If you are using a text font family with properly constructed OT1– encoded versions, then, no matter what you chose as the default shape for upper case Greek letters, \mathnormal{\Omega} etc will always produce the slanted version. (The macro \mathnormal means essentially "use the version of the symbol in letters"—i.e., the math italic form. This did not always work as expected in versions prior to 1.45.) Currently, this works as expected with newtxtext and libertine.

- Option `frenchmath` sets the default style in math mode for rendering uppercase Roman and Greek letters to upright, and lowercase Greek letters to upright. (Introduced in v. 1.28.)

- The option `cmbraces` instructs newtxmath to ignore the brace collections from txfonts, substituting a collection based on thickened versions of the Computer Modern braces, which I find much easier to distinguish from other delimiters. This works quite well in regular weight but looks a bit clunky in bold. The option bigdelims, which superseded cmbraces, is now not necessary—it is the default as of version 1.5.

- Option `nonewtxmathopt` (or `scale`, a mistake I cannot now erase) causes newtxmath to not make use of the optical math sizes (7pt, 5pt), as preferred by some.

- Option `subscriptcorrection` enables the special spacing of some subscripts. (The default is nosubscriptcorrection.)

- The newtxmath package contains three different Blackboard Bold alphabets, where original txfonts contained two. The default, triggered by \mathbb{}, takes its glyphs from the font which replaces msbm and has the same overall appearance of a hollowed-out text font, which I find neither bold nor blackboard-like. The second option, taken from txfonts, is triggered by \varmathbb{}, is more geometric and, in my opinion, preferable but not optimal. The option varbb makes \mathbb{} synonymous with \varmathbb{}. The third option is the double-struck glyphs from the STIX collection. See the expanded discussion below.

- `nosymbolsc` causes the package to not load the `symbolsC` fonts, saving a math family. (This font contains mostly exotic symbols, along with some very useful, commonly used symbols like `\coloneq` ≔, `\eqcolon` =:, `\notin` ∉, `\notni` ∌, `\neq` ≠, `\nsubset` ⊄ and `\nsupset` ⊅, but these have been moved (virtually) to `lettersA` so they may continue to be used even if you use the option `nosymbolsc`.) If this option is selected, then, as of version 1.53, new definitions are made for the missing negated symbols. The package `centernot` is now required.

- `amssymbols` (the default) and `noamssymbols` determine whether the `txfonts` versions of the AMS symbols (AMSm) are loaded—if so, they override previous settings in `amsmath`. If you use the option `noamssymbols`, then `\mathbb{}` is set to mean the same as `\varmathbb{}`. (One advantage of `noamssymbols` is that you save two of your precious math families for other purposes, such as setting a couple of external math alphabets by means of the `mathalfa` package.) **Important note:** if you load an AMS class, like `amsart`, then some trickery will be involved. The AMS classes have an option, `noamsfonts` which currently (2017) does not work as advertised, but is fixed in TEXLive 2018. It is supposed to prevent the loading of AMSa and AMSb, which waste two slots. The following workaround seems like a reasonable stopgap until then.

```
\def\symAMSb{5}
\documentclass[noamsfonts]{amsart} %or other AMS classes
\let\symAMSb\@undefined
```

This method of loading the AMS class will save you two slots.

- `libaltvw` has effect only if the libertine option is selected—in this case, it substitutes for math italic v and w hand-crafted versions based on the Libertine upsilon glyphs.

- `bigdelims` loads a different math extension font and redefines most of the small and big math delimiters to have larger sizes so that, for example, there is more of a distinction between (and `\big(` in math mode. If this option is specified, `cmbraces` is ignored. (This option is unnecessary, as of version 1.5.)

- `liby` has an effect only if the libertine option is selected—with this option, the math italic y is chosen to be Libertine's italic y instead of the default one from txfonts.

- As of version 1.18 of `newtxmath` (and version 1.07 of `newpxmath`) there are new math accents and macros available.

  - `\widehat` and `\widetilde` have been extended from 3 to 6 sizes, and the smallest is now not as wide as in previous versions. In particular, you can now use, eg, `$\widehat{X}^2$`, which gives $\widehat{X}^2$ without the hat colliding with the superscript.

