Configurable LTL math operators with the ltl package*

Malte Schmitz
malte@schmitz-sh.de

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Abstract

The ltl package contains a set of macros for type setting operators used in formulas of the linear temporal logic (LTL) in the Manna/P nueli or modern character based notation. This package provides options to switch between characters and symbols as operators. As a backend for the symbols either the ltlfonts by Matteo Slanina or ${\rm Ti}k{\rm Z}$ drawings provided in this package can be used.

1 Introduction

Put text here.

2 Usage

Put text here.

3 Showcase

3.1 Direct Symbol Usage

circle: $\bigcirc x$

circle with minus: $\bigcirc x$ circle with tilde: $\bigcirc x$

^{*}This document corresponds to ltl v0.3, dated 2015/04/03.

```
diamond: \diamondsuit x
diamond with minus: \diamondsuit x
square: \Box x
square with minus: \Box x
```

3.2 Semantic Interface Usage with symbols and without weakindex

```
until: x \mathcal{U} x
weak until: x \mathcal{W} x
release: x \mathcal{R} x
since: x \mathcal{S} x
weak since: x \mathcal{B} x (back: x \mathcal{B} x)
globally: \square x
finally: \Diamond x (eventually: \Diamond x)
next: \bigcirc x
weak next: \overline{\bigcirc} x
previous: \bigcirc x (prev: \bigcirc x)
weak previous: \overline{\bigcirc} x (weak prev: \overline{\bigcirc} x)
trigger: x \mathcal{T} y (past release: x \mathcal{T} y)
past globally: \Box x
past finally: \diamondsuit x (once: \diamondsuit x)
predict: \triangleright x
record: \triangleleft x
stop: stop x
implication: x \to x (imp: x \to x)
equal: x \leftrightarrow x (equ: x \leftrightarrow x)
and: x \wedge x
or: x \vee x
false: false
true: true
not: ¬
```

3.3 Semantic Interface Usage with symbols and with weakindex

```
until: x \mathcal{U} x weak until: x \mathcal{U}_w x release: x \mathcal{R} x since: x \mathcal{S} x weak since: x \mathcal{S}_w x (back: x \mathcal{S}_w x) globally: \square x finally: \diamondsuit x (eventually: \diamondsuit x) next: \bigcirc x weak next: \bigcirc_w x
```

```
previous: \bigcirc x (prev: \bigcirc x) weak previous: \bigcirc_{\mathbf{w}} x (weak prev: \bigcirc_{\mathbf{w}} x) trigger: x \mathcal{T} y (past release: x \mathcal{T} y) past globally: \bigcirc x past finally: \diamondsuit x (once: \diamondsuit x) predict: \triangleright x record: \lhd x stop: stop x implication: x \to x (imp: x \to x) equal: x \leftrightarrow x (equ: x \leftrightarrow x) and: x \land x or: x \lor x false: false true: true not: \neg
```

3.4 Semantic Interface Usage with characters and without weakindex

```
until: x \mathcal{U} x
weak until: x \mathcal{W} x
release: x \mathcal{R} x
since: x S x
weak since: x \mathcal{B} x (back: x \mathcal{B} x)
globally: \mathcal{G} x
finally: \mathcal{F} x (eventually: \mathcal{F} x)
next: \mathcal{X} x
weak next: \overline{\mathcal{X}} x
previous: \mathcal{P} x (prev: \mathcal{P} x)
weak previous: \overline{\mathcal{P}} x (weak prev: \overline{\mathcal{P}} x)
trigger: x \mathcal{T} y (past release: x \mathcal{T} y)
past globally: \mathcal{H} x
past finally: \mathcal{O} x (once: \mathcal{O} x)
predict: \triangleright x
record: \triangleleft x
stop: stop x
implication: x \to x (imp: x \to x)
equal: x \leftrightarrow x (equ: x \leftrightarrow x)
and: x \wedge x
or: x \vee x
false: false
true: true
not: \neg
```

