

L^AT_EX 2_ε font selection

© Copyright 1995–2020, L^AT_EX Project Team.*
All rights reserved.

November 2020

Contents

1	Introduction	2
1.1	L ^A T _E X 2 _ε fonts	2
1.2	Overview	2
1.3	Further information	3
2	Text fonts	4
2.1	Text font attributes	4
2.2	Selection commands	7
2.3	Internals	8
2.4	Parameters for author commands	9
2.5	Special font declaration commands	10
3	Math fonts	11
3.1	Math font attributes	11
3.2	Selection commands	12
3.3	Declaring math versions	13
3.4	Declaring math alphabets	13
3.5	Declaring symbol fonts	14
3.6	Declaring math symbols	15
3.7	Declaring math sizes	17
4	Font installation	17
4.1	Font definition files	17
4.2	Font definition file commands	18
4.3	Font file loading information	19
4.4	Size functions	20
5	Encodings	21
5.1	The fontenc package	21
5.2	Encoding definition file commands	22
5.3	Default definitions	25
5.4	Encoding defaults	26
5.5	Case changing	27

*Thanks to Arash Esbati for documenting the newer NFSS features of 2020

6	Miscellanea	27
6.1	Font substitution	27
6.2	Preloading	28
6.3	Accented characters	28
6.4	Naming conventions	29
6.5	The order of declaration	30
6.6	Font series defaults per document family	31
6.7	Handling of nested emphasis	32
6.8	Providing font family substitutions	32
7	Additional text symbols – <code>textcomp</code>	32
8	If you need to know more . . .	33

1 Introduction

This document describes the new font selection features of the L^AT_EX Document Preparation System. It is intended for package writers who want to write font-loading packages similar to `times` or `latexsym`.

This document is only a brief introduction to the new facilities and is intended for package writers who are familiar with T_EX fonts and L^AT_EX packages. It is *neither* a user-guide *nor* a reference manual for fonts in L^AT_EX 2_ε.

1.1 L^AT_EX 2_ε fonts

The most important difference between L^AT_EX 2.09 and L^AT_EX 2_ε is the way that fonts are selected. In L^AT_EX 2.09, the Computer Modern fonts were built into the L^AT_EX format, and so customizing L^AT_EX to use other fonts was a major effort.

In L^AT_EX 2_ε, very few fonts are built into the format, and there are commands to load new text and math fonts. Packages such as `times` or `latexsym` allow authors to access these fonts. This document describes how to write similar font-loading packages.

The L^AT_EX 2_ε font selection system was first released as the ‘New Font Selection Scheme’ (NFSS) in 1989, and then in release 2 in 1993. L^AT_EX 2_ε includes NFSS release 2 as standard.

1.2 Overview

This document contains an overview of the new font commands of L^AT_EX.

Section 2 describes the commands for selecting fonts in classes and packages.

It lists the five L^AT_EX font attributes, and lists the commands for selecting fonts. It also describes how to customize the author commands such as `\textrm` and `\textit` to suit your document design.

Section 3 explains the commands for controlling L^AT_EX math fonts. It describes how to specify new math fonts and new math symbols.

Section 4 explains how to install new fonts into L^AT_EX. It shows how L^AT_EX font attributes are turned into T_EX font names, and how to specify your own fonts using font definition files.

Section 5 discusses text font encodings. It describes how to declare a new encoding and how to define commands, such as `\AE` or `\"`, which have different definitions in different encodings, depending on whether ligatures, etc. are available in the encoding.

Section 6 covers font miscellanea. It describes how L^AT_EX performs font substitution, how to customize fonts that are preloaded in the L^AT_EX format, and the naming conventions used in L^AT_EX font selection.

1.3 Further information

For a general introduction to L^AT_EX, including the new features of L^AT_EX 2_ε, you should read *L^AT_EX: A Document Preparation System*, Leslie Lamport, Addison Wesley, 2nd ed, 1994.

A more detailed description of the L^AT_EX font selection scheme is to be found in *The L^AT_EX Companion*, 2nd ed, by Mittelbach and Goossens, Addison Wesley, 2004.

The L^AT_EX font selection scheme is based on T_EX, which is described by its developer in *The T_EXbook*, Donald E. Knuth, Addison Wesley, 1986, revised in 1991 to include the features of T_EX 3.

Sebastian Rahtz's `psnfss` software contains the software for using a large number of Type 1 fonts (including the Adobe Laser Writer 35 and the Monotype CD-ROM fonts) in L^AT_EX. It should be available from the same source as your copy of L^AT_EX.

The `psnfss` software uses fonts generated by Alan Jeffrey's `fontinst` software. This can convert fonts from Adobe Font Metric format into a format readable by L^AT_EX, including the generation of the font definition files described in Section 4. The `fontinst` software should be available from the same source as your copy of L^AT_EX.

Whenever practical, L^AT_EX uses the font naming scheme called 'fontname'; this was described in *Filenames for fonts*,¹ TUGboat 11(4), 1990.

The class-writer's guide *L^AT_EX 2_ε for Class and Package Writers* describes the new L^AT_EX features for writers of document classes and packages and is kept in `clsguide.tex`. Configuring L^AT_EX is covered by the guide *Configuration options for L^AT_EX 2_ε* in `cfgguide.tex` whilst the philosophy behind our policy on modifying L^AT_EX is described in *Modifying L^AT_EX* in `modguide.tex`.

¹An up-to-date electronic version of this document can be found on any CTAN server, in the directory `info/fontname`.

The documented source code (from the files used to produce the kernel format via `latex.ltx`) is now available as *The L^AT_EX 2_ε Sources*. This very large document also includes an index of L^AT_EX commands. It can be typeset from the L^AT_EX file `source2e.tex` in the `base` directory; this uses the class file `ltxdoc.cls`.

For more information about T_EX and L^AT_EX, please contact your local T_EX Users Group, or the international T_EX Users Group. Addresses and other details can be found at:

<http://www.tug.org/lugs.html>

2 Text fonts

This section describes the commands available to class and package writers for specifying and selecting fonts.

2.1 Text font attributes

Every text font in L^AT_EX has five *attributes*:

encoding This specifies the order that characters appear in the font. The two most common text encodings used in L^AT_EX are Knuth's 'T_EX text' encoding, and the 'T_EX text extended' encoding developed by the T_EX Users Group members during a T_EX Conference at Cork in 1990 (hence its informal name 'Cork encoding').

family The name for a collection of fonts, usually grouped under a common name by the font foundry. For example, 'Adobe Times', 'ITC Garamond', and Knuth's 'Computer Modern Roman' are all font families.

series How heavy and/or expanded a font is. For example, 'medium weight', 'narrow' and 'bold extended' are all series.

shape The form of the letters within a font family. For example, 'italic', 'oblique' and 'upright' (sometimes called 'roman') are all font shapes.

size The design size of the font, for example '10pt'. If no dimension is specified, 'pt' is assumed.

The possible values for these attributes are given short acronyms by L^AT_EX. The most common values for the font encoding are:

OT1	T _E X text
T1	T _E X extended text
OML	T _E X math italic
OMS	T _E X math symbols
OMX	T _E X math large symbols
U	Unknown
L $\langle xx \rangle$	A local encoding

The ‘local’ encodings are intended for font encodings which are only locally available, for example a font containing an organization’s logo in various sizes.

There are far too many font families to list them all, but some common ones are:

cmr	Computer Modern Roman
cmss	Computer Modern Sans
cmtt	Computer Modern Typewriter
cmm	Computer Modern Math Italic
cmsy	Computer Modern Math Symbols
cmex	Computer Modern Math Extensions
ptm	Adobe Times
phv	Adobe Helvetica
pcr	Adobe Courier

The font series is denoting a combination of the weight (boldness) and the width (amount of expansion). The standard supported for weights and widths are:

New
description
2019/07/10

ul	Ultra Light	uc	Ultra Condensed	50%
el	Extra Light	ec	Extra Condensed	62.5%
l	Light	c	Condensed	75%
sl	Semi Light	sc	Semi Condensed	87.5%
m	Medium (normal)	m	Medium	100%
sb	Semi Bold	sx	Semi Expanded	112.5%
b	Bold	x	Expanded	125%
eb	Extra Bold	ex	Extra Expanded	150%
ub	Ultra Bold	ux	Ultra Expanded	200%

These are concatenated to a single series value except that **m** is dropped unless both weight and width are medium in which case a single **m** is used.

Examples for series values are then:

m	Medium weight and width
b	Bold weight, medium width
bx	Bold extended
sb	Semi-bold, medium width
sbx	Semi-bold extended
c	Medium weight, condensed width

Note, that there are a large variety of names floating around like “regular”, “black”, “demi-bold”, “thin”, “heavy” and many more. If at all possible they should be matched into the standard naming scheme to allow for sensible default substitutions if necessary, e.g., “demi-bold” is normally just another name for “semi-bold”, so should get **sb** assigned, etc.

