

# The luaotfload package

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## Abstract

This package is an adaptation of the ConT<sub>E</sub>Xt font loading system, providing the ability to load OpenType fonts with extended font loading syntax supporting a large selection of OpenType font features.

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# 1 Introduction

Font management and installation has always been painful with  $\TeX$ . A lot of files are needed for one font (tfm, pfb, map, fd, vf), and as  $\TeX$  is 8-bit each font is limited to 256 characters. But the font world has evolved since  $\TeX$ , and new font technologies have appeared, most notably the so called *smart font* technologies like OpenType fonts. These fonts can contain a lot of characters, and additional functionalities like ligatures, old-style numbers, small capitals, etc., and support more complex writing systems like Arabic and Indic<sup>1</sup> scripts. They are widely deployed and available for all modern operating systems and are becoming the de facto standard fonts for advanced text layout. Until now the only way to use them directly in the  $\TeX$  world was by using them with  $\XeTeX$ .

Unlike  $\XeTeX$ , Lua $\TeX$  does not provide direct support for using these fonts by default, but it provides a way to hook Lua code in some points of the  $\TeX$  processing; for instance, we can improve the font loading system, and text procession, which what this package is about.

## 2 Loading fonts

luaotfload supports an extended font loading syntax which looks like:

$\backslash\text{font}\backslash\text{foo}=\{\langle\text{prefix}\rangle:\langle\text{font name}\rangle:\langle\text{font features}\rangle\}\langle\text{TeX font features}\rangle$

The curly brackets are optional and are used for escaping spaces in font names (double quotes can also be used for the same purpose).

**Prefix** The  $\langle\text{prefix}\rangle$  be either `file:` or `name:`, which specify whether to use a select the font from its filename or font name, respectively. If no prefix is specified, then `file:` is assumed.

For compatibility with  $\XeTeX$ , surrounding the  $\langle\text{font name}\rangle$  with square brackets is synonymous to using the `file:` prefix.

Accessing fonts by fontname allows loading system installed fonts as well as TEXMF ones, and requires a font names database; see Section 3 for more information.

**Font name** The  $\langle\text{font name}\rangle$  can be either a font filename or actual font name based on the  $\langle\text{prefix}\rangle$  as mentioned above.

Fonts loaded by filename may either include their absolute path in the filesystem or consist of just the filename with a path. If no path is specified then `kpathsea` is used to locate the font (which will typically be in the TEXMF tree or the current directory).

For example,

---

<sup>1</sup>Unfortunately, luaotfload doesn't support Indic scripts right now

```

\font\1={file:ec-lmr10} at 10pt
\font\2={/Users/Shared/Fonts/aldus.otf} at 11pt
\font\3={name:TeX Gyre Pagella} at 9pt

```

**Font features**  $\langle font\ features \rangle$  are a list of items separated by semi-colons, which are either key=value font parameters, or switches to enable/disable certain font features in the form of +feat/-feat. The supported keys are:

#### mode

luaotfload has two OpenType processing modes; base or node. Using mode=base only supports a subset of OpenType features and works by mapping those features to traditional  $\TeX$  ligature and kerning mechanisms and is a bit faster. Using mode=node hopefully supports OpenType fully and works by direct processing of the node list with Lua; it is slower and is not designed to work in math mode.

By default mode=base is used, but it is advisable to always enable node mode, except for math fonts, otherwise many OpenType features will not function properly or even not work at all, especially for advanced scripts like Arabic.

#### script

OpenType script string, default value is dflt. Some fonts don't assign features to the dflt script, in which case the script needs to be set explicitly.

#### language

OpenType language string, default value is latn.

#### featurefile

feature files are textual representation of OpenType tables and can be used to extend OpenType features of the font on fly. The file name of the feature file is passed, then features defined in the file can be enabled/disabled like any other feature. The actual syntax is described at <http://fontforge.sourceforge.net/featurefile.html> and [http://www.adobe.com/devnet/opentype/afdko/topic\\_feature\\_file\\_syntax.html](http://www.adobe.com/devnet/opentype/afdko/topic_feature_file_syntax.html).