3.5 Semantic Interface Usage with characters and with weakindex

```
until: x \mathcal{U} x
weak until: x \mathcal{U}_{\mathbf{w}} x
release: x \mathcal{R} x
since: x \mathcal{S} x
weak since: x \mathcal{S}_{w} x (back: x \mathcal{S}_{w} x)
globally: \mathcal{G} x
finally: \mathcal{F} x (eventually: \mathcal{F} x)
next: \mathcal{X} x
weak next: \mathcal{X}_{\mathbf{w}} x
previous: \mathcal{P} x (prev: \mathcal{P} x)
weak previous: \mathcal{P}_{\mathbf{w}} x (weak prev: \mathcal{P}_{\mathbf{w}} x)
trigger: x \mathcal{T} y (past release: x \mathcal{T} y)
past globally: \mathcal{H} x
past finally: \mathcal{O} x (once: \mathcal{O} x)
predict: \triangleright x
record: \triangleleft x
stop: stop x
implication: x \to x (imp: x \to x)
equal: x \leftrightarrow x (equ: x \leftrightarrow x)
and: x \wedge x
or: x \vee x
false: false
true: true
not: \neg
```

4 Installing Itlfonts

Itlfonts is a free font developed by Matteo Slanina containing mathematical symbols for typesetting formulas of linear temporal logic (LTL) in the Manna/Pnueli notation.

If ltlfonts is loaded this package will use the symbols of LTLFonts instead of the TikZ drawings provided in this package to define its macros.

ltlfonts can be downloaded from http://theory.stanford.edu/~matteo/ltlfonts/

To use it with TeX, LaTeX and dvips you can just copy all the files from the zip file (ignoring all folders) next to your tex file and run

```
latex yourfile.tex
dvips -u +ltlfonts.map yourfile.tex
```

To use it with PdfTeX or PdfLaTeX you have to install the font into your LaTeX system first. To do so follow these steps:

Find your local TeX tree (texmf-local). In TeX Live and MaxTeX the default is /usr/local/texlive/texmf-local. In MicTeX the default is %APPDATA%\MikTeX\2.9

Copy these files to the given directories:

- fonts/afm/matteo/ltlfonts/ltlfonts.afm
- fonts/map/dvips/matteo/ltlfonts.map
- fonts/tfm/matteo/ltlfonts/ltlfonts.tfm
- fonts/type1/matteo/ltlfonts/ltlfonts.pfb
- fonts/type1/matteo/ltlfonts/ltlfonts.pfm
- tex/latex/ltlfonts/ltlfonts.sty
- tex/latex/ltlfonts/Ultlfonts.fd

After getting your new files into their proper location, you must update the so-called "TeX filename database".

- on MikTeX run initexmf --update-fndb
- on MacTeX run mktexlsr
- on TeXLive run mktexlsr

After recording the new files, the last step is to update so-called "map" files with the information about the new font.

On MikTex run initexmf --edit-config-file updmap. A configuration file gets opened in your default editor. Add the line

```
Map ltlfonts.map
```

(Don't worry if the file is initially empty.)

On TeX Live and MacTeX run

```
updmap-sys --enable Map=ltlfonts.map
```

Itlfonts is now installed and can be used. As a test you can compile this LaTeX code:

```
\documentclass{article}
\usepackage{ltlfonts}
\begin{document}
LTLFonts provides some nice boxes and circles. For example:
\[ \LTLsquare \LTLdiamond \LTLcircle a, \LTLcircleminus \LTLdiamondminus \LTLsquareminus \LTLcircletilde b, \LTLsquaremat \LTLdiamondminushat c \]
\end{document}
```

The ltlfonts package provides a set of LTL symbols. It does not provide any semantically named commands and it does not allow switching to characeter based LTL symbols. It just lets you use the LTL symbols of the LTLFonts font in a LATEX document.