New
description
2019/07/10

The most common values for the font shape are:

New
description
2020/02/02

n	Normal (that is ‘upright’ or ‘roman’)
it	Italic
sl	Slanted (or ‘oblique’)
sc	Caps and small caps
scit	Caps and small caps italic
scsl	Caps and small caps slanted
sw	Swash

A less common value for font shape is:

ssc Spaced caps and small caps

The font size is specified as a dimension, for example 10pt or 1.5in or 3mm; if no unit is specified, pt is assumed. These five parameters specify every L^AT_EX font, for example:

<i>L^AT_EX specification</i>	<i>Font</i>	<i>T_EX font name</i>
OT1 cmr m n 10	Computer Modern Roman 10 point	cmr10
OT1 cmssmsl 1pc	Computer Modern Sans Oblique 1 pica	cmssi12
OML cmm mit 10pt	Computer Modern Math Italic 10 point	cmmi10
T1 ptm bit 1in	Adobe Times Bold Italic 1 inch	ptmb8t at 1in

These five parameters are displayed whenever L^AT_EX gives an overfull box warning, for example:

```
Overfull \hbox (3.80855pt too wide) in paragraph at lines 314--318
[]\OT1/cmr/m/n/10 Normally [] and [] will be iden-ti-cal,
```

The author commands for fonts set the five attributes:

<i>Author command</i>	<i>Attribute</i>	<i>Value in article class</i>
<code>\textnormal{...}</code> or <code>\normalfont</code>	family	cmr
	series	m
	shape	n
<code>\textrm{...}</code> or <code>\rmfamily</code>	family	cmr
<code>\textsf{...}</code> or <code>\sffamily</code>	family	cmss
<code>\texttt{...}</code> or <code>\ttfamily</code>	family	cmtt
<code>\textmd{...}</code> or <code>\mdseries</code>	series	m
<code>\textbf{...}</code> or <code>\bfseries</code>	series	bx
<code>\textit{...}</code> or <code>\itshape</code>	shape	it
<code>\textsl{...}</code> or <code>\slshape</code>	shape	sl
<code>\textsc{...}</code> or <code>\scshape</code>	shape	sc
<code>\textssc{...}</code> or <code>\sscshape</code>	shape	ssc
<code>\textsw{...}</code> or <code>\swshape</code>	shape	sw
<code>\textulc{...}</code> or <code>\ulcshape</code>	shape	ulc (virtual) → n, it, sl or ssc
<code>\textup{...}</code> or <code>\upshape</code>	shape	up (virtual) → n or sc
<code>\tiny</code>	size	5pt
<code>\scriptsize</code>	size	7pt
<code>\footnotesize</code>	size	8pt
<code>\small</code>	size	9pt
<code>\normalsize</code>	size	10pt
<code>\large</code>	size	12pt
<code>\Large</code>	size	14.4pt
<code>\LARGE</code>	size	17.28pt
<code>\huge</code>	size	20.74pt
<code>\Huge</code>	size	24.88pt

The values used by these commands are determined by the document class, using the parameters defined in Section 2.4.

Note that there are no author commands for selecting new encodings. These should be provided by packages, such as the `fontenc` package.

This section does not explain how L^AT_EX font specifications are turned into T_EX font names. This is described in Section 4.

2.2 Selection commands

The low-level commands used to select a text font are as follows.

```

\fontencoding {\langle encoding \rangle}
\fontfamily {\langle family \rangle}
\fontseries {\langle series \rangle}
\fontshape {\langle shape \rangle}
\fontsize {\langle size \rangle} {\langle baselineskip \rangle}
\linespread {\langle factor \rangle}

```

Each of the commands starting with `\font...` sets one of the font attributes; `\fontsize` also sets `\baselineskip`. The `\linespread` command prepares to multiply the current (or newly defined) `\baselineskip` with `\langle factor \rangle` (e.g., spreads the lines apart for values greater one).

New
description
1998/12/01

The actual font in use is not altered by these commands, but the current attributes are used to determine which font and baseline skip to use after the next `\selectfont` command.

`\selectfont`

Selects a text font, based on the current values of the font attributes.

Warning: There *must* be a `\selectfont` command immediately after any settings of the font parameters by (some of) the six commands above, before any following text. For example, it is legal to say:

```
\fontfamily{ptm}\fontseries{b}\selectfont Some text.
```

but it is *not* legal to say:

```
\fontfamily{ptm} Some \fontseries{b}\selectfont text.
```

You may get unexpected results if you put text between a `\font{parameter}` command (or `\linespread`) and a `\selectfont`.

`\usefont {<encoding>} {<family>} {<series>} {<shape>}`

A short hand for the equivalent `\font...` commands followed by a call to `\selectfont`.

2.3 Internals

The current values of the font attributes are held in internal macros.

```
\f@encoding
\f@family
\f@series
\f@shape
\f@size
\f@baselineskip
\tf@size
\sf@size
\ssf@size
```

These hold the current values of the encoding, the family, the series, the shape, the size, the baseline skip, the main math size, the ‘script’ math size and the ‘scriptscript’ math size. The last three are accessible only within a formula; outside of math they may contain arbitrary values.

For example, to set the size to 12 without changing the baseline skip:

```
\fontsize{12}{\f@baselineskip}
```

However, you should *never* alter the values of the internal commands directly; they must only be modified using the low-level commands like `\fontfamily`, `\fontseries`, etc. If you disobey this warning you might produce code that loops.

2.4 Parameters for author commands

The parameter values set by author commands such as `\textrm` and `\rmfamily`, etc. are not hard-wired into L^AT_EX; instead these commands use the values of a number of parameters set by the document class and packages. For example, `\rmdefault` is the name of the default family selected by `\textrm` and `\rmfamily`. Thus to set a document in Adobe Times, Helvetica and Courier, the document designer specifies:

```
\renewcommand{\rmdefault}{ptm}
\renewcommand{\sfdefault}{phv}
\renewcommand{\ttdefault}{pcr}
```

```
\encodingdefault
\familydefault
\seriesdefault
\shapedefault
```

The encoding, family, series and shape of the main body font. By default these are OT1, `\rmdefault`, m and n. Note that since the default family is `\rmdefault`, this means that changing `\rmdefault` will change the main body font of the document.

```
\rmdefault
\sfddefault
\ttdefault
```

The families selected by `\textrm`, `\rmfamily`, `\textsf`, `\sffamily`, `\texttt` and `\ttfamily`. By default these are `cmr`, `cmss` and `cmtt`.

\bfdefault
\mddefault

The series selected by `\textbf`, `\bfseries`, `\textmd` and `\mdseries`. By default these are `bx` and `m`. These values are suitable for the default families used. If other fonts are used as standard document fonts (for example, certain PostScript fonts) it might be necessary to adjust the value of `\bfdefault` to `b` since only a few such families have a ‘bold extended’ series. An alternative (taken for the fonts provided by `psnfss`) is to define silent substitutions from `bx` series to `b` series with special `\DeclareFontShape` declarations and the `ssub` size function, see Section 4.4.

```
\itdefault
\sldefault
\scdefault
\sscddefault
\swdefault
\ulcdefault
\updefault
```

The shapes selected by \textit, \itshape, \textsl, \slshape, \textsc, New feature
2020/02/02

`\scshape`, `\textssc`, `\sscshape`, `\textsw`, `\swshape`, `\textulc`, `\ulcshape`, `\textup` and `\upshape`. By default these are `it`, `sl`, `sc`, `ssc`, `sw`, `ulc` and `up`. Note that `ulc` and `up` are special here because they are virtual shapes; they don't exist as real shape values. Instead they alter the existing shape value based on rules, i.e., the result depends on context. The respective macros `\textulc` or `\ulcshape` change small capitals back to upper/lower case but will not change the font with respect to italics, slanted or swash. `\upshape` or `\textup` in contrast will switch italics or slanted back to upright but not alter the state of upper/lower case, e.g., keep small capitals if present. Finally, the command `\normalshape` is provided to reset the shape back to normal which is a shorthand for `\upshape\ulcshape`.

Note that there are no parameters for the size commands. These should be defined directly in class files, for example:

```
\renewcommand{\normalsize}{\fontsize{10}{12}\selectfont}
```

More elaborate examples (setting additional parameters when the text size is changed) can be found in `classes.dtx` the source documentation for the classes `article`, `report`, and `book`.

2.5 Special font declaration commands

`\DeclareFixedFont {<cmd>} {<encoding>} {<family>} {<series>} {<shape>} {<size>}`

Declares command `<cmd>` to be a font switch which selects the font that is specified by the attributes `<encoding>`, `<family>`, `<series>`, `<shape>`, and `<size>`.

The font is selected without any adjustments to baselineskip and other surrounding conditions.

This example makes `\picturechar .` select a small dot very quickly:

```
\DeclareFixedFont{\picturechar}{OT1}{cmr}{m}{n}{5}
```

`\DeclareTextFontCommand {<cmd>} {<font-switches>}`

Declares command `<cmd>` to be a font command with one argument. The current font attributes are locally modified by `<font-switches>` and then the argument of `<cmd>` is typeset in the resulting new font.

Commands defined by `\DeclareTextFontCommand` automatically take care of any necessary italic correction (on either side).

The following example shows how `\textrm` is defined by the kernel.

```
\DeclareTextFontCommand{\textrm}{\rmfamily}
```

To define a command that always typeset its argument in the italic shape of the main document font you could declare:

```
\DeclareTextFontCommand{\normalit}{\normalfont\itshape}
```

This declaration can be used to change the meaning of a command; if $\langle cmd \rangle$ is already defined, a log that it has been redefined is put in the transcript file.

```
\DeclareOldFontCommand{\langle cmd \rangle}{\langle text-switch \rangle}{\langle math-switch \rangle}
```

Declares command $\langle cmd \rangle$ to be a font switch (i.e. used with the syntax $\{\langle cmd \rangle \dots\}$) having the definition $\langle text-switch \rangle$ when used in text and the definition $\langle math-switch \rangle$ when used in a formula. Math alphabet commands, like $\backslash mathit$, when used within $\langle math-switch \rangle$ should not have an argument. Their use in this argument causes their semantics to change so that they here act as a font switch, as required by the usage of the $\langle cmd \rangle$.