For example, to set a tkrn feature from mykern.fea file:

```
\font\lmr=Latin Modern Roman:featurefile=mykern.fea;+tkrn
```

#### color

font color, defined as a triplet of two-digit hexadecimal RGB values, with optionally another value for the transparency (where 00 is completely transparent and FF is opaque.)

For example, to set text in semitransparent red:

```
\font\lmr=Latin Modern Roman:color=FF0000BB
```

### protrusion & expansion

Both keys control microtypographic features of the font, namely glyph protrusion and expansion. The value of the key is the name of predefined Lua tables of protrusion and expansion values; see the end of `otfl-font-dum.lua` file for an example of such tables. The only predefined value is `default`.

For example, to enable default protrusion<sup>2</sup>:

```
\font\lmr=Latin Modern Roman:protrusion=default
```

**Non-standard font features** `luaotfload` defines some additional font feature not defined in OpenType, currently three features are defined:

- `anum`: replaces European numbers with eastern Arabic numbers or Persian numbers, depending on the value of `language`.
- `tlig`: applies legacy  $\TeX$  ligatures (`'''-- -- !' ?' <>>`).
- `trep`: applies legacy  $\TeX$  replacements (`'"`).

(For  $\text{\XeTeX}$  users: these last two are the equivalent of writing `mapping=text-tex` using  $\text{\XeTeX}$ 's input remapping feature.)

## 3 Font names database

As introduced in the previous section, `luaotfload` uses a database to keep track of fonts available to  $\text{\LuaTeX}$ . Using this database, fonts can be loaded by font name as well as filename.

When `luaotfload` is asked to load a font by font name, it will check if font names database exists and load it, or generate a new database if non exists. This is all done automatically without user intervention. When the asked font is missing from the database, it will attempt to update the database and try to find the font again, so that the user can install new fonts without worrying about manually updating the database.

However, it is sometimes desirable to update the database manually, so `luaotfload` provides a `mkluatexfontdb` utility to manually update the database. `mkluatexfontdb` is a lua script that can be either run directly or as an argument to `texlua`, depending on your system<sup>3</sup>.

The first time the database is generated may take quite some time to process every font on your computer. This is particularly noticeable if it occurs during a typesetting run. Subsequent runs to update the database will be quite fast, however.

`luaotfload` will parse standard places for fonts in your system to build the font database. On Linux, it will read `fontconfig` configuration files to find the font

---

<sup>2</sup>You also need to set `\pdfprotrudechars2` `\pdfadjustspacing2` to activate protrusion and expansion, respectively. See  $\text{\PDFTeX}$  manual for details

<sup>3</sup>On MS Windows it can be run either by calling the wrapper application `mkluatexfontdb.exe` or with `texlua.exe mkluatexfontdb.lua`

locations; on Windows and Mac OS X, it will search in the standard font locations, %WINDIR%\Fonts in Windows and ~/Library/Fonts, /Library/Fonts, /System/Library/Fonts, and /Network/Library/Fonts in Mac OS X.

If you do not wish the standard font locations be searched by default but would rather specify the exact locations in which to find your fonts, set the OSFONTDIR environment variable instead. When this variable is set, only the specified directories will be searched.

`mkluatexfontdb.lua --help` provides a brief summary of the functionality of the script and includes some advanced options that we have not mentioned here.

### 3.1 Blacklisting fonts

Some fonts are problematic in Lua<sub>T</sub><sub>E</sub>X, if you found that your document takes too long to compile, or eats all the free memory, you can find the culprit file by running `mkluatexfontdb` utility with `-v` option to see which font file it is stuck with. You can then instruct `luaotfload` to ignore this font by adding it to the blacklist configuration file.

Simply, create a file named `otfl-blacklist.cnf` and added the to be black-listed files, one per line. Then put the file some where `kpse` can find. You can either use the base name or the full path. Any thing after a `%` sign is ignored.