5 Implementation

We start loading some required packages. xkeyval is used to handle the options. amsmath provides operatorname which handles the spacing around the declared operators automatically, amssymb provides some additional symbols some operator macros are based on and TikZ is used to draw the LTL symbols.

```
1 \RequirePackage{xkeyval}
2 \RequirePackage{amsmath}
3 \RequirePackage{amssymb}
4 \RequirePackage{tikz}
```

5.1 TikZ symbol operators

We now define the symbols using TikZ. The macros are named after the macros defined by the LTLFonts package. Every macro is only defined unless it is already defined. This way we use the macros of the LTLFonts package if it is loaded. The $\verb+\tikz+$ command with baseline option is used to create "inline" graphics as this technique called in the manual:

Normally, the lower end of the picture is put on the baseline of the surrounding text. Using this option, you can specify that the picture should be raised or lowered such that the given height is on the baseline.

The value defaults to Opt.

LTLcircle Draws a circle, e.g. for the LTL next operator.

```
5 \ifx\LTLcircle\undefined
6 \DeclareRobustCommand{\LTLcircle}{\operatorname{%}
7 \tikz[baseline,rounded corners=0pt,shorten >=0pt,shorten <=0pt]{
8 \draw[line width=.12ex]
9 (0,.6ex) circle (.8ex);
10 }}}{}</pre>
```

LTLcircleminus Draws a circle with minus in it, e.g. for LTL previous resp. past next operator.

12 \ifx\LTLcircleminus\undefined

```
\tikz[baseline,rounded corners=Opt,shorten >=Opt,shorten <=Opt]{</pre>
                  14
                          \draw[line width=.12ex]
                  15
                            (0,.6ex) circle (.8ex);
                  16
                          \draw[line width=.09ex,line cap=round]
                  17
                  18
                            (-.4ex,.6ex) -- (.4ex,.6ex);
                  19
                        }}}{}
                  20 \fi
 LTLcircletilde
                 Draw a circle with tilde in it, e.g. for LTL weak previous resp weak past next
                  operator.
                  21 \ifx\LTLcircletilde\undefined
                      \DeclareRobustCommand{\LTLcircletilde}{\operatorname{%
                        \tikz[baseline,rounded corners=Opt,shorten >=Opt,shorten <=Opt]{</pre>
                  23
                          \draw[line width=.12ex]
                  ^{24}
                            (0,.6ex) circle (.8ex);
                  25
                          \draw[line width=.09ex,line cap=round,rounded corners=0.2ex]
                  26
                  27
                            (-.4ex, .55ex) -- (-.2ex, .8ex) -- (.2ex, .4ex) -- (.4ex, .65ex);
                  28
                        }}}{}
                  29 \fi
     LTLdiamond Draws diamond, e.g. for the LTL finally resp. eventually operator.
                  30 \ifx\LTLdiamond\undefined
                  31
                      \DeclareRobustCommand{\LTLdiamond}{\operatorname{%
                  32
                        \tikz[baseline,rounded corners=Opt,shorten >=Opt,shorten <=Opt]{</pre>
                          \draw[line width=.12ex,line join=round]
                  33
                            (0ex,.6ex) -- (.95ex,1.55ex) -- (1.9ex,.6ex) -- (.95ex,-.35ex) -- cycle;
                  34
                  35
                        }}}{}
                  36 \fi
LTLdiamondminus
                 Draws a diamond with minus in it, e.g. for the LTL past finally resp. past
                  eventually resp. once operator.
                  37 \ifx\LTLdiamondminus\undefined
                      \DeclareRobustCommand{\LTLdiamondminus}{\operatorname{%
                  38
                        \tikz[baseline,rounded corners=Opt,shorten >=Opt,shorten <=Opt]{
                  39
                          \draw[line width=.12ex,line join=round]
                  40
                            (0ex,.6ex) -- (.95ex,1.55ex) -- (1.9ex,.6ex) -- (.95ex,-.35ex) -- cycle;
                  41
                  42
                          \draw[line width=.09ex,line cap=round]
                  43
                            (.5ex,.6ex) -- (1.3ex,.6ex);
                  44
                        }}}{}
                  45 \fi
      LTLsquare Draws a square, e.g. for the LTL globally operator.
                  46 \ifx\LTLsquare\undefined
                  47 \DeclareRobustCommand{\LTLsquare}{\operatorname{%
```