This declaration is useful for setting up commands like $\backslash rm$ to behave as they did in L^AT_EX 2.09. We strongly urge you *not* to misuse this declaration to invent new font commands.

The following example defines $\backslash it$ to produce the italic shape of the main document font if used in text and to switch to the font that would normally be produced by the math alphabet $\backslash mathit$ if used in a formula.

```
\DeclareOldFontCommand{\it}{\normalfont\itshape}{\mathit}
```

This declaration can be used to change the meaning of a command; if $\langle cmd \rangle$ is already defined, a log that it has been redefined is put in the transcript file.

3 Math fonts

This section describes the commands available to class and package writers for specifying math fonts and math commands.

3.1 Math font attributes

The selection of fonts within math mode is quite different to that of text fonts.

Some math fonts are selected explicitly by one-argument commands such as $\backslash mathsf{\max}$ or $\backslash mathbf{\vec{v}}$; such fonts are called *math alphabets*. These math alphabet commands affect only the font used for letters and symbols of type $\backslash mathalpha$ (see Section 3.6); other symbols within the argument will be left unchanged. The predefined math alphabets are:

<i>Alphabet</i>	<i>Description</i>	<i>Example</i>
$\backslash mathnormal$	default	<i>abcXYZ</i>
$\backslash mathrm$	roman	abcXYZ
$\backslash mathbf$	bold roman	abcXYZ
$\backslash mathsf$	sans serif	abcXYZ
$\backslash mathit$	text italic	<i>abcXYZ</i>
$\backslash mathtt$	typewriter	abcXYZ
$\backslash mathcal$	calligraphic	\mathcal{XYZ}

Other math fonts are selected implicitly by \TeX for symbols, with commands such as `\oplus` (producing \oplus) or with straight characters like `>` or `+`. Fonts containing such math symbols are called *math symbol fonts*. The predefined math symbol fonts are:

<i>Symbol font</i>	<i>Description</i>	<i>Example</i>
<code>operators</code>	symbols from <code>\mathrm</code>	$[+]$
<code>letters</code>	symbols from <code>\mathnormal</code>	$<<\star>>$
<code>symbols</code>	most \LaTeX symbols	$\leq * \geq$
<code>largesymbols</code>	large symbols	$\sum \prod f$

Some math fonts are both *math alphabets* and *math symbol fonts*, for example `\mathrm` and `operators` are the same font, and `\mathnormal` and `letters` are the same font.

Math fonts in \LaTeX have the same five attributes as text fonts: encoding, family, series, shape and size. However, there are no commands that allow the attributes to be individually changed. Instead, the conversion from math fonts to these five attributes is controlled by the *math version*. For example, the `normal` math version maps:

<i>Math font</i>		<i>External font</i>
<i>Alphabets</i>	<i>Symbol fonts</i>	<i>Attributes</i>
<code>\mathnormal</code>	<code>letters</code>	OML cmm m it
<code>\mathrm</code>	<code>operators</code>	OT1 cmr m n
<code>\mathcal</code>	<code>symbols</code>	OMS cmsy m n
	<code>largesymbols</code>	OMX cmex m n
<code>\mathbf</code>		OT1 cmr bx n
<code>\mathsf</code>		OT1 cmss m n
<code>\mathit</code>		OT1 cmr m it
<code>\mathtt</code>		OT1 cmtt m n

The `bold` math version is similar except that it contains bold fonts. The command `\boldmath` selects the `bold` math version.

Math versions can only be changed outside of math mode.

The two predefined math versions are:

<code>normal</code>	the default math version
<code>bold</code>	the bold math version

Packages may define new math alphabets, math symbol fonts, and math versions. This section describes the commands for writing such packages.

3.2 Selection commands

There are no commands for selecting symbol fonts. Instead, these are selected indirectly through symbol commands like `\oplus`. Section 3.6 explains how to define symbol commands.

<code>\mathnormal{⟨math⟩}</code>
<code>\mathcal{⟨math⟩}</code>
<code>\mathrm{⟨math⟩}</code>
<code>\mathbf{⟨math⟩}</code>
<code>\mathsf{⟨math⟩}</code>
<code>\mathit{⟨math⟩}</code>
<code>\mathtt{⟨math⟩}</code>

Each math alphabet is a command which can only be used inside math mode. For example, `$x + \mathsf{y} + \mathcal{Z}$` produces $x + y + Z$.

<code>\mathversion{⟨version⟩}</code>

This command selects a math version; it can only be used outside math mode. For example, `\boldmath` is defined to be `\mathversion{bold}`.

3.3 Declaring math versions

<code>\DeclareMathVersion {⟨version⟩}</code>
--

Defines `⟨version⟩` to be a math version.

The newly declared version is initialized with the defaults for all symbol fonts and math alphabets declared so far (see the commands `\DeclareSymbolFont` and `\DeclareMathAlphabet`).

If used on an already existing version, an information message is written to the transcript file and all previous `\SetSymbolFont` or `\SetMathAlphabet` declarations for this version are overwritten by the math alphabet and symbol font defaults, i.e. one ends up with a virgin math version.

Example:

```
\DeclareMathVersion{normal}
```

3.4 Declaring math alphabets

<code>\DeclareMathAlphabet {⟨math-alph⟩} {⟨encoding⟩} {⟨family⟩} {⟨series⟩} {⟨shape⟩}</code>
--

If this is the first declaration for `⟨math-alph⟩` then a new math alphabet with this as its command name is created.

The arguments `⟨encoding⟩` `⟨family⟩` `⟨series⟩` `⟨shape⟩` are used to set, or reset, the default values for this math alphabet in all math versions; if required, these must be further reset later for a particular math version by a `\SetMathAlphabet` command.

If `⟨shape⟩` is empty then this `⟨math-alph⟩` is declared to be invalid in all versions, unless it is set by a later `\SetMathAlphabet` command for a particular math version.

New
description
1997/12/01

Checks that the command $\langle math\text{-}alph \rangle$ is either already a math alphabet command or is undefined; and that $\langle encoding \rangle$ is a known encoding scheme, i.e., has been previously declared.

In these examples, $\backslash foo$ is defined for all math versions but $\backslash baz$, by default, is defined nowhere.

```
\DeclareMathAlphabet{\foo}{OT1}{cmtt}{m}{n}
\DeclareMathAlphabet{\baz}{OT1}{-}{-}{-}
```

```
\SetMathAlphabet {\langle math\text{-}alph \rangle} {\langle version \rangle}
{\langle encoding \rangle} {\langle family \rangle} {\langle series \rangle} {\langle shape \rangle}
```

Changes, or sets, the font for the math alphabet $\langle math\text{-}alph \rangle$ in math version $\langle version \rangle$ to $\langle encoding \rangle \langle family \rangle \langle series \rangle \langle shape \rangle$.

Checks that $\langle math\text{-}alph \rangle$ has been declared as a math alphabet, $\langle version \rangle$ is a known math version and $\langle encoding \rangle$ is a known encoding scheme.

This example defines $\backslash baz$ for the ‘normal’ math version only:

```
\SetMathAlphabet{\baz}{normal}{OT1}{cmss}{m}{n}
```

Note that this declaration is not used for all math alphabets: Section 3.5 describes $\backslash DeclareSymbolFontAlphabet$, which is used to set up math alphabets contained in fonts which have been declared as symbol fonts.

3.5 Declaring symbol fonts

```
\DeclareSymbolFont {\langle sym\text{-}font \rangle} {\langle encoding \rangle} {\langle family \rangle} {\langle series \rangle} {\langle shape \rangle}
```

If this is the first declaration for $\langle sym\text{-}font \rangle$ then a new symbol font with this name is created (i.e. this identifier is assigned to a new T_EX math group).

New
description
1997/12/01

The arguments $\langle encoding \rangle \langle family \rangle \langle series \rangle \langle shape \rangle$ are used to set, or reset, the default values for this symbol font in *all* math versions; if required, these must be further reset later for a particular math version by a $\backslash SetSymbolFont$ command.

Checks that $\langle encoding \rangle$ is a declared encoding scheme.

For example, the following sets up the first four standard math symbol fonts:

```
\DeclareSymbolFont{operators}{OT1}{cmr}{m}{n}
\DeclareSymbolFont{letters}{OML}{cmm}{m}{it}
\DeclareSymbolFont{symbols}{OMS}{cmsy}{m}{n}
\DeclareSymbolFont{largesymbols}{OMX}{cmex}{m}{n}
```

```
\SetSymbolFont {\langle sym\text{-}font \rangle} {\langle version \rangle}
{\langle encoding \rangle} {\langle family \rangle} {\langle series \rangle} {\langle shape \rangle}
```

Changes the symbol font $\langle sym\text{-}font \rangle$ for math version $\langle version \rangle$ to $\langle encoding \rangle \langle family \rangle \langle series \rangle \langle shape \rangle$.

Checks that $\langle sym-font \rangle$ has been declared as a symbol font, $\langle version \rangle$ is a known math version and $\langle encoding \rangle$ is a declared encoding scheme.

For example, the following come from the set up of the ‘bold’ math version:

```
\SetSymbolFont{operators}{bold}{OT1}{cmr}{bx}{n}
\SetSymbolFont{letters}{bold}{OML}{cmm}{b}{it}
```

<code>\DeclareSymbolFontAlphabet $\langle math-alpha \rangle$ $\langle sym-font \rangle$</code>

Allows the previously declared symbol font $\langle sym-font \rangle$ to be the math alphabet with command $\langle math-alpha \rangle$ in *all* math versions.