  - The math double bracket delimiters have been moved to another family so their use is less likely to cause a "too many math families" error. The ordinary sizes now have their own macros, `\dlb` and `\drb`, giving, eg, $[\![0, T]\!]$, as commonly used in probability theory.

  - The new macros `\overgroup`, `\undergroup`, `\overgroupra`, `\overgroupla`, `\undergroupra` and `\undergroupla` are intended as replacements for the `\wideparen` and related macros from the `yhmath` and `fourier` packages. In fact, `\overgroup` and `\undergroup` are variants of the existing macros `\overbrace` and `\underbrace`, while the suffixes `ra` and `la` signify right arrow and left arrow respectively. The macro `\widering` places a ring centered over an `\overgroup`, not dissimilar from its use in yhmath. Example:

    ```
    \[\overgroup{ABC}\quad\overgroupra{ABC}\quad\undergroup{ABC}\quad
    \undergroupla{ABC}\quad \widering{ABCD}\]
    ```

gives

$$\overline{ABC} \quad \overrightarrow{ABC} \quad \underline{ABC} \quad \underleftarrow{ABC} \quad \overset{\circ}{\overline{ABCD}}$$

- As of version 1.23, the package contains new math accents \widearc and \wideOarc similar in effect to those from fourier and kpfonts. Example:

  \[\widearc{BC}\quad\widearc{ABC}\quad\widearc{ABCD}\quad
  \wideOarc{BC}\quad\wideOarc{ABC}\quad\wideOarc{ABCD}\]

  gives

  $$\overgroup{BC} \quad \overgroup{ABC} \quad \overgroup{ABCD} \quad \overrightarrow{\overgroup{BC}} \quad \overrightarrow{\overgroup{ABC}} \quad \overrightarrow{\overgroup{ABCD}}$$

- The option timesmathacc changes the default selection of math accents from the Roman text font, forcing the use of the heavier Times accents. (Libertine has much lighter accents which can seem to almost disappear under some conditions.) If your language uses accented operator names, do not use this option.

4.1 Bold Math Italic macros

It can be a little awkward to specify bold math italic letters without using the bm package, which may have some unintended consequences for some users. The option useBImacros enables the definitions of macros of the form \BIA—\BIz that may be used instead, all based on the macro

\DeclareRobustCommand{\BI@}[1]{%
\begingroup\text{\mathversion{bold}$#1$}\endgroup}

following which, the package conditionally defines, e.g.,

\DeclareRobustCommand{\BIA}{\BI@{A}}

so that \BIA works as expected in all math styles (display, text, script, scriptscript). These macros may be copied with minor changes so that other alphabets may be specified similarly.

IMPORTANT: The Libertine text package is now once again named libertine, but requires arguments that are different from the original libertine package.

EXAMPLE 1:

\usepackage[osf]{newtxtext} % T1, lining figures in math, osf in text
\usepackage{textcomp} % required for special glyphs
%\usepackage{amsmath} % not needed, as it is Required by newtxmath
\usepackage[varvf,vvarbb]{newtxmath}
\usepackage{bm} % load after all math to give access to bold math
%\useosf %no longer required if osf specified

EXAMPLE 2:

\usepackage[lining,semibold]{libertine} % a bit lighter than Times--no osf in math
\usepackage[T1]{fontenc} % best for Western European languages
\usepackage{textcomp} % required to get special symbols
\usepackage[varqu,varl]{inconsolata}% a typewriter font must be defined

```
\usepackage{amsthm}% must be loaded before newtxmath
\usepackage[libertine,vvarbb]{newtxmath}
\usepackage[scr=rsfso]{mathalfa}
\usepackage{bm}% load after all math to give access to bold math
%After loading math package, switch to osf in text.
\useosf % for osf in normal text
```

Caution: If your text font lacks an OT1 encoded version with uppercase Greek, \mathrm and \mathit applied to Greek letters won't give you what you expect.

5   Usage with LuaLATEX and XeLATEX

As far as I can tell, newtxmath works with both, but requires a very specific loading order and choice of options. Briefly, except for libertine text, the math options must all be loaded prior to loading and using fontspec. Be aware that some text packages (eg, cabin) may contain a line like

```
\RequirePackage{fontspec}
```

which would prevent ("option clash" error) a subsequent

```
\usepackage[no-math]{fontspec}
```

unless suppressed by an appropriate option. E.g.,

```
\usepackage[type1]{cabin}
```

prevents the problem with the cabin package.