\DeclareRobustCommand{\LTLcircleminus}{\operatorname{%

13

```
\tikz[baseline,rounded corners=Opt,shorten >=Opt,shorten <=Opt]{
                48
                         \draw[line width=.12ex,line join=round]
                49
                           (0ex,-.2ex) -- (0ex,1.3ex) -- (1.5ex,1.3ex) -- (1.5ex,.-.2ex) -- cycle;
                50
                       }}}{}
                51
                52 \fi
                Draws a square with minus in it, e.g. for the LTL past globally operator.
LTLsquareminus
                53 \ifx\LTLsquareminus\undefined
                    \DeclareRobustCommand{\LTLsquareminus}{\operatorname{%
                       \tikz[baseline,rounded corners=Opt,shorten >=Opt,shorten <=Opt]{
                         \draw[line width=.12ex,line join=round]
                56
                           (0ex, -.2ex) -- (0ex, 1.3ex) -- (1.5ex, 1.3ex) -- (1.5ex, -.2ex) -- cycle;
                57
                         \draw[line width=.09ex,line cap=round]
                58
                           (.35ex,.6ex) -- (1.15ex,.6ex);
                59
                       }}}{}
                60
                61 \fi
                62 \DeclareMathOperator{\LTLcirclew}{\LTLcircle_w}
                63 \DeclareMathOperator{\LTLcircleminusw}{\LTLcircleminus_w}
                64 \DeclareMathOperator{\LTLcircleoverline}{\overline{\LTLcircle}}
                65 \DeclareMathOperator{\LTLcircleminusoverline}{\overline{\LTLcircleminus}}
                5.2
                       Character operators
                66 \newcommand{\ltl@operatorfont@mathcal}[1]{\mathcal{#1}}
                67 \let\ltl@operatorfont\relax
```

```
69 \DeclareMathOperator{\LTLu}{\ltl@operatorfont{U}}}
70 \label{lower} $$70 \end{thmoment} $$10 \e
71 \DeclareMathOperator{\LTLw}{\ltl@operatorfont{W}}}
72 \DeclareMathOperator{\LTLr}{\ltl@operatorfont{R}}}
73 \DeclareMathOperator{\LTLs}{\ltl@operatorfont{S}}
74 \DeclareMathOperator{\LTLsw}{\ltl@operatorfont{S}_w}
75 \DeclareMathOperator{\LTLb}{\ltl@operatorfont{B}}
76 \label{localize} $$76 \end{thmorphisms} $$76 \end{thmorphisms} $$16 \end{thmorphisms} 
77 \DeclareMathOperator{\LTLg}{\ltl@operatorfont{G}}
78 \DeclareMathOperator{\LTLx}{\ltl@operatorfont{X}}
79 \DeclareMathOperator{\LTLxw}{\ltl@operatorfont{X}_w}
80 \DeclareMathOperator{\LTLwx}{\overline{\ltl@operatorfont{X}}}
81 \DeclareMathOperator{\LTLp}{\ltl@operatorfont{P}}
82 \DeclareMathOperator{\LTLpw}{\ltl@operatorfont{P}_w}
83 \DeclareMathOperator{\LTLwp}{\overline{\ltl@operatorfont{P}}}}
84 \DeclareMathOperator{\LTLt}{\ltl@operatorfont{T}}
85 \DeclareMathOperator{\LTLh}{\ltl@operatorfont{H}}}
86 \DeclareMathOperator{\LTLo}{\ltl@operatorfont{0}}
```