New
description
1997/12/01

Checks that the command $\langle math-alpha \rangle$ is either already a math alphabet command or is undefined; and that $\langle sym-font \rangle$ is a symbol font.

Example:

```
\DeclareSymbolFontAlphabet{\mathrm}{operators}
\DeclareSymbolFontAlphabet{\mathcal}{symbols}
```

This declaration should be used in preference to `\DeclareMathAlphabet` and `\SetMathAlphabet` when a math alphabet is the same as a symbol font; this is because it makes better use of the limited number (only 16) of T_EX’s math groups.

Note that, whereas a T_EX math group is allocated to each symbol font when it is first declared, a math alphabet uses a T_EX math group only when its command is used within a math formula.

New
description
1997/12/01

3.6 Declaring math symbols

<code>\DeclareMathSymbol $\langle symbol \rangle$ $\langle type \rangle$ $\langle sym-font \rangle$ $\langle slot \rangle$</code>

The $\langle symbol \rangle$ can be either a single character such as ‘>’, or a macro name, such as `\sum`.

Defines the $\langle symbol \rangle$ to be a math symbol of type $\langle type \rangle$ in slot $\langle slot \rangle$ of symbol font $\langle sym-font \rangle$. The $\langle type \rangle$ can be given as a number or as a command:

<i>Type</i>	<i>Meaning</i>	<i>Example</i>
0 or <code>\mathord</code>	Ordinary	α
1 or <code>\mathop</code>	Large operator	\sum
2 or <code>\mathbin</code>	Binary operation	\times
3 or <code>\mathrel</code>	Relation	\leq
4 or <code>\mathopen</code>	Opening	\langle
5 or <code>\mathclose</code>	Closing	\rangle
6 or <code>\mathpunct</code>	Punctuation	$;$
7 or <code>\mathalpha</code>	Alphabet character	A

Only symbols of type `\mathalpha` will be affected by math alphabet commands: within the argument of a math alphabet command they will produce the character in slot $\langle slot \rangle$ of that math alphabet's font. Symbols of other types will always produce the same symbol (within one math version).

`\DeclareMathSymbol` allows a macro $\langle symbol \rangle$ to be redefined only if it was previously defined to be a math symbol. It also checks that the $\langle sym-font \rangle$ is a declared symbol font.

Example:

```
\DeclareMathSymbol{\alpha}{0}{letters}{0B}
\DeclareMathSymbol{\lessdot}{\mathbin}{AMSb}{0C}
\DeclareMathSymbol{\alphld}{\mathalpha}{AMSb}{0C}
```

<code>\DeclareMathDelimiter $\langle cmd \rangle$ $\langle type \rangle$ $\langle sym-font-1 \rangle$ $\langle slot-1 \rangle$ $\langle sym-font-2 \rangle$ $\langle slot-2 \rangle$</code>
--

Defines $\langle cmd \rangle$ to be a math delimiter where the small variant is in slot $\langle slot-1 \rangle$ of symbol font $\langle sym-font-1 \rangle$ and the large variant is in slot $\langle slot-2 \rangle$ of symbol font $\langle sym-font-2 \rangle$. Both symbol fonts must have been declared previously.

Checks that $\langle sym-font-i \rangle$ are both declared symbol fonts.

If T_EX is not looking for a delimiter, $\langle cmd \rangle$ is treated just as if it had been defined with `\DeclareMathSymbol` using $\langle type \rangle$, $\langle sym-font-1 \rangle$ and $\langle slot-1 \rangle$. In other words, if a command is defined as a delimiter then this automatically defines it as a math symbol.

In case $\langle cmd \rangle$ is a single character such as ‘[’, the same syntax is used. Previously the $\langle type \rangle$ argument was not present (and thus the corresponding math symbol declaration had to be provided separately).

New
description
1998/06/01

Example:

```
\DeclareMathDelimiter{\langle}{\mathopen}{symbols}{68}
\DeclareMathDelimiter{\Langle}{\mathopen}{largesymbols}{0A}
\DeclareMathDelimiter{[}{\mathopen}{operators}{28}
\DeclareMathDelimiter{[}{\mathopen}{largesymbols}{00}
```

<code>\DeclareMathAccent $\langle cmd \rangle$ $\langle type \rangle$ $\langle sym-font \rangle$ $\langle slot \rangle$</code>
--

Defines $\langle cmd \rangle$ to act as a math accent.

The accent character comes from slot $\langle slot \rangle$ in $\langle sym-font \rangle$. The $\langle type \rangle$ can be either `\mathord` or `\mathalpha`; in the latter case the accent character changes font when used in a math alphabet.

Example:

```
\DeclareMathAccent{\acute}{\mathalpha}{operators}{13}
\DeclareMathAccent{\vec}{\mathord}{letters}{7E}
```


$\backslash\text{DeclareMathRadical} \{ \langle cmd \rangle \} \{ \langle sym\text{-}font\text{-}1 \rangle \} \{ \langle slot\text{-}1 \rangle \} \{ \langle sym\text{-}font\text{-}2 \rangle \} \{ \langle slot\text{-}2 \rangle \}$

Defines $\langle cmd \rangle$ to be a radical where the small variant is in slot $\langle slot\text{-}1 \rangle$ of symbol font $\langle sym\text{-}font\text{-}1 \rangle$ and the large variant is in slot $\langle slot\text{-}2 \rangle$ of symbol font $\langle sym\text{-}font\text{-}2 \rangle$. Both symbol fonts must have been declared previously.

Example (probably the only use for it!):

$$\backslash\text{DeclareMathRadical}\{\sqrt{}\}\{\text{symbols}\}\{"70"\}\{\text{largesymbols}\}\{"70"\}$$

3.7 Declaring math sizes

$\backslash\text{DeclareMathSizes} \{ \langle t\text{-}size \rangle \} \{ \langle mt\text{-}size \rangle \} \{ \langle s\text{-}size \rangle \} \{ \langle ss\text{-}size \rangle \}$

Declares that $\langle mt\text{-}size \rangle$ is the (main) math text size, $\langle s\text{-}size \rangle$ is the ‘script’ size and $\langle ss\text{-}size \rangle$ the ‘scriptscript’ size to be used in math, when $\langle t\text{-}size \rangle$ is the current text size. For text sizes for which no such declaration is given the ‘script’ and ‘scriptscript’ size will be calculated and then fonts are loaded for the calculated sizes or the best approximation (this may result in a warning message).

Normally, $\langle t\text{-}size \rangle$ and $\langle mt\text{-}size \rangle$ will be identical; however, if, for example, PostScript text fonts are mixed with bit-map math fonts then you may not have available a $\langle mt\text{-}size \rangle$ for every $\langle t\text{-}size \rangle$.

Example:

$$\backslash\text{DeclareMathSizes}\{13.82\}\{14.4\}\{10\}\{7\}$$

4 Font installation

This section explains how L^AT_EX’s font attributes are turned into T_EX font specifications.

4.1 Font definition files

The description of how L^AT_EX font attributes are turned into T_EX fonts is usually kept in a *font definition file* (*.fd*). The file for family $\langle family \rangle$ in encoding $\langle ENC \rangle$ must be called $\langle enc \rangle \langle family \rangle .fd$: for example, *ot1cmr.fd* for Computer Modern Roman with encoding OT1 or *t1ptm.fd* for Adobe Times with encoding T1. Note that encoding names are converted to lowercase when used as part of file names.

New
description
1997/12/01

Whenever L^AT_EX encounters an encoding/family combination that it does not know (e.g. if the document designer says $\backslash\text{fontfamily}\{\text{ptm}\}\backslash\text{selectfont}$) then L^AT_EX attempts to load the appropriate *.fd* file. “Not known” means: there was

no `\DeclareFontFamily` declaration issued for this encoding/family combination. If the `.fd` file could not be found, a warning is issued and font substitutions are made.

The declarations in the font definition file are responsible for telling L^AT_EX how to load fonts for that encoding/family combination.

4.2 Font definition file commands

Note: A font definition file should contain only commands from this subsection.

Note that these commands can also be used outside a font definition file: they can be put in package or class files, or even in the preamble of a document.

<code>\ProvidesFile{<file-name>}[<release-info>]</code>

The file should announce itself with a `\ProvidesFile` command, as described in *L^AT_EX 2_ε for Class and Package Writers*. For example:

```
\ProvidesFile{t1ptm.fd}[1994/06/01 Adobe Times font definitions]
```

Spaces within the arguments specific to font definition files are ignored to avoid surplus spaces in the document. If a real space is necessary use `\space`. However, note that this is only true if the declaration is made at top level! If used within the definition of another command, within `\AtBeginDocument`, option code or in similar places, then spaces within the argument will remain and may result in incorrect table entries.

New
description
2004/02/10

<code>\DeclareFontFamily{<encoding>}{<family>}{<loading-settings>}</code>

Declares a font family `<family>` to be available in encoding scheme `<encoding>`.

The `<loading-settings>` are executed immediately after loading any font with this encoding and family.

Checks that `<encoding>` was previously declared.

This example refers to the Computer Modern Typewriter font family in the Cork encoding:

```
\DeclareFontFamily{T1}{cmtt}{\hyphenchar\font=-1}
```

Each `.fd` file should contain exactly one `\DeclareFontFamily` command, and it should be for the appropriate encoding/family combination.

<code>\DeclareFontShape{<encoding>}{<family>}{<series>}{<shape>}{<loading-info>}{<loading-settings>}</code>

Declares a font shape combination; here `<loading-info>` contains the information that combines sizes with external fonts. The syntax is complex and is described in Section 4.3 below.