The following examples illustrate some general models, the most unintuitive being the first because it loads a small version, minlibertine, of libertine text for use in math mode as numbers, basic symbols and operators.

EXAMPLE 3:

```
%load text components other than libertine text to be used in math
\usepackage[T1]{fontenc}
\usepackage[scaled=.85]{beramono}% used only by \mathtt
\usepackage[type1]{cabin}% used only by \mathsf
\usepackage{amsthm}% must be loaded before newtxmath
\usepackage[libertine]{newtxmath}
% loads minlibertine because no other Roman text package was specified
% so that \mathrm and \mathbf also use minlibertine
\usepackage[scr=rsfso]{mathalfa}
\usepackage{bm}% load after all math to give access to bold math
%Now load the otf text fonts using fontspec---won't affect math
\usepackage[no-math]{fontspec} % process with XeLaTeX or LuaLaTeX
\usepackage{libertine}
%\usepackage[osf,semibold]{libertine} for osf in text, semibold as bold
```

The next example is similar, but in math mode, numbers, basic symbols, operator names, \mathrm and \mathbf will render with fbb-LF, though math italic and math Greek letters will be from libertine. (Note that one specifies the encoding and redefines \rmdefault. For reasons I don't yet understand, it may not

work to load the font package—ie, don't substitute \usepackage{fbb}, as that will mess up bold in the libertine text package.)

EXAMPLE 4:

```
%load text components other than libertine text to be used in math
\usepackage[T1]{fontenc}
\renewcommand{\rmdefault}{fbb-LF}% Roman font for use in math mode
\usepackage[scaled=.85]{beramono}% used only by \mathtt
\usepackage[type1]{cabin}% used only by \mathsf
\usepackage{amsthm}% load before newtxmath
\usepackage[libertine,vvarbb]{newtxmath}
% does not load minlibertine because another Roman text package was specified
\usepackage[scr=rsfso]{mathalfa}
\usepackage{bm}% load after all math to give access to bold math
%Now load the otf text fonts using fontspec---won't affect math
\usepackage[no-math]{fontspec} % process with XeLaTeX or LuaLaTeX
\usepackage{libertine}
```

6   Alternate forms of glyphs

Prior to version 1.5, several math glyphs had alternate forms:

Command	Result	Alternate Commands	Alternate Forms
\emptyset	∅	\varnothing, \emptysetAlt	∅, ∅
\forall	∀	\forallAlt	∀
\exists	∃	\existsAlt	∃
\nexists	∄	\nexistsAlt	∄

To use an alternate form throughout your document without changing all occurrences of the usual command, insert something like the following in your preamble after loading newtxmath:

```
\let\forall\forallAlt
```

As of version 1.5, the old txfonts versions of \forall, \exists and \nexists have been removed and the Alt versions substituted. Both \forall and \forallAlt generate ∀, and similarly with \exists and \nexists.

7   Conformity with amsmath

The newtxmath package now contains a \RequirePackage{amsmath}, as it uses a number of the macros defined there. To pass options to amsmath, you can pass the options as options to \documentclass. For example,

```
\documentclass[11pt,intlimits]{article}
\usepackage{newtxtext}
\usepackage{newtxmath}
```

will load amsmath with option `intlimits`. As of version 1.14, newtxmath respects the amsmath macros for placement of limits on integrals.

8   The `minion` option

This option allows the use of MinionPro as math letters (Latin and Greek) within the math font, but there are some caveats:

- you must use a recent version of MinionPro, such as the version that comes with recent versions of Adobe Reader. In addition, the fonts must installed under special names so they can be recognized by the support files—this is spelled out in the documentation for the minion2newtx package that must be downloaded from `CTAN.tug.org` and installed separately.

9   The TEX math font problem

Math font packages in LATEX are susceptible to the "Too many math alphabets" error, due to exceeding the limit of just sixteen math font families, or mathgroups, as they are called in LATEX. Put in oversimplified terms that do however correctly represent how this all works in newtxmath, the following math fonts are always loaded and permanently (if you didn't prevent loading of some features) occupying slots immediately following \begin{document}, and others that may be called for in typesetting a mathematical expression can add to the list as the document grows.