## 4 Required Con<sub>T</sub><sub>E</sub>Xt files

This package is a wrapper for several files taken from the Con<sub>T</sub><sub>E</sub>Xt macro package. The philosophy is to let Con<sub>T</sub><sub>E</sub>Xt do all the implementation and update these files from time to time. To do so we did not modify the files taken from Con<sub>T</sub><sub>E</sub>Xt, we only changed their names to prevent name clashes. You can thus update the font system of this package simply by updating the files taken from Con<sub>T</sub><sub>E</sub>Xt, without (theoretically) changing the `.sty` file nor the main `.lua` file.

The Con<sub>T</sub><sub>E</sub>Xt files are renamed by adding the prefix `otfl-` to them (`otfl` as OTF Load). The files are:

- |                             |                             |                             |
|-----------------------------|-----------------------------|-----------------------------|
| • <code>luat-dum.lua</code> | • <code>font-ott.lua</code> | • <code>font-otc.lua</code> |
| • <code>data-con.lua</code> | • <code>font-otf.lua</code> | • <code>font-def.lua</code> |
| • <code>node-inj.lua</code> | • <code>font-otd.lua</code> | • <code>font-xtx.lua</code> |
| • <code>node-dum.lua</code> | • <code>font-oti.lua</code> | • <code>font-map.lua</code> |
| • <code>font-ini.lua</code> | • <code>font-otb.lua</code> | • <code>font-dum.lua</code> |
| • <code>font-tfm.lua</code> | • <code>font-otn.lua</code> |                             |
| • <code>font-cid.lua</code> | • <code>font-ota.lua</code> |                             |

The following files have been written for this package:

- font-clr.lua
- font-nms.lua
- luat-ovr.lua

## 5 Troubleshooting

If you encounter problems with some fonts, please first update to the latest version of this package before reporting a bug, as this package is under active development.

A very common problem is the lack of features for some OpenType fonts even when specified. It can be related to the fact that some fonts do not provide features for the `df1t` script, which is the default one in this package, so you may have to specify the script in the command line, for example:

```
\font\myfont = MyFont.otf:script=latn;+liga;
```

Also remember to set `mode=node` as most OpenType features (such as contextual substitution, `calt`), will not work without it.

## File I

### luaotfload.lua

First some usual initializations.

```
1 module('luaotfload', package.seeall)
2
3 luaotfload.module = {
4   name      = "luaotfload",
5   version   = 1.20,
6   date      = "2010/10/16",
7   description = "OpenType layout system.",
8   author    = "Elie Roux & Hans Hagen",
9   copyright  = "Elie Roux",
10  license    = "CC0"
11 }
12
13 luatexbase.provides_module(luaotfload.module)
14
```

This is a necessary initialization in order not to rebuild an existing font. Maybe 600 should be replaced by `\pdfpkresolution` or `texconfig.pk_dpi` (and it should be replaced dynamically), but we don't have access (yet) to the `texconfig` table, so we let it be 600. Anyway, it does still work fine even if `\pdfpkresolution` is changed.

```
15
16 kpse.init_prog('', 600, '/')
17
```

Some helper functions.

```

18
19 local format = string.format
20
21 local function log(...)
22     luatexbase.module_log    ('luaotfload', format(...))
23 end
24
25 local function error(...)
26     luatexbase.module_error  ('luaotfload', format(...))
27 end
28
29 local function warning(...)
30     luatexbase.module_warning('luaotfload', format(...))
31 end
32

```

The minimal required Lua<sub>T</sub><sub>E</sub>X version.

```

33
34 local luatex_version = 60
35
36 if tex.luatexversion < luatex_version then
37     warning('LuaTeX v%.2f is old, v%.2f is recommended.',
38             tex.luatexversion/100,
39             luatex_version   /100)
40 end
41

```

## 5.1 Module loading

We load the Con<sub>T</sub><sub>E</sub>Xt files with this function. It automatically adds the `otfl-` prefix to it, so that we call it with the actual Con<sub>T</sub><sub>E</sub>Xt name.

```

42
43 function luaotfload.loadmodule(name)
44     local tofind = 'otfl-'..name
45     local found = kpse.find_file(tofind,"tex")
46     if found then
47         log('loading file %s.', found)
48         dofile(found)
49     else
50         error('file %s not found.', tofind)
51     end
52 end
53