The $\langle loading-settings \rangle$ are executed after loading any font with this font shape. They are executed immediately after the ‘loading-settings’ which were declared by `\DeclareFontFamily` and so they can be used to overwrite the settings made at the family level.

Checks that the combination $\langle encoding \rangle \langle family \rangle$ was previously declared via `\DeclareFontFamily`.

Example:

```
\DeclareFontShape{OT1}{cmr}{m}{sl}{%
  <5-8> sub * cmr/m/n
  <8> cmsl8
  <9> cmsl9
  <10> <10.95> cmsl10
  <12> <14.4> <17.28> <20.74> <24.88> cmsl12
}{}
```

The file can contain any number of `\DeclareFontShape` commands, which should be for the appropriate $\langle encoding \rangle$ and $\langle family \rangle$.

The font family declarations for the OT1-encoded fonts now all contain:

New feature
1996/06/01

```
\hyphenchar\font='\-
```

This enables the use of an alternative `\hyphenchar` in other encodings whilst maintaining the correct value for all fonts.

According to NFSS conventions the series value should be a combination of weight and width abbreviated each with one or two letters as described on page 5. In particular it should not contain an “m” unless it consists of just one character. In the past incorrect values such as “cm” were simply accepted, but since this now leads to problems with the extended mechanism, the correct syntax is now enforced.

New feature
2020/02/02

More exactly, if the series values is a member of a specific set of values (ulm, elm, lm, slm, mm, sbm, bm, ebm, ubm, muc, mec, mc, msc, msx, mx, mex or mux) it is assumed to be in incorrect NFSS notation and so a warning is given and a surplus “m” is dropped. Other values are not touched to allow for the usage of values like “semibold” or “medium” as used by the `autoinst` program.

4.3 Font file loading information

The information which tells L^AT_EX exactly which font (`.tfm`) files to load is contained in the $\langle loading-info \rangle$ part of a `\DeclareFontShape` declaration. This part consists of one or more $\langle fontshape-decl \rangle$ s, each of which has the following form:

$$\begin{aligned} \langle fontshape-decl \rangle &::= \langle size-infos \rangle \langle font-info \rangle \\ \langle size-infos \rangle &::= \langle size-infos \rangle \langle size-info \rangle \mid \langle size-info \rangle \\ \langle size-info \rangle &::= "<" \langle number-or-range \rangle ">" \\ \langle font-info \rangle &::= [\langle size-function \rangle "*"] ["[" \langle optarg \rangle "]"] \langle fontarg \rangle \end{aligned}$$

The $\langle number-or-range \rangle$ denotes the size or size-range for which this entry applies.

If it contains a hyphen it is a range: lower bound on the left (if missing, zero implied), upper bound on the right (if missing, ∞ implied). For ranges, the upper bound is *not* included in the range and the lower bound is.

Examples:

$\langle 10 \rangle$	simple size	10pt only
$\langle -8 \rangle$	range	all sizes less than 8pt
$\langle 8-14.4 \rangle$	range	all sizes greater than or equal to 8pt but less than 14.4pt
$\langle 14.4- \rangle$	range	all sizes greater than or equal 14.4pt

If more than one $\langle size-info \rangle$ entry follows without any intervening $\langle font-info \rangle$, they all share the next $\langle font-info \rangle$.

The $\langle size-function \rangle$, if present, handles the use of $\langle font-info \rangle$. If not present, the ‘empty’ $\langle size-function \rangle$ is assumed.

All the $\langle size-info \rangle$ s are inspected in the order in which they appear in the font shape declaration. If a $\langle size-info \rangle$ matches the requested size, its $\langle size-function \rangle$ is executed. If $\backslash external@font$ is non-empty afterwards this process stops, otherwise the next $\langle size-info \rangle$ is inspected. (See also $\backslash DeclareSizeFunction$.)

If this process does not lead to a non-empty $\backslash external@font$, L^AT_EX tries the nearest simple size. If the entry contains only ranges an error is returned.

4.4 Size functions

L^AT_EX provides the following size functions, whose ‘inputs’ are $\langle fontarg \rangle$ and $\langle optarg \rangle$ (when present).

‘’ (**empty**) Load the external font $\langle fontarg \rangle$ at the user-requested size. If $\langle optarg \rangle$ is present, it is used as the scale-factor.

s Like the empty function but without terminal warnings, only loggings.

gen Generates the external font from $\langle fontarg \rangle$ followed by the user-requested size, e.g. $\langle 8 \rangle \langle 9 \rangle \langle 10 \rangle$ **gen** * **cm****tt**

s**gen** Like the ‘gen’ function but without terminal warnings, only loggings.

genb Generates the external font from $\langle fontarg \rangle$ followed by the user-requested size, using the conventions of the ‘ec’ fonts. e.g. $\langle 10.98 \rangle$ **genb** * **d****ctt** produces **d****ctt**1098. New feature
1995/12/01

s**genb** Like the ‘genb’ function but without terminal warnings, only loggings. New feature
1995/12/01

sub Tries to load a font from a different font shape declaration given by $\langle fontarg \rangle$ in the form $\langle family \rangle / \langle series \rangle / \langle shape \rangle$.

ssub Silent variant of ‘sub’, only loggings.

alias Same as ‘ssub’ but with a different logging message. Intended for cases where the substitution is only done to change the name, e.g., going from **regular** series to the official name **m**. In that case given a warning that some shape is not found is not correct. New feature
2019/10/15

subf Like the empty function but issues a warning that it has to substitute the external font $\langle fontarg \rangle$ because the desired font shape was not available in the requested size.

ssubf Silent variant of ‘subf’, only loggings.

fixed Load font $\langle fontarg \rangle$ as is, disregarding the user-requested size. If present, $\langle optarg \rangle$ gives the “at ...pt” size to be used.

sfixed Silent variant of ‘fixed’, only loggings.

Examples for the use of most of the above size functions can be found in the file `cmfonts.fdd`—the source for the standard `.fd` files describing the Computer Modern fonts by Donald Knuth.

`\DeclareSizeFunction { $\langle name \rangle$ } { $\langle code \rangle$ }`

Declares a size-function $\langle name \rangle$ for use in `\DeclareFontShape` commands. The interface is still under development but there should be no real need to a define new size functions.

The $\langle code \rangle$ is executed when the size or size-range in `\DeclareFontShape` matches the user-requested size.

The arguments of the size-function are automatically parsed and placed into `\mandatory@arg` and `\optional@arg` for use in $\langle code \rangle$. Also available, of course, is `\f@size`, which is the user-requested size.

To signal success $\langle code \rangle$ must define the command `\external@font` to contain the external name and any scaling options (if present) for the font to be loaded.

This example sets up the ‘empty’ size function (simplified):

```
\DeclareSizeFunction{}
{\edef\external@font{\mandatory@arg\space at\f@size}}
```

5 Encodings

This section explains how to declare and use new font encodings and how to declare commands for use with particular encodings.

5.1 The fontenc package

Users can select new font encodings using the **fontenc** package. The **fontenc** package has options for encodings; the last option becomes the default encoding. For example, to use the OT2 (Washington University Cyrillic encoding) and T1 encodings, with T1 as the default, an author types:

```
\usepackage[OT2,T1]{fontenc}
```

For each font encoding $\langle ENC \rangle$ given as an option, this package loads the *encoding definition* ($\langle enc \rangle$ `enc.def`, with an all lower-case name) file; it also sets `\encodingdefault` to be the last encoding in the option list.

New
description
1997/12/01

The declarations in the encoding definition file $\langle enc \rangle$ `enc.def` for encoding $\langle ENC \rangle$ are responsible for declaring this encoding and telling L^AT_EX how to produce characters in this encoding; this file should contain nothing else (see Section 5.2).

The standard L^AT_EX format declares the OT1 and T1 text encodings by inputting the files `ot1enc.def` and `t1enc.def`; it also sets up various defaults which require that OT1-encoded fonts are available. Other encoding set-ups might be added to the distribution at a later stage.

Thus the example above loads the files `ot2enc.def` and `t1enc.def` and sets `\encodingdefault` to T1.

Warning: If you wish to use T1-encoded fonts other than the ‘cmr’ family then you may need to load the package (e.g. `times`) that selects the fonts *before* loading `fontenc` (this prevents the system from attempting to load any T1-encoded fonts from the ‘cmr’ family).

5.2 Encoding definition file commands

Note: An encoding definition file should contain only commands from this subsection.

As an exception it may also contain a `\DeclareFontsubstitution` declaration (described in 5.4) to specify how font substitution for this encoding should be handled. In that case it is important that the values used point to a font that is guaranteed to be available on all L^AT_EX installations.²

New
description
2019/07/10

As with the font definition file commands, it is also possible (although normally not necessary) to use these declarations directly within a class or package file.

New
description
1997/12/01

Warning: Some aspects of the contents of font definition files are still under development. Therefore, the current versions of the files `ot1enc.def` and `t1enc.def` are temporary versions and should not be used as models for producing further such files. For further information you should read the documentation in `ltoutenc.dtx`.

`\ProvidesFile{<file-name>}[<release-info>]`

The file should announce itself with a `\ProvidesFile` command, described in L^AT_EX 2_ε for Class and Package Writers. For example:

```
\ProvidesFile{ot2enc.def}
[1994/06/01 Washington University Cyrillic encoding]
```

²If the font encoding file is made available as part of a CTAN bundle, that could be a font that is provided together with that bundle, but it should not point to font which requires further installation steps and therefore may or may not be installed.