ALWAYS LOADED:

```
0: operators
1: letters
2: symbols
3: largesymbols
4: AMSm (a combination of the old AMSa and AMSb)
5: lettersA
6: symbolsC
7: largesymbolsTXA
8: boldoperators
9: boldletters
10: boldsymbols
11: boldlargesymbols
```

NOTES:

- If using one of the AMS classes (e.g., amsart, amsbook), you can save two or more math families by adding the option noamsfonts in your \documentclass call. As of early 2018, This works only with the most recent versions the AMS classes available in both TexLive and MiKTeX.

- The operators font is essentially the Roman text font, used for names of operators and as the target for \mathrm—its bold version is used as the target for \mathbf;

- operators is defined to be the OT1 encoded version of the text font in cases where that version is known to contain upright uppercase Greek letters in its forst eleven slots—eg, newtxtext, libertine.

- if you typeset an expression that, say, calls for a single bold glyph from `symbolsC`, that costs you an entire new slot, leaving only two remaining;

- same with, eg, \mathit;

- same with an external Fraktur, Blackboard Bold or Script glyphs;

- if you run out of math alphabets, look first to dropping `AMSm` as well as `symbolsC`, which can save you at least two slots;

- if space is tight, do not call bold versions of the fonts listed above where the bold version is not already loaded, to avoid loading a new mathgroup;

- if you absolutely need a letter (not a math symbol) from some math font that would normally cost you another mathgroup, you might consider using as if it were text, with something like

  `\mbox{{\usefont{U}{ntxmia}{b}{n} X}}`

  which allows you to use letter X from `boldlettersA` but without any math features;

- there is a macro `\ShowMathFonts` in `newtxmath` which may be called at any point in your document, which will provide you a list of the mathgroups currently in use. This can be helpful in figuring out where problems occur. The output lines take the form

  `(<fam number>: <internal font id> = <tfm name> [newtx name])`

10   Bold math fonts

Every math font in the `txfonts` package, and in the `newtx` package, is accompanied by a bold version. Some usage examples are given below. Generally, one may use either `\boldmath` to change an entire formula to bold, or `\boldsymbol` to change one symbol, but the spacing generally works better after loading the `bm` package and using the `\bm` macro.

The text glyphs dotlessi (\i) and dotlessj (\j) are rarely needed in actual text—in many fonts, roman dotlessi is very similar to the numeral 1. They are however sometimes needed to build special math glyphs. The following table shows how to generate the mathematical forms of dotlessi and dotlessj. I illustrate with only dotlessi—dotlessj is entirely analogous.

Type	Weight	Command	Result
Math Italic	Regular	`$\hat{\imath}$`	$\hat{\imath}$
Math Italic	Bold	`$\bm{\hat{\imath}}$`	$\boldsymbol{\hat{\imath}}$
Roman	Regular	`$\hat{\textrm{\i}}$`	$\hat{\textrm{i}}$
Roman	Bold	`$\bm{\hat{\textbf{\i}}}$`	$\boldsymbol{\hat{\textbf{i}}}$

In math, bold roman characters are often used to indicate vector quantities, and for this one uses constructions like

- `$\mathbf{x}$` produces **x**;

- `$\bm{\mathrm{x}}$` produces **x** (same as previous but may offer improved spacing);

- `$\bm{x}$` produces $\boldsymbol{x}$ (not roman);

- `$\bm{\hat{\mathbf{x}}}$` produces $\hat{\mathbf{x}}$ (with a bold accent);

- `$\bm{\dot{x}}$` produces $\dot{\boldsymbol{x}}$ (bold but not roman);

- the macro definition

  `\newcommand{\xyvec}[2]{%`
  `\ensuremath{#1\mkern1.5mu\bm{\textbf{\i}}#2\mkern1.5mu\bm{\textbf{\j}}}}`

  allows you to write \xyvec{x}{+y} to output $x\mathbf{\imath} + y\mathbf{\jmath}$;

- `$\bm{\Gamma}$` produces $\boldsymbol{\Gamma}$ (bold Gamma);

- `$\bm{\hat{\Gamma}}$` produces $\hat{\boldsymbol{\Gamma}}$ (bold Gamma with bold accent).