```

We start loading some lua files. These two are some code not used by Con<sub>T</sub><sub>E</sub>Xt at all that allow other modules to be used, it provides some low-level Con<sub>T</sub><sub>E</sub>Xt functions.

```

54
55 luaotfload.loadmodule('luat-dum.lua') -- not used in context at all

```

```

56 luaotfload.loadmodule('luat-ovr.lua') -- override some luat-dum functions
57 luaotfload.loadmodule('data-con.lua') -- maybe some day we don't need this one
58

```

A hack to remove a warning from node-dum.lua as it is ConT<sub>E</sub>Xt specific.

```

59
60 tex.attribute[0] = 0
61

```

Node support modules.

```

62
63 luaotfload.loadmodule('font-ini.lua')
64 luaotfload.loadmodule('node-dum.lua')
65 luaotfload.loadmodule('node-inj.lua')
66

```

By default ConT<sub>E</sub>Xt takes some private attributes for internal use. To avoid attribute clashes with other packages, we override the function that allocates new attributes, making it a wrapper around `luatexbase.new_attribute()`. We also prefix attributes with `otfl@` to avoid possible name clashes.

```

67
68 function attributes.private(name)
69     local attr = 'otfl@' .. name
70     local number = luatexbase.attributes[attr]
71     if not number then
72         number = luatexbase.new_attribute(attr)
73     end
74     return number
75 end
76

```

Font handling modules.

```

77
78 luaotfload.loadmodule('font-tfm.lua')
79 luaotfload.loadmodule('font-cid.lua')
80 luaotfload.loadmodule('font-ott.lua')
81 luaotfload.loadmodule('font-map.lua')
82 luaotfload.loadmodule('font-otf.lua')
83 luaotfload.loadmodule('font-otd.lua')
84 luaotfload.loadmodule('font-oti.lua')
85 luaotfload.loadmodule('font-otb.lua')
86 luaotfload.loadmodule('font-otn.lua')
87 luaotfload.loadmodule('font-ota.lua')
88 luaotfload.loadmodule('font-otc.lua')
89 luaotfload.loadmodule('font-def.lua')
90 luaotfload.loadmodule('font-xtx.lua')
91 luaotfload.loadmodule('font-dum.lua')
92

```



This is a patch for `otfl-font-def.lua`, that defines a reader for ofm fonts, this is necessary if we set the forced field of the specification to ofm, we use it only when using `luaotfload`, not `mkluatexfontdb`.

```

93
94 if fonts and fonts.tfm and fonts.tfm.readers then
95     fonts.tfm.readers.ofm = fonts.tfm.readers.tfm
96 end
97

```

luaotfload specific modules.

```

98
99 luaotfload.loadmodule('font-nms.lua')
100 luaotfload.loadmodule('font-clr.lua')
101

```

## 5.2 Post-processing TFM table

Here we do some final touches to the loaded TFM table before passing it to the  $\TeX$  end.

```

102 local function def_font(...)
103     local fontdata = fonts.define.read(...)
104     if type(fontdata) == "table" and fontdata.shared then

```

First, we add some code to emulate  $\text{\TeX}$ 's `\fontdimen8`, which stores the caps-height of the font. (Cf. `\fontdimen5` which stores the x-height.)

Falls back to measuring the glyph if the font doesn't contain the necessary information. This needs to be extended for fonts that don't contain an 'X'.

```

105         local capheight
106         local units      = fontdata.units
107         local size        = fontdata.size
108         local otfddata    = fontdata.shared.otfddata
109
110         if otfddata.pfminfo.os2_capheight > 0 then
111             capheight = otfddata.pfminfo.os2_capheight / units * size
112         else
113             if fontdata.characters[string.byte("X")] then
114                 capheight = fontdata.characters[string.byte("X")].height
115             else
116                 capheight = otfddata.metadata.ascent / units * size
117             end
118         end
119         fontdata.parameters[8] = capheight