<code>\DeclareFontEncoding {<encoding>} {<text-settings>} {<math-settings>}</code>
--

Declares a new encoding scheme *<encoding>*.

The *<text-settings>* are declarations which are executed every time `\selectfont` changes the encoding to be *<encoding>*.

The *<math-settings>* are similar but are for math alphabets. They are executed whenever a math alphabet with this encoding is called.

It also saves the value of *<encoding>* in the macro `\LastDeclaredEncoding`.

New feature
1998/12/01

Example:

```
\DeclareFontEncoding{OT1}{}{}
```

Some author commands need to change their definition depending on which encoding is currently in use. For example, in the OT1 encoding, the letter ‘Æ’ is in slot "1D, whereas in the T1 encoding it is in slot "C6. So the definition of `\AE` has to change depending on whether the current encoding is OT1 or T1. The following commands allow this to happen.

<code>\DeclareTextCommand {<cmd>} {<encoding>} [<num>] [<default>] {<definition>}</code>
--

This command is like `\newcommand`, except that it defines a command which is specific to one encoding. For example, the definition of `\k` in the T1 encoding is:

```
\DeclareTextCommand{\k}{T1}[1]
{\oalign{\null#1\crcr\hidewidth\char12}}
```

`\DeclareTextCommand` takes the same optional arguments as `\newcommand`.

The resulting command is robust, even if the code in *<definition>* is fragile.

It does not produce an error if the command has already been defined but logs the redefinition in the transcript file.

<code>\ProvideTextCommand {<cmd>} {<encoding>} [<num>] [<default>] {<definition>}</code>
--

New feature
1994/12/01

This command is the same as `\DeclareTextCommand`, except that if *<cmd>* is already defined in encoding *<encoding>*, then the definition is ignored.

<code>\DeclareTextSymbol {<cmd>} {<encoding>} {<slot>}</code>

This command defines a text symbol with slot *<slot>* in the encoding. For example, the definition of `\ss` in the OT1 encoding is:

```
\DeclareTextSymbol{\ss}{OT1}{25}
```

It does not produce an error if the command has already been defined but logs the redefinition in the transcript file.

`\DeclareTextAccent {<cmd>} {<encoding>} {<slot>}`

This command declares a text accent, with the accent taken from slot *<slot>* in the encoding. For example, the definition of `\"` in the OT1 encoding is:

```
\DeclareTextAccent{"}{OT1}{127}
```

It does not produce an error if the command has already been defined but logs the redefinition in the transcript file.

`\DeclareTextComposite {<cmd>} {<encoding>} {<letter>} {<slot>}`

This command declares that the composite letter formed from applying *<cmd>* to *<letter>* is defined to be simply slot *<slot>* in the encoding. The *<letter>* should be a single letter (such as `a`) or a single command (such as `\i`).

For example, the definition of `\'a` in the T1 encoding could be declared like this:

```
\DeclareTextComposite{\'}{T1}{a}{225}
```

The *<cmd>* will normally have been previously declared for this encoding, either by using `\DeclareTextAccent`, or as a one-argument `\DeclareTextCommand`.

`\DeclareTextCompositeCommand {<cmd>} {<encoding>} {<letter>} {<definition>}`

New feature
1994/12/01

This is a more general form of `\DeclareTextComposite`, which allows for an arbitrary *<definition>*, not just a *<slot>*. The main use for this is to allow accents on `i` to act like accents on `\i`, for example:

```
\DeclareTextCompositeCommand{\'}{OT1}{i}{\'\i}
```

It has the same restrictions as `\DeclareTextComposite`.

`\LastDeclaredEncoding`

New feature
1998/12/01

This holds the name of the last encoding declared via `\DeclareFontEncoding` (this should also be the currently most efficient encoding). It can be used in the *<encoding>* argument of the above declarations in place of explicitly mentioning the encoding, e.g.

```
\DeclareFontEncoding{T1}{}{}
\DeclareTextAccent{\'}{\LastDeclaredEncoding}{0}
\DeclareTextAccent{\'}{\LastDeclaredEncoding}{1}
```

This can be useful in cases where encoding files sharing common code are generated from one source.

5.3 Default definitions

The declarations used in encoding definition files define encoding-specific commands but they do not allow those commands to be used without explicitly changing the encoding. For some commands, such as symbols, this is not enough. For example, the `OMS` encoding contains the symbol ‘§’, but we need to be able to use the command `\S` whatever the current encoding may be, without explicitly selecting the encoding `OMS`.

New
description
1997/12/01

To allow this, \LaTeX has commands that declare default definitions for commands; these defaults are used when the command is not defined in the current encoding. For example, the default encoding for `\S` is `OMS`, and so in an encoding (such as `OT1`) which does not contain `\S`, the `OMS` encoding is selected in order to access this glyph. But in an encoding (such as `T1`) which does contain `\S`, the glyph in that encoding is used. The standard \LaTeX 2_ε format sets up several such defaults using the following encodings: `OT1`, `OMS` and `OML`.

New
description
1997/12/01

Warning: These commands should *not* occur in encoding definition files, since those files should declare only commands for use when that encoding has been selected. They should instead be placed in packages; they must, of course, always refer to encodings that are known to be available.

`\DeclareTextCommandDefault {<cmd>} {<definition>}`

New feature
1994/12/01

This command allows an encoding-specific command to be given a default definition. For example, the default definition for `\copyright` is defined be a circled ‘c’ with:

```
\DeclareTextCommandDefault{\copyright}{\textcircled{c}}
```

`\DeclareTextAccentDefault {<cmd>} {<encoding>}`
`\DeclareTextSymbolDefault {<cmd>} {<encoding>}`

New feature
1994/12/01

These commands allow an encoding-specific command to be given a default encoding. For example, the default encoding for `\"` and `\ae` is set to be `OT1` by:

```
\DeclareTextAccentDefault{\"}{OT1}
\DeclareTextSymbolDefault{\ae}{OT1}
```

Note that `\DeclareTextAccentDefault` can be used on any one-argument encoding-specific command, not just those defined with `\DeclareTextAccent`. Similarly, `\DeclareTextSymbolDefault` can be used on any encoding-specific command with no arguments, not just those defined with `\DeclareTextSymbol`.

For more examples of these definitions, see `ltoutenc.dtx`.

`\ProvideTextCommandDefault {<cmd>} {<definition>}`

New feature
1994/12/01

This command is the same as `\DeclareTextCommandDefault`, except that if the command already has a default definition, then the definition is ignored. This is

useful to give ‘faked’ definitions of symbols which may be given ‘real’ definitions by other packages. For example, a package might give a fake definition of `\textonequarter` by saying:

```
\ProvideTextCommandDefault{\textonequarter}{\m@th\frac{1}{4}}
```

5.4 Encoding defaults

```
\DeclareFontEncodingDefaults {<text-settings>} {<math-settings>}
```

Declares *<text-settings>* and *<math-settings>* for all encoding schemes. These are executed before the encoding scheme dependent ones are executed so that one can use the defaults for the major cases and overwrite them if necessary using `\DeclareFontEncoding`.

If `\relax` is used as an argument, the current setting of this default is left unchanged.

This example is used by `amsfonts.sty` for accent positioning; it changes only the math settings:

```
\DeclareFontEncodingDefaults{\relax}{\def\accentclass@{7}}
```

```
\DeclareFontSubstitution {<encoding>} {<family>} {<series>} {<shape>}
```

Declares the default values for font substitution which will be used when a font with encoding *<encoding>* should be loaded but no font can be found with the current attributes.

These substitutions are local to the encoding scheme because the encoding scheme is never substituted! They are tried in the order *<shape>* then *<series>* and finally *<family>*.

This declaration is normally done in an encoding definition file (see 5.2), but can also be used in a class file or the document preamble to alter the default for a specific encoding.

New
description
2019/07/10

If no defaults are set up for an encoding, the values given by `\DeclareErrorFont` are used.

The font specification for *<encoding>**<family>**<series>**<shape>* must have been defined by `\DeclareFontShape` before the `\begin{document}` is reached.

Example:

```
\DeclareFontSubstitution{T1}{cmr}{m}{n}
```

5.5 Case changing

<code>\MakeUppercase {<text>}</code> <code>\MakeLowercase {<text>}</code>
--

TeX provides the two primitives `\uppercase` and `\lowercase` for changing the case of text. Unfortunately, these TeX primitives do not change the case of characters accessed by commands like `\ae` or `\aa`. To overcome this problem, L^AT_EX provides these two commands.

New feature
1995/06/01

In the long run, we would like to use all-caps fonts rather than any command like `\MakeUppercase` but this is not possible at the moment because such fonts do not exist.

For further details, see `clsguide.tex`.

In order that upper/lower-casing will work reasonably well, and in order to provide any correct hyphenation, L^AT_EX 2_ε *must* use, throughout a document, the same fixed table for changing case. The table used is designed for the font encoding T1; this works well with the standard TeX fonts for all Latin alphabets but will cause problems when using other alphabets. As an experiment, it has now been extended for use with some Cyrillic encodings.

New
description
1999/04/23

6 Miscellanea

This section covers the remaining font commands in L^AT_EX and some other issues.

6.1 Font substitution

<code>\DeclareErrorFont {<encoding>} {<family>} {<series>} {<shape>} {<size>}</code>
--

Declares `<encoding>{<family>{<series>{<shape>}}` to be the font shape used in cases where the standard substitution mechanism fails (i.e. would loop). For the standard mechanism see the command `\DeclareFontSubstitution` above.