(The last two assume that you have effectively set the option uprightGreek—the default.)

11   Blackboard bold

As mentioned briefly above, the package now has a new blackboard bold alphabet built-in, and some new macros to call the non-default versions. To summarize, the problems are:

- the default, called by \mathbb is quite ugly and indistinct, but does cooperate with the bolding macros \bm and \boldsymbol;

- the original variant form called with the macro \varmathbb is better, but the macro conflicts with \bm. (In fact, the bold version is identical to the regular version, but it is still not right that it conflicts with them.) The problem stems from the part of the definition of \varmathbb which allows you to insert an argument with more than one character, like \varmathbb{ABC}. Another problem with \varmathbb is that it conflicts with hyperref—if you use the macro in a moveable argument such as a section heading, you will provoke a LaTeX error message. The solution is to use macros that take a single character as argument, like \vmathbb{A} and \vvmathbb{A}, which both cooperate with hyperref.

- the third, new, alphabet is borrowed from the STIX fonts—it is sharp and quite clear, geometric in design. The macro \vvmathbb provided to access this alphabet. The new option vvarbb effectively makes \mathbb mean the same as \vvmathbb. (The reason for including these in the newtx package rather than calling them from the mathalfa package is that newtx leaves very little space for new math symbol fonts and math alphabets, and this way requires no additional such resources.

- **Important note:** Under the option stix2, there are still three blackboard fonts but the macro \vmathbb now points to glyphs from DSSerif, a serifed double-struck family that replaces the original variant that is still available under other options.

One interesting feature of the new alphabet is that it contains blackboard bold numbers, of which 0 and 1 will likely be the most useful, perhaps as operator names. I find 1=$\vvmathbb{1}$ useful in specifying an indicator, AKA characteristic function. Here are some examples:

	Regular	Bold	Remarks
Default	$\mathbb{R}$ $\mathbb{R}$	$\bm{\mathbb{R}}$ $\mathbb{R}$	
Variant 1	$\varmathbb{R}$ $\mathbb{R}$		Bold is same as regular
. . . or	$\vmathbb{R}$ $\mathbb{R}$		Single char. argument
Variant 2	$\vvmathbb{R}}$ $\mathbb{R}$	{\boldmath $\vvmathbb{R}$} $\mathbb{R}$	Make a macro for this!

The macros \vmathbb and \vvmathbb have been substantially rewritten as of version 1.55 and can now accept strings as arguments rather than just single characters. At some point in time, the \bm and \boldsymbol macros stopped working with the prior versions of these macros, and that remains a problem with the new versions. If you need only a few blackboard bold symbols, it may be better practice to define macros for each, including bold versions you might need. E.g., the your preamble:

```
\let\bbZ\undefined
\DeclareMathSymbol{\bbZ}{\mathord}{lettersA}{218} $ Z may not always be in this location
```

Then, \bm will correctly understand

```
\bbZ\;\bm{\bbZ}
```

and render it as

$$\mathbb{Z} \; \mathbb{Z}$$

12   Samples from free Times and Libertine packages

TXFONTS:

```
\usepackage{txfonts}
```

A formula from the LATEX Companion, 2nd Edition, p.390:

$$t[u_1, \ldots, u_n] = \sum_{k=1}^{n} \binom{n-1}{k-1} (1-t)^{n-k} t^{k-1} u_k.$$

The ISO would prefer that a formula like

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} \, dt$$

be typeset instead as

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} \mathrm{e}^{-t^2/2} \, \mathrm{d}t,$$

with upright π, e and d. I dislike the look of dt when the slope of t is too great.

- Complete match between text and math size and weight;
- first formula much too cramped;
- upper limit of integral much too close to integral sign;
- square on t in integrand comes very close to colliding with it;
- square root in denominator aligned too far right.

NEWTXFONTS:

```
\usepackage{newtxtext}
```

```
\usepackage{newtxmath}
```

A formula from the LaTeX Companion, 2nd Edition, p.390:

$$t[u_1, \ldots, u_n] = \sum_{k=1}^{n} \binom{n-1}{k-1}(1-t)^{n-k}t^{k-1}u_k.$$

The ISO would prefer that a formula like

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} dt$$

be typeset instead as

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} \mathrm{e}^{-t^2/2} \mathrm{d}t,$$

with upright π, e and d. I dislike the look of dt when the slope of t is too great.