5.3 Semantic Macros for LTL Operators

```
87 \let\LTLuntil\LTLu
   88 \let\LTLrelease\LTLr
   89 \let\LTLsince\LTLs
   90 \verb|\lambda| let\LTLtrigger\LTLt
   91 \left\langle LTLpastrelease \right\rangle
   93 \let\LTLweakuntil\relax
   94 \let\LTLweaksince\relax
   95 \left| \text{LTLglobally} \right|
   96 \left| \text{LTLfinally} \right|
   97 \let\LTLnext\relax
   98 \left| \text{LTLweaknext} \right|
   99 \let\LTLprevious\relax
101 \let\LTLpastglobally\relax
102 \verb|\label{loss} 102 \verb|\labe
103
104 \newcommand{\ltl@define}{%
105
                \ifKV@ltl@mathcal%
106
                       \let\ltl@operatorfont\ltl@operatorfont@mathcal
107
                 \else
                       \let\ltl@operatorfont\relax
108
                \fi
109
                 \ifKV@ltl@weakindex%
110
                       \let\LTLweakuntil\LTLuw
111
112
                       \let\LTLweaksince\LTLsw
113
                       \let\LTLweakuntil\LTLw
114
                       \let\LTLweaksince\LTLb
115
                \fi
116
                 \ifKV@ltl@characters%
117
118
                       \let\LTLglobally\LTLg
119
                       \let\LTLfinally\LTLf
                       \let\LTLnext\LTLx
120
121
                       \let\LTLprevious\LTLp
122
                       \ifKV@ltl@weakindex
                              \label{localize} $$ \left( LTLxw \right) $$
123
                              \let\LTLweakprevious\LTLpw
124
125
                       \else
126
                              \let\LTLweaknext\LTLwx
127
                              \let\LTLweakprevious\LTLwp
128
                       \let\LTLpastglobally\LTLh
129
                       \let\LTLpastfinally\LTLo
130
131
                 \else
132
                       \let\LTLglobally\LTLsquare
133
                       \let\LTLfinally\LTLdiamond
                       \let\LTLnext\LTLcircle
134
135
                       \let\LTLprevious\LTLcircleminus
                       \ifKV@ltl@weakindex
136
```

```
\let\LTLweakprevious\LTLcircleminusw
137
         \let\LTLweaknext\LTLcirclew
138
       \else
139
         \let\LTLweakprevious\LTLcircleminusoverline
140
         \let\LTLweaknext\LTLcircleoverline
141
142
143
       \let\LTLpastglobally\LTLsquareminus
       \let\LTLpastfinally\LTLdiamondminus
144
145
     \let\LTLeventually\LTLfinally
146
     \let\LTLprev\LTLprevious
147
     \let\LTLweakprev\LTLweakprevious
148
     \let\LTLonce\LTLpastfinally
     \let\LTLback\LTLweaksince
150
151 }
```

5.4 Option Handling

We now declare the xkeyval boolean keys. The optional parameter true is the default value that gets used if you only specify the key with a value.

```
152 \define@boolkeys{ltl}{characters,mathcal,weakindex}[true]
```

This macro processes the keys and values passed by the user to the class or package.

```
153 \ProcessOptionsX<ltl>
154 \ltl@define
```

ltlsetup

```
155 \newcommand{\ltlsetup}[1]{%
156 \setkeys{ltl}{#1}%
157 \ltl@define%
158}
```

5.5 Further macros

auxilaries

```
159 \DeclareMathOperator{\LTLpredict}{\rhd}
160 \DeclareMathOperator{\LTLrecord}{\lhd}
161 \DeclareMathOperator{\LTLstop}{stop}
162 \DeclareMathOperator{\LTLimplication}{\rightarrow}
163 \DeclareMathOperator{\LTLequivalent}{\leftrightarrow}
164 \DeclareMathOperator{\LTLand}{\wedge}
165 \DeclareMathOperator{\LTLor}{\vee}
166 \DeclareMathOperator{\LTLtor}{false}
167 \DeclareMathOperator{\LTLtrue}{true}
```

168 \DeclareMathOperator{\LTLnot}{\neg} 169 \let\LTLimp\LTLimplication 170 \let\LTLequ\LTLequivalent

Change History

v0.1		v0.2				
		General: M	lacro	collection	trans-	
General: Initial version	 1	formed i	nto a	IAT _F X pack	age	

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