The font specification for `<encoding>{<family>{<series>{<shape>}}` must have been defined by `\DeclareFontShape` before the `\begin{document}` is reached.

Example:

```
\DeclareErrorFont{OT1}{cmr}{m}{n}{10}
```

This declaration is a system wide fallback and it should normally not be changed, in particular it does not belong into font encoding definition files but rather into the L^AT_EX format. It is normally set up in `fonttext.cfg`. Adjustments on a per encoding base should be made through `\DeclareFontSubstitution` instead!

New
description
2019/07/10

`\fontsubfuzz`

This parameter is used to decide whether or not to produce a terminal warning if a font size substitution takes place. If the difference between the requested and the chosen size is less than `\fontsubfuzz` the warning is only written to the transcript file. The default value is 0.4pt. This can be redefined with `\renewcommand`, for example:

```
\renewcommand{\fontsubfuzz}{0pt} % always warn
```

6.2 Preloading

`\DeclarePreloadSizes {<encoding>} {<family>} {<series>} {<shape>} {<size-list>}`

Specifies the fonts that should be preloaded by the format. These commands should be put in a `preload.cfg` file, which is read in when the L^AT_EX format is being built. Read `preload.dtx` for more information on how to build such a configuration file.

Example:

```
\DeclarePreloadSizes{OT1}{cmr}{m}{sl}{10,10.95,12}
```

Preloading is really an artifact of the days when loading fonts while processing a document contributed substantially to the processing time. These days it is usually best not to use this mechanism any more.

New
description
2019/07/10

6.3 Accented characters

Accented characters in L^AT_EX can be produced using commands such as `\"a` etc. The precise effect of such commands depends on the font encoding being used. When using a font encoding that contains the accented characters as individual glyphs (such as the T1 encoding, in the case of `\"a`) words that contain such accented characters can be automatically hyphenated. For font encodings that do not contain the requested individual glyph (such as the OT1 encoding) such a command invokes typesetting instructions that produce the accented character as a combination of character glyphs and diacritical marks in the font. In most cases this involves a call to the T_EX primitive `\accent`. Glyphs constructed as composites in this way inhibit hyphenation of the current word; this is one reason why the T1 encoding is preferable to the original T_EX font encoding OT1.

New
description
1996/06/01

It is important to understand that commands like `\"a` in L^AT_EX 2_ε represent just a name for a single glyph (in this case ‘umlaut a’) and contain no information about how to typeset that glyph—thus it does *not* mean ‘put two dots on top of the character a’. The decision as to what typesetting routine to use will depend on the encoding of the current font and so this decision is taken at the last minute. Indeed, it is possible that the same input will be typeset in more than one way in the same document; for example, text in section headings may also

appear in table of contents and in running heads; and each of these may use a font with a different encoding.

For this reason the notation `\a` is *not* equivalent to:

```
\newcommand \chara {a}      \"\chara
```

In the latter case, \LaTeX does not expand the macro `\chara` but simply compares the notation (the string `\"\chara`) to its list of known composite notations in the current encoding; when it fails to find `\"\chara` it does the best it can and invokes the typesetting instructions that put the umlaut accent on top of the expansion of `\chara`. Thus, even if the font actually contains ‘ä’ as an individual glyph, it will not be used.

The low-level accent commands in \LaTeX are defined in such a way that it is possible to combine a diacritical mark from one font with a glyph from another font; for example, `\"\textparagraph` will produce ¶. The umlaut here is taken from the OT1 encoded font `cmr10` whilst the paragraph sign is from the OMS encoded font `cmsy10`. (This example may be typographically silly but better ones would involve font encodings like OT2 (Cyrillic) that might not be available at every site.)

There are, however, restrictions on the font-changing commands that will work within the argument to such an accent command. These are \TeX nical in the sense that they follow from the way that \TeX ’s `\accent` primitive works, allowing only a special class of commands between the accent and the accented character.

The following are examples of commands that will not work correctly as the accent will appear above a space: the font commands with text arguments (`\textbf{...}` and friends); all the font size declarations (`\fontsize` and `\Large`, etc.); `\usefont` and declarations that depend on it, such as `\normalfont`; box commands (e.g. `\mbox{...}`).

The lower-level font declarations that set the attributes family, series and shape (such as `\fontshape{sl}\selectfont`) will produce correct typesetting, as will the default declarations such as `\bfseries`.

6.4 Naming conventions

- Math alphabet commands all start with `\math...`: examples are `\mathbf`, `\mathcal`, etc.
- The text font changing commands with arguments all start with `\text...`: e.g. `\textbf` and `\textrm`. The exception to this is `\emph`, since it occurs very commonly in author documents and so deserves a shorter name.
- Names for encoding schemes are strings of up to three letters (all upper case) plus digits.

The \LaTeX Project reserves the use of encodings starting with the following letters: T (standard 256-long text encodings), TS (symbols that are designed to extend a corresponding T encoding), X (text encodings that

do not conform to the strict requirements for T encodings), M (standard 256-long math encodings), S (other symbol encodings), A (other special applications), OT (standard 128-long text encodings) and OM (standard 128-long math encodings).

Please do not use the above starting letters for non-portable encodings. If new standard encodings emerge then we shall add them in a later release of L^AT_EX.

Encoding schemes which are local to a site or a system should start with L, experimental encodings intended for wide distribution will start with E, whilst U is for Unknown or Unclassified encodings.

- Font family names should contain only upper and lower case letters and hyphen characters. Where possible, these should conform to the *Filenames for fonts* font naming scheme of the scheme implemented by `autoinst` with suffixes such as `-LF`, `-OsF`, etc. to indicate different figure styles. New description
2019/10/15
- Font series names should contain up to four lower case letters. If at all possible standard names as suggested in Section 2.1 should be used. Font specific names such as `regular` or `black`, etc. should be at least aliased to a corresponding standard name. New description
2019/10/15
- Font shapes should contain up to four letters lower case. Use the names suggested in Section 2.1. New description
2019/10/15
- Names for symbol fonts are built from lower and upper case letters with no restriction.

Whenever possible, you should use the series and shape names suggested in *The L^AT_EX Companion* since this will make it easier to combine new fonts with existing fonts.

Where possible, text symbols should be named as `\text` followed by the Adobe glyph name: for example `\textonequarter` or `\textsterling`. Similarly, math symbols should be named as `\math` followed by the glyph name, for example `\mathonequarter` or `\mathsterling`. Commands which can be used in text or math can then be defined using `\ifmmode`, for example:

```
\DeclareRobustCommand{\pounds}{%
  \ifmmode \mathsterling \else \textsterling \fi
}
```

Note that commands defined in this way must be robust, in case they get put into a section title or other moving argument.

6.5 The order of declaration

NFSS forces you to give all declarations in a specific order so that it can check whether you have specified all necessary information. If you declare objects in the wrong order, it will complain. Here are the dependencies that you have to obey: New description
2019/10/15

- `\DeclareFontFamily` checks that the encoding scheme was previously declared with `\DeclareFontEncoding`.
- `\DeclareFontShape` checks that the font family was declared to be available in the requested encoding (`\DeclareFontFamily`).
- `\DeclareSymbolFont` checks that the encoding scheme is valid.
- `\SetSymbolFont` additionally ensures that the requested math version was declared (`\DeclareMathVersion`) and that the requested symbol font was declared (`\DeclareSymbolFont`).
- `\DeclareSymbolFontAlphabet` checks that the command name for the alphabet identifier can be used and that the symbol font was declared.
- `\DeclareMathAlphabet` checks that the chosen command name can be used and that the encoding scheme was declared.
- `\SetMathAlphabet` checks that the alphabet identifier was previously declared with `\DeclareMathAlphabet` or `\DeclareSymbolFontAlphabet` and that the math version and the encoding scheme are known.
- `\DeclareMathSymbol` makes sure that the command name can be used (i.e., is undefined or was previously declared to be a math symbol) and that the symbol font was previously declared.
- When the `\begin{document}` command is reached, NFSS makes some additional checks—for example, verifying that substitution defaults for every encoding scheme point to known font shape group declarations.

6.6 Font series defaults per document family

With additional weights and widths being available in many font families nowadays, it is more likely that somebody will want to match, say, a medium weight serif family with a semi-light sans serif family, or that with one family one wants to use the bold-extended face when `\textbf` is used, while with another it should be bold (not extended) or semi-bold, etc. The default values can be altered using the `\DeclareFontSeriesDefault` declaration in packages or document preambles:

New feature
2020/02/02

<code>\DeclareFontSeriesDefault [<i>meta family</i>] {<i>meta series</i>} {<i>series value</i>}</code>
--

This declaration takes three arguments:

Meta family interface: Can be either `rm`, `sf` or `tt`. This is optional and if not present the next two arguments apply to the overall default.

Meta series interface: Can be `md` or `bf`.

Series value: This is the value that is going to be used when the combination of *meta family* and *meta series* is requested.

For example,

```
\DeclareFontSeriesDefault[rm]{bf}{sb}
```

would use `sb` (semi-bold) when `\rmfamily\bfseries` is requested in document.

6.7 Handling of nested emphasis

`\DeclareEmphSequence {⟨list of font declarations⟩}`

This declaration takes a comma separated list of font declarations each specifying how increasing levels of emphasis should be handled. For example:

New feature
2020/02/02

```
\DeclareEmphSequence{\itshape,%  
                    \upshape\scshape,%  
                    \itshape}
```

uses italics for the first, small capitals for the second, and italic small capitals for the third level. If there are more nesting levels than provided, declarations stored in `\emreset` (by default `\ulcshape\upshape`) are used for the next level and then the list restarts.