- Complete match between text and math size and weight;

- first formula much less cramped;

- upper limit of integral not too close to integral sign;

- square not too close to t in exponent;

- better alignment of square root in denominator.

MATHTIMEPRO2:

```
\usepackage{newtxtext}
\usepackage[lite]{mtpro2}
```

A formula from the LaTeX Companion, 2nd Edition, p.390:

$$t[u_1, \ldots, u_n] = \sum_{k=1}^{n} \binom{n-1}{k-1}(1-t)^{n-k}t^{k-1}u_k.$$

The ISO would prefer that a formula like

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} dt$$

be typeset instead as

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} \mathrm{e}^{-t^2/2} \mathrm{d}t,$$

with upright π, e and d. I dislike the look of dt when the slope of t is too great.

- Complete match between text and math size and weight;

- first formula quite spread out;

- upper limit of integral not too close to integral sign;

- plenty of space between square and t in exponent.

LIBERTINE AND MATHTIMEPRO2:

```
\usepackage{libertine}
\usepackage[T1]{fontenc}
\usepackage[lite]{mtpro2}
```

A formula from the LATEX Companion, 2nd Edition, p.390:

$$t[u_1, \ldots, u_n] = \sum_{k=1}^{n} \binom{n-1}{k-1} (1-t)^{n-k} t^{k-1} u_k.$$

The ISO would prefer that a formula like

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} \, dt$$

be typeset instead as

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} \mathrm{e}^{-t^2/2} \, \mathrm{d}t,$$

with upright π, e and d. I dislike the look of dt when the slope of t is too great.

- Mismatch of weight between text and math;

- first formula quite spread out;

- upper limit of integral not too close to integral sign;

- plenty of space between square and t in exponent.

LIBERTINE AND NEWTXMATH:

```
\usepackage{libertine}
\usepackage[T1]{fontenc}
\usepackage[libertine]{newtxmath}
```

A formula from the LaTeX Companion, 2nd Edition, p.390:

$$t[u_1, \ldots, u_n] = \sum_{k=1}^{n} \binom{n-1}{k-1} (1-t)^{n-k} t^{k-1} u_k.$$

The ISO would prefer that a formula like

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} \, dt$$

be typeset instead as

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} \, \mathrm{d}t,$$

with upright π, e and d. I dislike the look of dt when the slope of t is too great.

- Very good match between text and math in size and weight;
- first formula not cramped;
- upper limit of integral not too close to integral sign;
- space between square and t in exponent;
- better alignment of square root in denominator.

MATHPTMX:

\usepackage{mathptmx}

A formula from the LaTeX Companion, 2nd Edition, p.390:

$$t[u_1, \ldots, u_n] = \sum_{k=1}^{n} \binom{n-1}{k-1} (1-t)^{n-k} t^{k-1} u_k.$$

The ISO would prefer that a formula like

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} \, dt$$

be typeset instead as

$$\Phi(u) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{u} e^{-t^2/2} \, \mathrm{d}t,$$

with upright π, e and d. I dislike the look of dt when the slope of t is too great.

- Good match between text and math size and weight, though the summation symbol (from the system symbol font) is too small and too dark;
- first formula well spread;
- upper limit of integral not too close to integral sign;
- space between square and t in exponent;
- there are no upright Greek lowercase letters in this package;

- good alignment of square root in denominator;

- infinity symbol not sufficiently large?

- the package lacks a number of amenities that are present in other packages.

13 Items installed

As well as a collection of PostScript fonts, virtual fonts, font definition files and the central `newtxtext.sty` and `newtxmath.sty` files, the package contains one map file `newtx.map` that must be enabled for the package to function correctly. Its name was changed from `ntx.map` to mirror the package name.) The file `implementation.pdf` in this distribution provides a manifest of all files installed together with a brief indication of the sources. (This file is somewhat outdated. The file `mathnotes.pdf` adds details about the sources for the math fonts, though it is rather cursory.)