```

Then we populate `MathConstants` table, which is required for OpenType math.

```

120         if otfddata.metadata.math then
121             local mc = { }
122             for k,v in next, otfddata.metadata.math do
123                 if k:find("Percent") then

```

```

124             -- keep percent values as is
125             mc[k] = v
126         else
127             mc[k] = v / units * size
128         end
129     end
130     -- for \overwithdelims
131     mc["FractionDelimiterSize"] = 1.01 * size
132     mc["FractionDelimiterDisplayStyleSize"] = 2.39 * size
133
134     fontdata.MathConstants = mc
135 end
136
137 end
138 return fontdata
139 end

```

### 5.3 ConT<sub>E</sub>Xt override

Here we override some defaults set in ConT<sub>E</sub>Xt code.

```

140
141 fonts.mode = "node"
142

```

The following features are useful in math (e.g. in XITS Math font), but luaotfload does not recognize them in base mode.

```

143
144 local register_base_sub = fonts.otf.features.register_base_substitution
145 local gsubs = {
146     "ss01", "ss02", "ss03", "ss04", "ss05",
147     "ss06", "ss07", "ss08", "ss09", "ss10",
148     "ss11", "ss12", "ss13", "ss14", "ss15",
149     "ss16", "ss17", "ss18", "ss19", "ss20",
150 }
151
152 for _,v in next, gsubs do
153     register_base_sub(v)
154 end
155

```

Finally two functions

```

156
157 function luaotfload.register_callbacks()
158     luatexbase.add_to_callback('pre_linebreak_filter',
159                             nodes.simple_font_handler,
160                             'luaotfload.pre_linebreak_filter')
161     luatexbase.add_to_callback('hpack_filter',
162                             nodes.simple_font_handler,
163                             'luaotfload.hpack_filter')

```

```

164     luatexbase.reset_callback('define_font')
165     luatexbase.add_to_callback('define_font',
166                               def_font,
167                               'luaotfload.define_font', 1)
168     luatexbase.add_to_callback('find_vf_file',
169                               fonts.vf.find,
170                               'luaotfload.find_vf_file')
171 end
172
173 function luaotfload.unregister_callbacks()
174     luatexbase.remove_from_callback('pre_linebreak_filter',
175                                     'luaotfload.pre_linebreak_filter')
176     luatexbase.remove_from_callback('hpack_filter',
177                                     'luaotfload.hpack_filter')
178     luatexbase.remove_from_callback('define_font',
179                                     'luaotfload.define_font')
180     luatexbase.remove_from_callback('find_vf_file',
181                                     'luaotfload.find_vf_file')
182 end

```

## File II

# luaotfload.sty

Classical Plain+ $\TeX$  package initialization.

```

1 \csname ifluaotfloadloaded\endcsname
2 \let\ifluaotfloadloaded\endinput
3
4 \bgroup\expandafter\expandafter\expandafter\egroup
5 \expandafter\ifx\csname ProvidesPackage\endcsname\relax
6   \input luatextra.sty
7 \else
8   \NeedsTeXFormat{LaTeX2e}
9   \ProvidesPackage{luaotfload}%
10    [2010/10/16 v1.20 OpenType layout system]
11   \RequirePackage{luatextra}
12 \fi
13
14 \expandafter\edef\csname otfl@AtEnd\endcsname{%
15   \catcode64 \the\catcode64\relax
16 }
17
18 \catcode64 11
19

```

Two small macros to register or unregister the callbacks. Without the callbacks this package is totally turned off.

```

20
21 \def\otfl@off{
22 \directlua{luaotfload.unregister_callbacks()}
23 }
24
25 \def\otfl@on{
26 \directlua{luaotfload.register_callbacks()}
27 }
28

```

We load the lua file, and we turn the package on.

```

29
30 \luatexUseModule{luaotfload}
31
32 \otfl@on
33
34 \otfl@AtEnd

```

# 6 The GNU GPL License v2

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**END OF TERMS AND CONDITIONS**

**Appendix: How to Apply These Terms to Your New Programs**

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