6.8 Providing font family substitutions

`\DeclareFontFamilySubstitution {⟨encoding⟩} {⟨family⟩} {⟨new-family⟩}`

This declaration selects the font family `⟨new-family⟩` as replacement for `⟨family⟩` in the font encoding `⟨encoding⟩`. For example,

New feature
2020/02/02

```
\DeclareFontFamilySubstitution{LGR}  
    {Montserrat-LF}{IBMPlexSans-TLF}
```

tells \LaTeX to substitute the sans serif font `Montserrat-LF` in the Greek encoding LGR with `IBMPlexSans-TLF` once requested in a document.

7 Additional text symbols – `textcomp`

For a long time the interface to additional text symbols and the text companion encoding TS1 in general was the `textcomp` package. All the symbols provided by the `textcomp` package are now available in \LaTeX kernel. Furthermore, an intelligent substitution mechanism has been implemented so that glyphs missing in some fonts are automatically substituted with default glyphs that are sans serif if you typeset in `\textsf` and monospaced if you typeset using `\texttt`. In the past they were always taken from Computer Modern Roman if substitution was necessary.

New feature
2020/02/02

This is most noticeable with `\oldstylenums` which are now taken from TS1 so that you no longer get 1234 but 1234 when typesetting in sans serif fonts and 1234 when using typewriter fonts.

<code>\legacyoldstylenums {⟨nums⟩}</code> <code>\UseLegacyTextSymbols</code>

If there ever is a need to use the original (inferior) definition, then that remains available as `\legacyoldstylenums`; and to fully revert to the old behavior there is also `\UseLegacyTextSymbols`. The latter declaration reverts `\oldstylenums` and also changes the footnote symbols, such as `\textdagger`, `\textparagraph`, etc., to pick up their glyphs from the math fonts instead of the current text font (this means they always keep the same shape and do not nicely blend in with the text font).

The following tables show the macros available. The next commands are ‘constructed’ accents and are built via \TeX macros:

<code>\capitalcedilla</code>	<code>_A</code>	\AA
<code>\capitalogonek</code>	<code>_A</code>	\AA
<code>\textcircled</code>	<code>_a</code>	$\text{\textcircled{a}}$

These accents are available via font encoding. The numbers in third row show the slot number:

<code>\capitalgrave</code>	<code>\`</code>	0	<code>\capitalbreve</code>	<code>\~</code>	8
<code>\capitalacute</code>	<code>\^</code>	1	<code>\capitalmacron</code>	<code>\=</code>	9
<code>\capitalcircumflex</code>	<code>\^</code>	2	<code>\capitaldotaccent</code>	<code>\.</code>	10
<code>\capitaltilde</code>	<code>\~</code>	3	<code>\t</code>	<code>\^</code>	26
<code>\capitaldieresis</code>	<code>\"</code>	4	<code>\capitaltie</code>	<code>\^</code>	27
<code>\capitalhungarumlaut</code>	<code>\~</code>	5	<code>\newtie</code>	<code>\^</code>	28
<code>\capitalring</code>	<code>\.</code>	6	<code>\capitalnewtie</code>	<code>\^</code>	29
<code>\capitalcaron</code>	<code>\^</code>	7			

Table 1 on the following page contains macros to access text symbols. Again, the numbers are the slots in the encoding.

8 If you need to know more ...

The `tracefnt` package provides for tracing the actions concerned with loading, substituting and using fonts. The package accepts the following options:

New
description
1996/06/01

errorshow Write all information about font changes, etc. but only to the transcript file unless an error occurs. This means that information about font substitution will not be shown on the terminal.

warningshow Show all font warnings on the terminal. This setting corresponds to the default behavior when this `tracefnt` package is *not* used!

<code>\textcapitalcompwordmark</code>	23	<code>\textflorin</code>	f	140
<code>\textascendercompwordmark</code>	31	<code>\textcolonmonetary</code>	₯	141
<code>\textquotestraightbase</code>	'	<code>\textwon</code>	₩	142
<code>\textquotestraightdblbase</code>	"	<code>\textnaira</code>	₦	143
<code>\texttwelvewardash</code>	—	<code>\textguarani</code>	₧	144
<code>\textthreequartersemdash</code>	—	<code>\textpeso</code>	₱	145
<code>\textleftarrow</code>	←	<code>\textlira</code>	₺	146
<code>\textrightarrow</code>	→	<code>\textrecipe</code>	℞	147
<code>\textblank</code>	␣	<code>\textinterrobang</code>	‡	148
<code>\textdollar</code>	\$	<code>\textinterrobangdown</code>	‡	149
<code>\textquotesingle</code>	'	<code>\textdong</code>	₫	150
<code>\textasteriskcentered</code>	*	<code>\texttrademark</code>	™	151
<code>\textdblhyphen</code>	=	<code>\textpertenthousand</code>	‰	152
<code>\textfractionsolidus</code>	/	<code>\textpilcrow</code>	¶	153
<code>\textzerooldstyle</code>	0	<code>\textbaht</code>	฿	154
<code>\textoneoldstyle</code>	1	<code>\textnumero</code>	№	155
<code>\texttwooldstyle</code>	2	<code>\textdiscount</code>	ℳ	156
<code>\textthreeoldstyle</code>	3	<code>\textestimated</code>	€	157
<code>\textfouroldstyle</code>	4	<code>\textopenbullet</code>	◦	158
<code>\textfiveoldstyle</code>	5	<code>\textservicemark</code>	℠	159
<code>\textsixoldstyle</code>	6	<code>\textlquill</code>	{	160
<code>\textsevenoldstyle</code>	7	<code>\extrquill</code>	}	161
<code>\texteightoldstyle</code>	8	<code>\textcent</code>	¢	162
<code>\textnineoldstyle</code>	9	<code>\textsterling</code>	£	163
<code>\textlangle</code>	⟨	<code>\textcurrency</code>	₹	164
<code>\textminus</code>	—	<code>\textyen</code>	¥	165
<code>\textrangle</code>	⟩	<code>\textbrokenbar</code>	⎵	166
<code>\textmho</code>	Ω	<code>\textsection</code>	§	167
<code>\textbigcircle</code>	◯	<code>\textasciidieresis</code>	¨	168
<code>\textohm</code>	Ω	<code>\textcopyright</code>	©	169
<code>\textlbracketdbl</code>	⌈	<code>\textordfeminine</code>	♀	170
<code>\textrbracketdbl</code>	⌋	<code>\textcopyleft</code>	Ⓒ	171
<code>\textuparrow</code>	↑	<code>\textlnot</code>	¬	172
<code>\textdownarrow</code>	↓	<code>\textcircledP</code>	Ⓟ	173
<code>\textasciigrave</code>	`	<code>\textregistered</code>	®	174
<code>\textborn</code>	*	<code>\textasciimacron</code>	˘	175
<code>\textdivorced</code>	∕	<code>\textdegree</code>	°	176
<code>\textdied</code>	†	<code>\textpm</code>	±	177
<code>\textleaf</code>	☛	<code>\texttwosuperior</code>	²	178
<code>\textmarried</code>	∞	<code>\textthreesuperior</code>	³	179
<code>\textmusicalnote</code>	♪	<code>\textasciiacute</code>	´	180
<code>\texttildelow</code>	~	<code>\textmu</code>	μ	181
<code>\textdblhyphenchar</code>	=	<code>\textparagraph</code>	¶	182
<code>\textasciibreve</code>	˘	<code>\textperiodcentered</code>	·	183
<code>\textasciicaron</code>	ˇ	<code>\textreferencemark</code>	※	184
<code>\textacutedbl</code>	¨	<code>\textonesuperior</code>	¹	185
<code>\textgravedbl</code>	˝	<code>\textordmasculine</code>	♂	186
<code>\textdagger</code>	†	<code>\textsurd</code>	√	187
<code>\textdaggerdbl</code>	‡	<code>\textonequarter</code>	¼	188
<code>\textbardbl</code>	‖	<code>\textonehalf</code>	½	189
<code>\textperthousand</code>	‰	<code>\textthreequarters</code>	¾	190
<code>\textbullet</code>	•	<code>\texteuro</code>	€	191
<code>\textcelsius</code>	°C	<code>\texttimes</code>	×	214
<code>\textdollaroldstyle</code>	\$	<code>\textdiv</code>	÷	246
<code>\textcentoldstyle</code>	¢			

Table 1: Text symbols formerly from the `textcomp` package

infoshow Show all font warnings and all font info messages (that are normally only written to the transcript file) also on the terminal. This is the default when this `tracefmt` package is loaded.

debugshow In addition to what is shown by `infoshow`, show also changes of math fonts (as far as possible): beware, this option can produce a large amount of output.

loading Show the names of external font files when they are loaded. This option shows only ‘newly loaded’ fonts, not those already preloaded in the format or the class file before this `tracefmt` package becomes active.

pausing Turn all font warnings into errors so that \LaTeX will stop.

Warning: The actions of this package can change the layout of a document and even, in rare cases, produce clearly wrong output, so it should not be used in the final formatting of ‘real documents’.

References

- [1] Frank Mittelbach and Michel Goossens. *The \LaTeX Companion second edition*. With Johannes Braams, David Carlisle, and Chris Rowley. Addison-Wesley, Reading, Massachusetts, 2004.
- [2] Donald E. Knuth. Typesetting concrete mathematics. *TUGboat*, 10(1):31–36, April 1989.
- [3] Leslie Lamport. *\LaTeX : A Document Preparation System*. Addison-Wesley, Reading, Massachusetts, second edition, 1994.