The font files `ntxexmods.pfb` and `ntxbexmods.pfb` were derived from `cmex10.pfb` by FontForgery, thickening the Computer Modern braces to match the weight of the txfonts braces. The pair `ntxexb.pfb` and `ntxbexb.pfb` were similarly derived from `cmsy7.pfb` and `cmex10.pfb` to produce more braces and matching integral signs based on Computer Modern. The `.tfm` files `rtx[b]mio.tfm` are simply unslanted versions of `rtxmi`, from which we construct upright partial derivative symbols. The last two entries provide us with a way to access custom-encoded versions of `fxlri.pfb` and `fxlbi.map` in order to access some of the unencoded alternate characters—eg, Greek letters, `J.alt` and `v.alt`. The font file LibertineTheta-Regular.pfb was created from the Theta symbol in `fxlri.pfb`, which requires some FontForge help to look correct.

This version contains optical versions of the math italic and symbol fonts at 7pt and 5pt, allowing better rendering in \scriptstyle and \scriptscriptstyle.

14 Appendix: Changes made in version 1.5

- The large delimiters have been modified so match the heights in common usage by `cmex10` and other packages. (Those formerly used by `newtxmath` were somewhat shorter, resulting in unexpected behavior of \Big, \bigg, etc.)

- The integrals used in previous versions have been discarded and replaced by an upright and a slanted form, the latter being the default. The option `upint` switches to the upright form. (The former option `cmintegrals` now has no effect.) Integrals are of three types: small, textstyle and displaystyle. Each size is available in twelve variants. Assuming slanted (the default) is selected, there are 36 regular-weight forms:

Small		Text, Display	
∫	`$\smallint$`	∫, ∫	`$\int$`
∬	`$\smalliint$`	∬, ∬	`$\iint$`
∭	`$\smalliiint$`	∭, ∭	`$\iiint$`
⨌	`$\smalliiiint$`	⨌, ⨌	`$\iiiint$`
∮	`$\smalloint$`	∮, ∮	`$\oint$`
∯	`$\smalloiint$`	∯, ∯	`$\oiint$`
∰	`$\smalloiiint$`	∰, ∰	`$\oiiint$`
⨍	`$\smallfint$`	⨍, ⨍	`$\fint$`
⨖	`$\smallsqint$`	⨖, ⨖	`$\sqint$`
⨋	`$\smallsumint$`	⨋, ⨋	`$\sumint$`
∲	`$\smallvarointclockwise$`	∲, ∲	`$\varointclockwise$`
∳	`$\smallointctrclockwise$`	∳, ∳	`$\ointctrclockwise$`

- The overly small delimiters ([{ in Times are no longer used in math mode, being replaced by bigger versions. The former option `bigdelims` no longer has any effect.

- There is a new option `smallerops` which chooses smaller renditions (20% smaller in displaystyle, 10% smaller in textstyle) of the `bigoperators`:

```
\bigsqcup
\bigodot
\bigoplus
\bigotimes
\sum
\prod
\bigcup
\bigcap
\biguplus
\bigwedge
\bigvee
\bigcupdot
\bigcapplus
\bigsqcupplus
\bigsqcapplus
\bigsqcap
```

```
\bigtimes
\coprod
```

- The dot accents are now taken from a slightly larger series, making available \dot, \ddot, \dddot and \ddddot. For best horizontal alignment with other accents, choose the option timesmathacc when loading newtxmath.

- New accents have been added and the old vector accent has been replaced. The new accents are:
```
\vec       →
\lvec      ←
\lrvec     ↔
\harpoonacc    ⇀
\lharpoonacc   ↼
\lrharpoonacc  ⇌
\barbar    =
\bartilde  ≃
\barhat    ᷓ
\tildebar  ≃
\tildetilde ≈
\tildehat  ᷓ
\hatbar    ᷓ
\hattilde  ᷓ
\hathat    ᷓ
```

- New glyphs: (B denotes bigger, S denotes smaller)
```
\cdotB    · (cf. \cdot   ·)
\cdotBB   ·
\circS    ∘ (cf. \circ   ∘)
\bulletS  • (cf. \bullet  •)
\bulletSS •
\bulletSSS •
\primeS   ′ (cf. \prime  ′)
```

- New macros \setSYdimens and \setEXdimens allow experts to modify some math font dimensions.